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1.0 PROJECT OBJECTIVES

The project objective is to design and construct facilities for the military that are consistent with the design and construction practices used for civilian sector projects that perform similar functions to the military projects. For example, a Company Operations Facility has the similar function as an office/warehouse in the civilian sector; therefore the design and construction practices for a company operations facility should be consistent with the design and construction of an office/warehouse building.

Comparison of Military Facilities to Civilian Facilities

Military Facility	Civilian Facility
Warriors in Transition Unit Administration Services (WTUAS)	Office Building
Soldier & Family Assistance Center (SFAC)	Community Center

***Not included in this contract**

It is the Army's objective that these buildings will have a 25-year useful design life before a possible re-use/re-purpose or renovation requirement, to include normal sustainment, restoration, modernization activities and a 50-year building replacement life. Therefore, the design and construction should provide an appropriate level of quality to ensure the continued use of the facility over that time period with the application of reasonable preventive maintenance and repairs that would be industry-acceptable to a major civilian sector project OWNER. The site infrastructure will have at least a 50-year life expectancy with industry-accepted maintenance and repair cycles.

The project site should be developed for efficiency and to convey a sense of unity or connectivity with the adjacent buildings and with the Installation as a whole.

Requirements stated in this contract are minimums. Innovative, creative, and life cycle cost effective solutions, which meet or exceed these requirements are encouraged. Further, the OFFEROR is encouraged to seek solutions that will expedite construction (panelization, pre-engineered, etc.) and shorten the schedule. **The intent of the Government is to emphasize the placement of funds into functional/operational requirements. Materials and methods should reflect this by choosing the lowest Type of Construction allowed by code for this occupancy/project allowing the funding to be reflected in the quality of interior/exterior finishes and systems selected.**

1.1. SECTION ORGANIZATION

This Section is organized under 6 major “paragraphs”.

(1) Paragraph 1 is intended to define the project objectives and to provide a comparison between the military facility(ies) and comparable “civilian” type buildings.

(2) Paragraph 2 describes the scope of the project.

(3) Paragraph 3 provides the functional, operational and facility specific design criteria for the specific facility type(s) included in this contract or task order.

(4) Paragraph 4 lists applicable industry and government design criteria, generally applicable to all facility types, unless otherwise indicated in the Section. It is not intended to be all-inclusive. Other industry and government standards may also be used, where necessary to produce professional designs, unless they conflict with those listed.

(5) Paragraph 5 contains Army Standard Design Criteria, generally applicable to all facility types, unless otherwise indicated in the Section.

(6) Paragraph 6 contains installation and project specific criteria supplementing the other 5 paragraphs.

2.0 SCOPE

2.1. WARRIORS IN TRANSITION (WT) COMPLEX

The facility floor plans for the Warriors in Transition (WT) facilities are provided in Appendix J. These drawings indicate functional and operational arrangements that meet the user's requirements. The Design/Build (D/B) contractor is required to follow these mandatory designs. Minor plan alterations are permitted to accommodate building system requirements. However, the Minimum Area Requirements shall not be reduced in order to accommodate building system requirements.

Minor plan alterations, not more than eight (8) inches, are permitted only when necessary to accommodate building system requirements. However, the Minimum Area Requirements identified in Chapter 3 shall not be reduced in order to accommodate building system requirements. Office locations shown on the facility floor plans included in this RFP shall not be altered or relocated as they meet the mandatory adjacency requirements.

2.1.1. NOT USED

2.1.2. WTUAS

Provide a standard WTUAS consisting of:

Super-COF at 16,600 gross square feet

2.1.3. SFAC

Provide a standard Small SFAC. This facility type is to provide various services to soldiers and their family while the soldier is undergoing medical treatment. The facility will also serve as a social gathering place for scheduled activities.

The maximum gross area for the SFAC is 7,000

2.1.4. NOT USED

2.2. SITE:

Appendix J includes a conceptual site plan.

The blank site plan provides the limits of construction for the approved site.

Other concept site plans provide possible facility arrangement, orientation as well as site features and amenities. These plans are included as design development proposals and may have conflicting information. The D/B Contractor may utilize any of the included site plans in order to develop their proposal. However, it is the responsibility of the D/B Contractor to ensure their proposed site plan is in accordance with required functional, operational and building requirements as stated in the Request for Proposal (RFP) for this project. If a conflict exists between any of the concept site plans and the technical requirements of the RFP, the RFP technical requirements shall govern.

The included building renderings and elevations describe the required architectural theme for the WT facilities. These drawings are provided to convey the Government's desired architectural theme that is contextually compatible with the installation's requirements.

Provide all site improvements necessary to support the new building facilities. Refer to Paragraph 6 for additional information.

Include Antiterrorism/Force Protection measures in the facility design in accordance with applicable criteria. The Contractor shall be responsible for all repairs to existing sidewalks, pavements, curb and gutter, utilities, and/or landscaping damaged as a result of his construction activities.

Approximate area available 3.15 acres in the limits of construction, as shown on the site layout plan. Refer to Appendix J - Drawings.

2.3. GOVERNMENT-FURNISHED GOVERNMENT-INSTALLED EQUIPMENT (GFGI)

Coordinate with Government on GFGI item requirements and provide suitable structural support, brackets for projectors/VCRs/TVs, all utility connections and space with required clearances for all GFGI items. Fire extinguishers are GF/GI personal property, while fire extinguisher brackets and cabinets are Contractor furnished and installed CF/CI. Include tables/cabinets/carts/etc. for GFGI equipment that is not freestanding in furniture design. All Computers and related hardware, copiers, faxes, printers, video projectors, VCRs and TVs microwave ovens, electric ranges, refrigerators, washers, dryers, and fire extinguishers are GFGI.

The following are also GFGI items: [Not Supplied - FacilityAddREq : GFGI_ITEMS]

- Vending Machines
- Dumpsters

2.4. FURNITURE REQUIREMENTS

Provide furniture design for all spaces listed in Chapter 3 and including any existing furniture and equipment to be re-used. Coordinate with the user to define requirements for furniture systems, movable furniture, storage systems, equipment, any existing items to be reused, etc. Early coordination of furniture design is required for a complete and usable facility.

The procurement and installation of furniture is NOT included in this contract. Furniture will be provided and installed under a separate furniture vendor/installer contract. The general contractor shall accommodate that effort with allowance for entry of the furniture vendor/installer onto this project site at the appropriate time to permit completion of the furniture installation for a complete and usable facility to coincide with the Beneficial Occupancy Date (BOD) of this project. The furniture vendor/installer contract will include all electrical pre-wiring and the whips for final connection to the building electrical systems however; the general contractor shall make the final connections to the building electrical systems under this contract. Furthermore, the general contractor shall provide all Information/Technology (IT) wiring (i.e. LAN, phone, etc.) up to and including the face plate of all freestanding and/or systems furniture desk tops as applicable, the services to install the cable and face plates in the furniture,

the coordination with the furniture vendor/installer to accomplish the installation at the appropriate time, and all the final IT connections to the building systems under this contract.

The Government reserves the right to change the method for procurement of and installation of furniture to Contractor Furnished/Contractor Installed (CF/CI). CF/CI furniture will require competitive open market procurement by the Contractor using the Furniture, Fixtures and Equipment (FF&E) package.

2.5. NOT USED

3.0 WARRIORS IN TRANSITION COMPLEX (WT)

3.1. General

WT Complexes are required by the Army to encompass living, training, social interaction and administrative/command operations. This Request for Proposal includes the following facilities in the WT Complex: WTUAS, SFAC, . These facilities with outdoor areas and any additional support facilities shall be arranged on the site as a unit to allow injured or temporarily disabled soldiers to live, eat, train, and work together.

WTUAS are comprised of administration, command operations, special functions, storage and other support areas.

SFAC is a community building for social interaction and special assistance to the soldiers and their families.

3.2. FUNCTIONAL AND AREA REQUIREMENTS

Gross building area shall be calculated in accordance with Appendix Q. Net area is measured to the inside face of the room or space walls. Minimum dimension where stated shall be measured to the inside face of the defining enclosure. Net area requirements for programmed spaces are included in this paragraph. If net area requirements are not specified, the space shall be sized to accommodate the required function and to comply with code requirements, overall gross area limitations, and any other requirement of this RFP. Area requirements for corridors, stairs, electrical rooms, and mechanical rooms will typically be left to the discretion of the offeror but shall be counted in the general authorized gross square footage for each facility. Coordinate column spacing and layout with the building's floor plan so that columns occur within or in alignment with walls where they may be concealed as much as possible. Hold columns occurring within spaces to a minimum and limit them to larger public spaces. Plan column placement such that they do not interfere with the functionality of the space.

3.2.1. ACCESSIBILITY REQUIREMENTS

General Requirements: All buildings in the WT Complex shall be accessible and shall comply with the Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities as currently amended.

"Compliant" Apartment: The Army Standard for WT Complexes requires a minimum of 10% of apartments, based on the total number of apartments constructed, to be fully compliant with the Accessibility Guidelines set forth in the ABA as currently amended.

"Adaptable" Apartment: The Army Standard for WT Complexes requires that 100% of apartments constructed be connected to the building entrance via an accessible route and shall be designed and constructed in such a manner that all contain the following features of adaptable design: (A) An accessible route into and through the apartment; (B) Light switches, electrical outlets, thermostats, and other environmental controls be placed in accessible locations; (C) Reinforcements in bathroom walls to allow later installation of grab bars around the toilet, tub, shower, stall and shower seat where such facilities are provided; and (D) Kitchens and bathrooms such that an individual in a wheelchair can maneuver about the space. Adaptable Design features shall be designed in compliance with the ABA Accessibility Guidelines as currently amended.

Elevators: The Army Standard for WT Complexes requires that an elevator be provided for any building which exceeds one-story (1-Story). The elevator system shall fully comply with ASME A17.1 and ASME A17.2.1 in their entirety, as well as any additional requirements specified herein. Primary elevators shall be centrally located within the facility and shall have a minimum rated load capacity of 3,500 lb (1588 kg), with center opening doors and interior dimensions sized to accommodate a fully extended Emergency Medical Services (EMS) gurney, approximately 24 inches wide by 77 inches long, and four average sized adults. An additional elevator, meeting all specifications outlined above, shall be provided for every additional one-hundred (100) persons, or fraction thereof over the first one-hundred (100) persons the building is designed to accommodate, unless determined otherwise by a foot-traffic analysis. Such foot-traffic analysis shall be included in the general facility Design Analysis. All elevator interior walls, doors, and fixtures shall have a Satin No. 4 Stainless Steel Finish. All elevators shall be furnished with removable hanging protective pads and fixed hooks to facilitate conversion to use for moving freight.

Elevator Machinery Spaces: Elevator pits, penthouses, and other such elevator equipment spaces are exempt from accessibility requirements in accordance with ABA Section F203.6.

Certified Elevator Inspector: The Elevator Inspector shall be certified in accordance with the requirements of ASME A17.1 and ASME QEI-1 and licensed as a Certified Elevator Inspector by the State where the project is constructed. The Certified Elevator Inspector shall inspect the installation of the elevator(s) to assure that the installation conforms to all contract requirements. The Certified Elevator Inspector shall be directly employed by the Prime Contractor and shall be independent of the Elevator System Manufacturer and the Elevator System Installer.

3.2.2. Not Used

3.2.3. CoHQ (Note: Not all offices are included on every building size. See 3.2.3.2 Space Allocation Table).

3.2.3.1. Functional Space Requirements

(a) Commander: Provide a private administrative office.

(b) Executive Officer: Provide a private administrative office.

(c) Supervisory Case Manager: Provide a private administrative office.

(d) Nurse Case Manager: Provide a private administrative office.

(e) Case Manager: Provide a private administrative office.

(f) First Sergeant: Provide a private administrative office.

(g) Platoon Sergeant: Provide a private administrative office.

(h) Squad Leader: Provide a private administrative office.

(i) Social Worker: Provide a private administrative office.

(j) Extra Office: Provide a private administrative office.

(k) Conference Room: Self Explanatory.

(l) Supply Room: Provide room for miscellaneous administrative supplies.

(m) Records Room: Provide room for administrative records storage.

(n) Reception/Waiting Room: Provide a vestibule between the exterior and the reception/waiting room. Provide a minimum of 7 feet clearance between doors. Provide a means for the doors to open automatically via a sensor or push button. Provide a reception station consisting of a built-in reception counter for each company (shall be combined in a multi-company setting). Reception counter shall be capable of serving both able and disabled personnel.

(o) Distribution Center: Provide room for administration personnel to provide support service for the distribution of materials.

(p) Copier and Fax Room: Self explanatory.

(q) Interior Corridors: Provide 6 feet minimum wide corridors.

(r) Men's Restrooms: Provide toilet facilities and one shower stall to serve the public and administrative personnel assigned to the building. Provide a dressing area with a built-in 18 in. bench adjacent to the shower stall. Showers will only be provided in staff restrooms in those buildings where public and staff restrooms are separated.

(s) Women's Restrooms: Provide toilet facilities and one shower stall to serve the public and administrative personnel assigned to the building. Provide a dressing area with a built-in 18 in. bench adjacent to the shower stall. Showers will only be provided in staff restrooms in those buildings where public and staff restrooms are separated.

(t) Janitor Closet: Provide with a 10 in. deep floor mounted stainless steel mop sink with hot and cold service faucet, a four holder mop rack, and two 18 in. deep by 48 in. long heavy duty stainless steel shelves for storage of cleaning supplies. Provide space for storage of buckets and a vacuum.

(u) Open Office Space: Provide space for multiple cubicles for administrative personnel. See 3.2.3.2 Allocation Table for requirements.

(v) Kitchenette: Provide a countertop with both lower and upper storage cabinets (including shelves) with a double sink. Provide space for a microwave oven. Provide space for a full size refrigerator 28 in. wide. Provide seating space for a minimum of two 36 in. x 36 in. (or 36 in. diameter) tables with four chairs each and space for two vending machines.

(w) Mechanical, Electrical, and Telecommunications Rooms: Mechanical rooms shall accommodate space for equipment maintenance/repair access without having to remove other equipment. Mechanical, electrical and telecommunications rooms shall be keyed separately for access by Installation maintenance personnel. First floor exterior access is required for centralized mechanical room. Refer to paragraphs 3.6 MECHANICAL REQUIREMENTS and 3.7 ELECTRICAL AND TELECOMMUNICATIONS REQUIREMENTS for additional information.

3.2.3.2. Space Allocation Table

CoHQ MINIMUM AREA REQUIREMENTS NET SQ FT (NSF) PER ROOM								
NAME	X-Small[2]		Small[2]		Medium[2]		Large[2]	
	Ea	Area	Ea	Area	Ea	Area	Ea	Area
COMMANDER	1	120	1	120	1	120	1	120
EXECUTIVE OFFICER	NR		NR		1	120	1	120
SUPERVISORY CASE MGR	NR		NR		1	120	1	120
CASE MANAGER	1	120	1	120	2	120	4	120
FIRST SERGEANT	1	120	1	120	1	120	1	120
PLATOON SERGEANT	2	120	2	120	3	120	3	120
SQUAD LEADER	3	140	4	140	6	140	6	140
SOCIAL WORKER	1	120	1	120	NR		NR	
NURSE CASE MANAGER	2	120	3	120	4	120	8	120
EXTRA OFFICE	NR		2	120	NR		NR	
MEDICAL NCO - See Note 1	1	48	1	48	NR		1	48
TRAINING SPECIALIST- See Note 1	1	48	2	48	2	48	2	48
OCCUPATIONAL THERAPY ASST- See Note 1	1	48	1	48	1	48	1	48
FINANCIAL TECH SPEC - See Note 1	1	48	2	48	1	48	2	48
MEDICAL SUPPORT ASST- See Note 1	1	48	2	48	1	48	2	48
SUPPLY TECHNICIAN - See Note 1	1	48	1	48	2	48	1	48
HR SPECIALIST- See Note 1	1	48	2	48	1	48	2	48
HR ASSISTANT- See Note 1	NR		NR		3	48	NR	
FAMILY READINESS SUPPORT ASST- See Note 1	1	48	1	48	1	48	1	48
COPIER & FAX	1	96	1	96	1	96	1	96
KITCHENNETTE	1	100	1	100	1	100	1	100
RECORDS ROOM	1	100	1	100	1	100	1	100
DISTRIBUTION CENTER	1	110	1	110	1	110	1	110
CONFERENCE ROOM	1	255	1	255	1	255	1	255
SUPPLY ROOM	1	100	1	100	1	100	1	100
RECEPTION / WAITING ROOM	1	250	1	250	1	250	1	250
JANITOR'S CLOSET	1	20	1	20	1	40	1	40
BUILDING SUPPORT AREAS (Restrooms, Mechanical, Telecomminications, Electrical, etc	As needed		As needed		As needed		As needed	

NR - No Requirement

Notes:

(1) Collocated in “open office” area (cubicles).

(2) Numbers in table are per company.

(3) One per facility when multiple CoHQs are combined

3.2.4. Not Used

3.2.5. SFAC

3.2.5.1. Functional Space Requirements

(a) Reception Area: Provide a large waiting/lounge area immediately adjacent to building entry. The large space will be used as a social interaction space for soldiers and their families. It will also serve as a waiting room for soldiers/families waiting to be assisted by staff members in the administrative areas. Provide a welcoming and warm atmosphere preferably with a visual connection to outside wooded areas and/or courtyard. A central gas-fired fireplace is a mandatory feature of this space. The fireplace shall be back to back type, also serving the exterior courtyard area. Provide a built-in reception desk for 2 people adjacent to administrative office area. Reception desk shall be able to oversee operations around the reception area. Reception desk must be able to serve both able and disabled personnel. Provide space for an ATM kiosk located within the reception area. The kiosk shall be within visual control of the reception desk. Provide a dual height electric water cooler in the vicinity of the public restrooms. The exterior courtyard area shall have roofed seating areas adjacent to building for tables and chairs. Provide a vestibule between the exterior and the reception area. Provide a minimum of 7 feet clearance between interior and exterior doors. Provide a means for the doors to open automatically via a sensor or push button.

(b) Public Computer Access Room: Provide chair-height counter space along room perimeter to accommodate 6 chairs for personnel utilizing individual personal computers.

(c) Multi-Use/Conference Room: Provide a room for social gatherings and conferences. Provide a minimum 50 NSF chair storage room accessible from within the multi-use/conference room.

(d) Nourishment Center: Provide a nourishment center that will serve as a snack bar / food preparation and serving area. Provide a built-in countertop with under/overhead storage cabinets (including shelves), space for a standard size GFGI under the counter dishwasher, space for a GFGI standard size residential oven/4-burner range combo 30 in. wide with hooded exhaust, double stainless steel sink with garbage disposal, shelf for a GFGI microwave, space for a GFGI full size refrigerator 28 in. wide. Provide space for a minimum of two GFGI vending machines and trash/recycle receptacles. Provide a pass-through opening from the nourishment center to the multi-use/conference room.

(e) Provide private and open offices for staff as outlined in 3.2.5.2 Space Allocation Table.

(f) Child Activity Room and Exterior Playground: Provide a room for child activities for different age groups, mainly infants and toddlers. Room shall have its own restrooms designed for each age group population. Provide one diaper changing station measuring 35 ¼” H x 60 ½” W x 24” D minimum with a sink and storage for fourteen (14) underneath storage trays. An exhaust fan is required at the diaper changing station capable of exhausting 100 – 150 cfm. The diaper changing table shall have and integral 6” lip to prevent infant from rolling off and an unbreakable mirror installed along the back wall. The sink at the diaper changing station shall have a Goose-neck faucet with wrist blade handles. Retractable stairs which lock into place are also required. Provide one food preparation area with space for full size refrigerator 30 in. wide, built-in solid surface countertop with microwave, two separate stainless steel sinks and upper and lower cabinets. Provide a built-in sign-in desk located immediately inside the room entrance with power and a data port (See drawings in Appendix J). The built-in desk shall be a minimum of 4 feet long and must contain a lockable coat closet to store coats and personal items. Provide storage cubicles for a population of 12 children and adequate storage shelving for books, magazines, toys, etc. See drawings in Appendix J. Provide a doorbell button in the reception area adjacent to the door leading into the child activity room. Doorbell shall be located inside the child activity room and shall be audible throughout the entire room. Interior door into activity room shall not be capable of being opened by guests within the reception area. See paragraph 3.3 SITE REQUIREMENTS for playground requirements.

(g) Men's Restrooms: Provide toilet facilities to serve the public and administrative personnel assigned to the SFAC.

(h) Women's Restrooms: Provide toilet facilities to serve the public and administrative personnel assigned to the SFAC.

(i) Janitor Closet: Provide with a 10 in. deep floor mounted stainless steel mop sink with hot and cold service faucet, a four holder mop rack, and two 18 in. deep by 48 in. long heavy duty stainless steel shelves for storage of cleaning supplies. Provide space for storage of buckets and a vacuum.

(j) Interior Corridors: Provide 6 feet minimum wide interior corridors.

(k) Mechanical, Electrical, and Telecommunications Rooms: Mechanical rooms shall accommodate space for equipment maintenance/repair access without having to remove other equipment. Mechanical, electrical and telecommunications rooms shall be keyed separately for access by Installation maintenance personnel. Refer to paragraphs 3.6 MECHANICAL REQUIREMENTS and 3.7 ELECTRICAL AND TELECOMMUNICATIONS REQUIREMENTS for additional information.

(l) Camera Room: Provide a room for a video monitoring security equipment rack. Rack is 36 in. wide by 30 in. deep by 84 in. high. Provide 3 feet working clearance behind rack. Provide 2 feet working clearance on at least one side and in front of rack. Space shall be conditioned with same equipment required for the telecommunications room.

(m) The wall perpendicular to the diaper changing station shall be no more than 54 inches high from the finished floor. There shall be no door at the entrance to the pre-toddler/toddler toilet to allow supervision from the caregiver.

3.2.5.2. Space Allocation Table

SFAC MINIMUM AREA REQUIREMENTS NET SQUARE FEET (NSF) PER ROOM				
NAME	SMALL		LARGE	
RECEPTION AREA	1,650		2,760	
PUBLIC COMPUTER ACCESS	160		240	
MULTI-USE/CONFERENCE ROOM W/ CHAIR STORAGE	450 (400/50)		1095 (1000/95)	
NOURISHMENT CENTER	195		450	
CHILD ACTIVITY ROOM	870		1,400	
STORAGE ROOM	N/A		140	
EXTERIOR COURTYARD - SEE NOTE 1	500		800	
BUILDING SUPPORT AREAS (Cam Room, Mechanical, Communications, Electrical, & Restrooms, etc.)	AS NEEDED		AS NEEDED	
ADMINISTRATIVE OFFICES				
OFFICE	**QTY**		**QTY**	
DIRECTOR	1	140	1	140
FAMILY SUPPORT	1	160	1	230
DISTRIBUTION CENTER	1	140	1	260
STORAGE ROOM	1	140	1	140
STORAGE ROOM			1	40
SOCIAL SERVICES ASSISTANT	1	140	1	140
VOLUNTEER	1	140	-	-
CHAPLAIN	1	140	1	140
TRANSITIONAL EMPLOYMENT	-	-	1	140
DFAS	-	-	2	140
DFAS/TRANSITIONAL EMPLOYMENT	1	140	-	-
MILITARY BENEFITS/ID PROCESSING	1	140	1	140
MILITARY BENEFITS	-	-	1	140
EDUCATION	1	140	2	140
VA	-	-	1	140
TSGLI	-	-	1	140
AW2	-	-	1	140

OUTREACH	-	-	1	140
ACS I & R (INFO EXPL)	-	-	1	140
FINANCIAL COUNSEL	-	-	1	140
OPEN OFFICES (CUBICLES)				
NCOIC	-	-	1	64
ADMINISTRATION	-	-	1	64
LEGAL	-	-	1	64
C & Y SERVICES	-	-	1	64
CPAC	-	-	1	64
VOLUNTEER	-	-	2	64
OPEN	-	-	1	64

Note:

(1) Areas shown are for roofed areas, courtyard may be larger as allowed by overall building area.

(2) Director's Office shall be adjacent to the Reception waiting area and accessible to parents and visitors.

(3) Storage Room (140 sf) in the Large SFAC Reception Area (located behind the reception desk) shall be a conditioned space

(4) Storage Room (140 sf) in the Large and Small SFAC Administrative Office area shall be a conditioned space.

3.2.6. Not Used

3.3. SITE REQUIREMENTS

3.3.1. Walks: Construct pedestrian walks within the designated construction area and connect to existing sidewalks, where applicable.

(a) The geometric design of walks for pedestrian circulation shall adhere to UFC 3-210-01A "Area Planning, Site Planning, and Design".

(b) Sidewalks shall be a minimum of 6 feet wide. Sidewalks designed to support emergency vehicle traffic shall be a minimum of 20 feet wide per NFPA requirements. Sidewalks designed to support service vehicle traffic shall be a minimum of 10 feet wide. Construct walks paralleling buildings beyond the eave drip line and at least 5 feet from the foundation.

(c) Construct non-vehicular pedestrian sidewalks of Portland Cement Concrete having a minimum nominal thickness of 4 inches. Design joint patterns uniformly, symmetrical, and in accordance with the American Association of State Highway and Transportation Officials (AASHTO) standards. For joints, do not exceed the length to width ratio of 1.25 for non-reinforced pavements.

(d) Sidewalks designed to support emergency and service vehicle traffic will be considered roadway pavements and shall be designed to meet the AASHTO standards. Construct vehicular supported walks of Portland Cement Concrete having a minimum nominal thickness of 7 inches. Design joints uniformly, symmetrical, and in accordance with AASHTO standards. Do not exceed the length to width ratio of 1.25 for non-reinforced pavements.

3.3.2. Site Structures and Amenities

(a) Dumpster Area: The Contractor shall locate, design, and construct the dumpster enclosure area(s) and screening. Dumpster screening shall be aesthetically and architecturally compatible with the building it serves and shall be designed in accordance with Installation Guidelines. Locate the dumpster areas in accordance with UFC 4-010-01 "DoD Minimum Antiterrorism Standards for Buildings". Position the GFGI dumpsters outside of restricted areas to allow for servicing activities.

(b) Not Used

(c) Child Outdoor Play Area: The outdoor play area must meet guidelines contained in the Consumer Products Safety Commission (CPSC) Handbook for Public Playground Safety, the American Society for Testing

Materials (ASTM) F-1487-93, UFC 3-210-04 Chapter 7 “Children’s Outdoor Play Area, Child Safety Requirements for Outdoor Play Areas”, and any ABA guidelines for Play Areas (www.access-board.gov).

Design and construct the play area within allotted programmed funds. The play area shall be a minimum 50 foot by 60 foot area surrounded by a 4 foot high vinyl coated chain-link security type fence. Provide a 3 foot wide gate to allow emergency egress. The gate shall allow keyed entry only and the exit from the playground shall have an adult controlled securing device. Cut off the fence bolts so no more than two threads are exposed and cover the end with plastic caps or silicone caulk. Install the bolts so that the threaded end faces away from the play area.

The play area shall contain four foot (4’) wide trike paths/sidewalks, a minimum 12-foot by 12-foot (12’ x12’) shade structure, a hard surface area with a basketball goal, a composite play system for ages two to five, and benches for viewing each area. Also provide swings if space is available.

Provide a safety surface throughout all use zones and under all play equipment. The safety surface shall be a unitary or poured in place material. The safety surface in the swing zone shall be wood fiber, with approved rubber matting at the foot contact point underneath the swings. Provide a unitary safety surface beneath infant swings.

Provide landscaping. Poisonous plants, plants with thorns, and fruit bearing plants are not permitted.

Provide a frost/freeze protected hose bib 18 inches above finished grade with removable cut off handles and integral vacuum breakers.

3.3.3. Site Functional Requirements

(a) Travel Distance: The CoHQ shall be no more than 160 feet from the WT Barracks. The distance shall be measured based on a pedestrian’s path of travel from an entrance of one building to the nearest entrance of the other building.

(b) Privately Owned Vehicle (POV) Parking: The Contractor shall design and construct the POV parking, within the designated construction area. Base the location and design of the POV parking area(s) on the Installation's site constraints. Either consolidate the parking or position it along the perimeter of the complex. The Contractor shall ensure that the location of parking complies with UFC 4-010-01. See paragraph 5.2.3, “VEHICLE PAVEMENTS”, for additional information. Provide POV parking as follows:

WTUAS:

Provide POV parking spaces for 90 percent of the personnel plus 10 parking spaces for visitor parking. Provide handicap parking in accordance with the Americans with Disabilities Act Section 4.1.2. The maximum travel distance from POV parking to the buildings shall not exceed a distance of 1200 feet. The maximum travel distance from handicap parking to the buildings shall not exceed a distance of 225 feet.

SFAC:

Provide a minimum 20 [2 are handicap] POV parking spaces.

(c) Service Drives: The Contractor shall provide service drives to each building. Locate the drives in accordance with UFC 4-010-01. Restrict access to the drives, where applicable, as required by UFC 4-010-01. Design the pavements as required by paragraph 5.2.3, “VEHICLE PAVEMENTS”. The minimum access drive width shall be 10 feet. The Contractor shall design and construct drives with curbs and gutters when necessary for drainage purposes.

(d) Fire Access Lanes: The Contractor shall provide fire access lanes to each building. Access must be within 33 feet of a building’s entrance. Design the fire access lanes in accordance with NFPA 1, UFC-3-600-01, and the installation’s requirements.

(e) Drop off Lane: The Contractor shall provide drop off lanes at the WT Barracks and the SFAC. The drop lanes shall be ABA accessible.

3.4. ARCHITECTURAL REQUIREMENTS

3.4.1. Hardware

3.4.1.1. Non-Destructive Emergency Access System: Fire Department Secure Lock-Box: [Not Supplied - WTGeneral : WT_LOCKBOX_DESCRIPTION]

3.4.1.2. Finish Hardware: All requirements for hardware keying shall be coordinated with the Contracting Officer. Extension of the existing Installation keying system shall be provided, the Installation keying system is Best BASIS V hardware and BASIS G software. Cores shall have not less than seven pins; cylinders shall have key-removable type cores. Locksets for mechanical, electrical and communications rooms only shall be keyed to the existing Installation Master Keying System. HVAC terminal units that are accessed from a central corridor shall have a deadbolt to minimize protrusion into corridor. Plastic cores are unacceptable.

3.4.1.3. Not Used

3.4.2. Special Acoustical Requirements

3.4.2.1. Exterior walls and roof/floor/ceiling assemblies, doors, windows and interior partitions shall be designed to provide for attenuation of external noise sources such as airfields in accordance with applicable criteria. Provide sound insulation to meet a minimum rating of STC 42 at interior walls and floor/ceiling assemblies. At interior doors provide solid core wood doors in metal frame with sound insulation to meet a minimum rating of STC 25. In addition to the sound insulation required, video teleconferencing areas shall meet a Noise Criteria (NC) 30 rating in accordance with ASHRAE Fundamentals Handbook.

3.4.2.2. Sound conditions and levels for interior spaces, due to the operation of mechanical and electrical systems and devices, shall not exceed levels as recommended by ASHRAE handbook criteria.

3.4.3. Exterior Design Objectives

Provide durable and easily maintainable materials. Do not use exterior materials that require periodic repainting or similar refinishing processes. Material exposed to weather shall be factory pre-finished, integrally colored or provided with intrinsic weathering finish.

3.4.3.1. Exterior Walls: Where Exterior Insulation and Finish Systems (EIFS), or any other material except CMU or other Masonry material is used as exterior finish material, it shall be in conjunction with a CMU wainscot. EIFS shall be “high-impact” type and shall be “drainable” type.

3.4.3.2. Roof: Minimum roof slope for membrane roof systems shall be 1/4 inch per foot.

3.4.3.3. Trim and Flashing: Gutters, downspouts, and fascias shall be factory pre-finished metal and shall comply with SMACNA Architectural Sheet Metal Manual.

3.4.3.4. Bird Habitat Mitigation: The Contractor shall provide details in the design necessary to eliminate the congregating and nesting of birds at, on, and in the facility.

3.4.3.5. Exterior Doors and Frames:

(a) Main Entrance Doors: Provide aluminum storefront doors and frames with Architectural Class 1 anodized finish, fully glazed, with medium or wide stile for entry into lobbies or corridors. Framing systems shall have thermal-break design. Storefront systems shall comply with wind-load requirements of applicable codes and criteria including UFC 4-010-01.

(b) Other Exterior Doors: Provide insulated hollow metal exterior doors for entry to all spaces other than corridors, lobbies, or reception/waiting rooms. Doors and frames shall comply with applicable codes and criteria. Doors shall be minimum Level 3, physical performance Level A, Model 2 flush. Frames shall be 12-gauge, with continuously welded mitered corners and seamless face joints. Doors and frames shall be A60 galvannealed, in compliance with ASTM A653 and shall be factory primed. Fire-rated openings shall comply with applicable codes, and the requirements of the labeling authority. Door and frame installation shall comply with applicable codes and criteria.

3.4.3.6. Exterior Windows: Provide insulated, high efficiency window systems, with thermally broken frames complying with applicable codes and criteria including UFC 4-010-01. Curtain wall systems shall be capable of withstanding area wind loads, thermal and structural movement required by location and project requirements, and

shall comply with applicable codes and criteria including UFC 4-010-01. Window sills shall be designed to discourage bird nesting.

3.4.3.7. Exterior Louvers: Exterior louvers shall have bird screens and shall be designed to exclude wind-driven rain. Exterior louvers shall be made to withstand wind loads in accordance with the applicable codes. Wall louvers shall bear the Air Movement & Control Association (AMCA) International certified ratings program seal for air performance and water penetration in accordance with AMCA 500-D and AMCA 511. Louver finish shall be factory applied and color shall match adjacent finish.

3.4.4. Interior Design Objectives

Provide sustainable materials and furnishings that are easily maintained and replaced. Maximize use of daylighting. Provide interior surfaces that are easy to clean and light in color. Design WTUAS building(s) with an office ambience.

3.4.4.1. Not Used

3.4.4.2. Bulletin Boards: Provide one bulletin board near the main entrance. Each bulletin board shall be 4 feet high and 6 feet wide and shall have a header panel and lockable, glazed doors.

3.4.4.3. Corner Guards: Provide surface mounted, high impact resistant, integral color, snap-on type resilient corner guards, extending from floor to ceiling for wall and column outside corners in high traffic areas such as corridors, waiting areas, lobbies, conference and multi-purpose rooms. Factory fabricated end closure caps shall be furnished for top and bottom of surface mounted corner guards.

3.4.4.4. Chair Rail: Chair rails shall be installed in areas prone to hi-impact use, such as corridors, waiting areas, lobbies, conference and multi-purpose rooms.

3.4.4.5. Casework: Provide cabinets complying with Architectural Woodwork Institute Quality Standards. Countertops shall have waterfall front edge and integral coved backsplash.

3.4.4.6. Fire Extinguisher Cabinets: Furnish and install fire extinguisher cabinets and mounting brackets as required by applicable codes and criteria.

3.4.4.7. Interior Doors and Frames:

(1) Provide hollow metal doors, or flush solid core wood doors as required. All door frames shall be hollow metal.

(2) Wood Doors: All doors shall be wood doors except noted otherwise Provide flush solid core wood doors conforming to WDMA I.S.-1A. Stile edges shall be non-finger jointed hardwood compatible with face veneer. Provide Architectural Woodwork Institute (AWI) Grade A hardwood face veneer for transparent finished doors.

(3) Insulated Hollow Metal Doors: Comply with ANSI A250.8/SDI 100. Doors shall be minimum Level 2, physical performance Level B, Model 2; factory primed. Provide insulated hollow metal doors for utility rooms, storage rooms and bathrooms.

(4) Hollow Metal Frames: Comply with ANSI A250.8/SDI 100. Frames shall be minimum Level 2, 16 gauge, with continuously welded mitered corners and seamless face joints; factory primed.

(5) Fire-rated and Smoke Control Doors and Frames: Comply with applicable codes, criteria and requirements of labeling authority.

(6) STC ratings shall be of the sound classification required and shall include the entire door and frame assembly.

3.4.4.8. Window Treatment: Provide horizontal mini blinds at all exterior windows. Uniformity of window covering color and material shall be maintained to the maximum extent possible throughout each building.

3.4.4.9. Toilet Accessories: Furnish and install the items listed below and all other toilet accessories necessary for a complete and usable facility. All toilet accessories shall be Type 304 stainless steel with satin finish.

(a) Public Toilets/Showers: Accessories shall include the following items.

(1) Glass mirrors on stainless steel frame and shelf – at each lavatory

(2) Liquid soap dispenser – at each lavatory

(3) Combination recessed mounted paper-towel dispenser/waste receptacle

(4) Sanitary napkin disposal at each female toilet/unisex toilet

(5) Recessed mounted lockable double toilet paper holder – at each water closet

(6) Sanitary toilet seat cover dispenser – one per toilet

(7) Grab bars – as required by ABAAG

(8) Shower curtain rod - curved extra heavy duty

(9) Shower curtain – white anti-bacterial nylon/vinyl fabric shower curtain shall completely close the shower stall width.

(10) Soap dish – built-in in shower

(11) Robe hook – adjacent to shower stall entry

(b) Not Used

(c) Public Toilets: Toilet accessories shall conform to the requirements of the ABA and shall include, but are not limited to the following.

(1) Glass mirrors on stainless steel frame and shelf – at each lavatory

(2) Liquid soap dispenser – at each lavatory

(3) Combination recessed mounted paper-towel dispenser/waste receptacle

(4) Sanitary napkin disposal at each female toilet/unisex toilet

(5) Recessed mounted lockable double toilet paper holder – at each water closet

(6) Sanitary toilet seat cover dispenser – one per toilet

(7) Grab bars – as required by ABAAG

(8) One Wall-mounted Diaper Changing Station

3.4.4.10. Mold and Mildew Mitigation: The Designer of Record shall provide details in the design analysis and design showing steps taken to mitigate the potential growth of mold and mildew in the facility.

3.4.5. Finishes: Finishes Designers are not limited to the minimum finishes listed in this paragraph and are encouraged to offer higher quality finishes

3.4.5.1. Minimum Paint Finish Requirements

(a) All paints used shall be listed on the "Approved product list" of the Master Painters Institute, (MPI). Application criteria shall be as recommended by Master Painters Institute (MPI) guide specifications for the substrate to be painted and the environmental conditions existing at the project site.

(b) Exterior surfaces, except factory pre-finished material or exterior surfaces receiving other finishes shall be painted a minimum of one prime coat and two finish coats. Paints having a lead content over 0.06 percent by weight of nonvolatile content are unacceptable. Paints containing zinc-chromate, strontium-chromate, mercury or mercury compounds, confirmed or suspected human carcinogens shall not be used on this project. Exterior paints and coating products shall be classified as containing low volatile organic compounds (VOCs) in accordance with MPI criteria. Application criteria shall be as recommended by MPI guide specifications. Provide an MPI Gloss Level 5 Finish (Semi-gloss), unless otherwise specified.

(c) Interior surfaces, except factory pre-finished material or interior surfaces receiving other finishes shall be painted a minimum of one prime coat and two finish coats. Paints having a lead content over 0.06 percent by weight of nonvolatile content are unacceptable. Paints containing zinc-chromate, strontium-chromate, mercury or mercury compounds, confirmed or suspected human carcinogens shall not be used on this project. Interior paints and coating products shall contain a maximum level of 150 g/l (grams per liter) of volatile organic compounds

(VOCs) for non-flat coatings and 50 g/l of VOCs for flat coatings. Provide an MPI Gloss Level 5 Finish (Semi-gloss) in wet areas and a flat finish in all other areas.

3.4.5.2. Minimum Interior Finishes

(a) Designers are not limited to finishes listed in the following INTERIOR FINISHES table(s) and are encouraged to offer higher quality finishes.

(b) Wall, ceiling and floor finishes shall conform to the requirements of the IBC, NFPA and UFC 3-600-01. Where code requirements conflict, the most stringent code requirement shall apply.

(c) Carpet shall be minimum of 2 yarn ply, modular tile conforming to ISO 2551, ASTM D 418, ASTM D 5793, ASTM D 5848, solution dyed, tufted, cut and loop pile, commercial 100% branded (federally registered trademark) nylon continuous filament. Vinyl composition tile (VCT) shall be minimum 1/8 inch thick, conforming to ASTM F 1066, Class 2, through pattern tile, Composition 1, asbestos free, with color and pattern uniformly distributed throughout the thickness of the tile.

(d) Walls: All gypsum board shall achieve a score of 10, the highest level of performance for mold resistance under the ASTM D 3273 test method. All gypsum board shall be transported, handled, stored and installed in accordance with the GYPSUM ASSOCIATION – Guidelines For Prevention Of Mold Growth On Gypsum Board (GA-238-03). Use impact resistant gypsum board in corridors, storage rooms, stairwells and activity rooms and centralized laundries (if centralized laundries are required by RFP).

(e) Ceiling: All gypsum board shall achieve a score of 10, the highest level of performance for mold resistance under the ASTM D 3273 test method. All gypsum board shall be transported, handled, stored and installed in accordance with the GYPSUM ASSOCIATION – Guidelines For Prevention Of Mold Growth On Gypsum Board (GA-238-03).

3.4.5.3. Not Used

3.4.5.4. CoHQ Interior Finishes

CoHQ INTERIOR FINISHES																	
	FLOORS						BASE			WALLS				CEILING			REMARKS
	RESILIENT FLOORING	PORCELAIN OR QUARRY TILE	CERAMIC TILE	RECESSED ENTRY MAT	SEALED CONCRETE	CARPET	RESILIENT BASE	PORCELAIN OR QUARRY BASE	CERAMIC BASE	GYPSUM WALL BOARD-PAINT	LAMINATED GLASS, INSUL. CURTAIN WALL SYSTEM	CERAMIC TILE	LAMINATED GLASS, INSUL . STORE FRONT SYSTEM	GYPSUM WALL BOARD-PAINT	ACOUSTICAL CEILING TILE	MINIMUM HEIGHT 8'-0" UNLESS STATED OTHERWISE	REFER TO NOTE
COMMANDER						●	●			●					●		NOTE 5
EXECUTIVE OFFICER						●	●			●					●		NOTE 5
SUPERVISORY CASE MANAGER						●	●			●					●		NOTE 9
CASE MANAGER						●	●			●					●		
FIRST SERGEANT						●	●			●					●		NOTE 5
PLATOON SERGEANT	●						●			●					●		
SQUAD LEADER	●						●			●					●		
SOCIAL WORKER						●	●			●					●		NOTE 5
NURSE CASE MANAGER						●	●			●					●		NOTE 5
EXTRA OFFICE						●	●			●					●		NOTE 8
OPEN OFFICE AREA	●						●			●					●	9'	

COPIER AND FAX	●						●			●					●		
KITCHENETTE	●						●			●					●		NOTE 3 AND 4
RECORDS ROOM	●						●			●					●		
CONFERENCE ROOM						●	●										NOTE 5
SUPPLY ROOM	●						●										
RECEPTION/WAITING ROOM		●						●		●					●	9’	
MESSAGE CENTER	●						●			●					●		
STORAGE ROOM	●						●			●					●		NOTE 10
MEN’S RESTROOM			●						●	●		●		●			NOTE 1 AND 3
WOMEN’S RESTROOM			●						●	●		●		●			NOTE 1 AND 3
JANITOR CLOSET			●						●	●		●		●			NOTE 2
CORRIDORS	●						●			●					●	9’	
VESTIBULES		●		●				●		●	●		●	●		9’	
STAIRS	●				●		●			●				●			NOTE 7
ELEVATOR		●						●		●					●		NOTE 11
PUMP ROOM					●		●			●				●			NOTE 11
MECHANICAL					●		●			●				●			NOTE 6
ELECTRICAL					●		●			●				●			NOTE 6
TELECOMM					●		●			●					●	10’	

1. ALL WET WALLS IN TOILET ROOMS SHALL HAVE 4'-0" HIGH CERAMIC TILE WAINSCOT. ALL SHOWERS SHALL HAVE FULL HEIGHT TILE WALLS.
2. WALLS ADJACENT TO JANITOR’S SINK SHALL HAVE A 4’-0” HIGH CERAMIC TILE WAINSCOT.
3. ALL COUNTERS SHALL HAVE A MINIMUM OF 4" HIGH BACKSPLASH.
4. IN VENDING OR RECYCLABLES STORAGE AREA, MATCH FLOORING, WALL, AND CEILING FINISHES TO THOSE OF ADJACENT AREA.
5. EXTEND PARTITIONS TO DECK. PROVIDE SOUND INSULATION TO MEET A MINIMUM RATING AT DOORS AND WALLS OF STC 49.
6. CEILING MAY BE PAINTED EXPOSED STRUCTURE IF ALLOWED BY APPLICABLE CODE.
7. RISERS SHALL BE PAINTED STEEL. STAIR LANDINGS AND TREADS SHALL HAVE RESILIENT FLOORING OR SEALED CONCRETE. PROVIDE TREADS WITH SLIP RESISTANT NOSING.
8. ONLY USED ON SMALL CoHQ
9. USED ON ALL MEDIUM AND LARGE CoHQs.
10. ONLY USED ON MEDIUM DUPLEX CoHQ.
11. USED ONLY ON MEDIUM STACKED AND LARGE STACKED CoHQs.

3.4.5.5. Not Used

3.4.5.6. SFAC Interior Finishes

Finishes shall be coordinated through the United States Army Corps of Engineers Center of Standardization to ensure use of therapeutic colors, flooring material, and countertop textures.

The Contact address is:
Corps of Engineers – Ft Worth District
CESWF-EC-DA
819 Taylor Street
Room 4A05
Fort Worth, TX 76102

SFAC INTERIORS FINISHES					
	FLOORS	BASE	WALLS	CEILING	REMARKS

	RESILIENT FLOORING	PORCELAIN TILE	RUBBER FLOORING	RECESSED ENTRY MAT	SEALED CONCRETE	CARPET	RESILIENT BASE	WOOD BASE	CERAMIC BASE	GYPSUM WALL BOARD - PAINT	WOOD VENEER WALL COVERING	CERAMIC TILE	VENEER STONE WALL FINISH	LAMINATED GLASS, INSUL. STORE FRONT SYSTEM	GYPSUM WALL BOARD - PAINT	ACOUSTICAL CEILING TILE	LAY-IN WOOD TILE	MINIMUM-HEIGHT 8'-0" UNLESS STATED OTHERWISE	REFER TO NOTE
PUBLIC & SUPPORT SPACES																			
RECEPTION AREA						●	●			●	●		●		●	●	●		
PUBLIC COMPUTER ACCESS						●	●			●						●			
MULTI-USE/CONFERENCE ROOM W/STORAGE						●	●			●					●	●			
NOURISHMENT CENTER		●						●		●					●				
CHILD ACTIVITY ROOM	●		●				●			●					●	●			
STORAGE ROOM						●	●			●					●				
MEN'S RESTROOM		●							●			●			●				
WOMEN'S RESTROOM		●							●			●			●				
TOILET		●							●			●			●				
JANITOR CLOSET		●							●	●		●			●				NOTE 5
MECHANICAL					●		●			●					●				NOTES 3 & 4
ELECTRICAL					●		●			●					●				NOTES 3 & 4
TELECOMM					●		●			●					●			**10'**	
CAM ROOM					●		●			●					●				
ADMINISTRATIVE OFFICES																			
DIRECTOR						●	●			●						●			
FAMILY SUPPORT						●	●			●						●			
DISTRIBUTION CENTER						●	●			●						●			
STORAGE ROOM						●	●			●					●				
SOCIAL SERVICES ASST.						●	●			●						●			
VOLUNTEER						●	●			●						●			NOTE 1
CHAPLAIN						●	●			●						●			
TRANSITIONAL EMPLOYMENT						●	●			●						●			NOTE 2
DFAS						●	●			●						●			NOTE 2
DFAS/TRANSITIONAL EMPLOYMENT						●	●			●						●			
MILITARY BENEFITS/ID PROCESSING						●	●			●						●			
MILITARY BENEFITS						●	●			●						●			NOTE 2
EDUCATION						●	●			●						●			
VA						●	●			●						●			NOTE 2
TSGLI						●	●			●						●			NOTE 2

AW2						●	●			●						●			NOTE 2
OUTREACH						●	●			●						●			NOTE 2
ACS I & R (INFO EXPL)						●	●			●						●			NOTE 2
FINANCIAL COUNSEL						●	●			●						●			NOTE 2
ADMINISTRATIVE OPEN OFFICES																			
NCOIC						●	●			●						●			NOTE 2
ADMINISTRATION						●	●			●						●			NOTE 2
LEGAL						●	●			●						●			NOTE 2
C & Y SERVICES						●	●			●						●			NOTE 2
CPAC						●	●			●						●			NOTE 2
VOLUNTEER						●	●			●						●			NOTE 2
OPEN						●	●			●						●			NOTE 2

Notes:

1. ONLY USED IN SMALL SFAC
2. ONLY USED IN LARGE SFAC
3. WALL PAINT TO BE WATER-BASED EPOXY
4. CEILINGS MAY BE PAINTED EXPOSED STRUCTURE IF ALLOWED BY APPLICABLE CODE
5. WALLS ADJACENT TO JANITOR'S SINK SHALL HAVE A 4"-0" HIGH CERAMIC TILE WAINSCOT

3.4.5.7. Not Used

3.4.5.8. Not Used

3.4.5.9. CoHQ Furniture Chart

CoHQ FURNITURE CHART		
Description	**Comments**	**Furniture Required**
Commander	Private Office	U-shaped executive desk with 2 pedestals, hutch, one 4-drawer lateral file, 2 guest chairs, 1 executive chair
Executive Officer	Private Office	L-shaped double pedestal desk unit, hutch, one 4-drawer lateral file, 2 guest chairs, 1 task chair
First Sergeant	Private Office	L-shaped double pedestal desk unit, hutch, two 4-drawer lateral files, 2 guest chairs, 1 executive chair
Office 1 (See note 1)	Private Office	L-shaped double pedestal desk unit, hutch, two 4-drawer lateral files, 2 guest chairs, 1 task chair
Platoon Sergeant	Shared Office	2 L-shaped modular furniture workstations with work surfaces, file pedestals, and overhead storage, one 4-drawer lateral files, 2 task chairs, 2 guest chairs
Squad Leaders	Shared Office	3 single pedestal desks, 3 task chairs, 3 guest chairs
Open Office (See note 2)	48 NSF Open Workstations	6 x 8 systems furniture workstation with work surfaces, file pedestals, and overhead storage, 1 task chair, 1 guest chair, room enough for wheelchair access into cubical
Conference Room	Commander’s Conference Room	Boat-shaped conference table, 12 conference chairs, minimum of 4 side chairs, 1 small storage credenza
Copier and Fax	Copy Room with Fax Machine	1 work surface with storage for paper

CoHQ FURNITURE CHART		
Description	**Comments**	**Furniture Required**
Records Room	Storage	Minimum of five 4-drawer lateral files
Supply Room	Storage	Minimum of 80 linear feet of shelving, Minimum of 1 locking cabinet
Reception/Waiting Room	Building Reception and Waiting Area	1 reception station with task chair(s), minimum of 10 lobby seats with side tables.

Notes:

(1) Office 1 layout applies to Case manager, Nurse Case manager, Social Worker, Extra Office and Supervisor Case Manager.

(2) Open Office workstations apply to Occupational Therapy Assistant, Medical NCO, Financial Tech. Specialist, Training Specialist, Medical Support Assistant, Supply Technician, HR Specialist, HR Assistant and Family Readiness Support Assistant.

3.4.5.10. Not Used

3.4.5.11. SFAC Furniture Chart

SFAC FURNITURE CHART (See note 1)		
Description	**Comments**	**Furniture Required**
Office (See note 2)	Private Office	L-shaped systems furniture workstation with 1 pedestal, one 2-drawer lateral file, 2 guest chairs, 1 executive chair
Open Office-Large Only (See note 3)	48 NSF Open Workstations	6 x 8 systems furniture workstation with work surfaces, 2 file pedestals, and overhead storage, 1 task chair, 1 guest chair, room enough for wheelchair access into cubical
Family Support-Small	Private Lounge	One 3-seat upholstered arrangement, one 2-seat upholstered arrangement, 1 upholstered chair, 1 side table, 1 computer table
Family Support-Large	Private Lounge	One 3-seat upholstered arrangement, one 2-seat upholstered arrangement, 2 upholstered chairs, 2 side tables, 1 computer table
Nourishment Center-Small	Food prep area	3 round tables, 6 chairs
Nourishment Center-Large	Food prep area	3 round tables, 10 chairs
Multi-Use/Conference Room-Small	Conference Room	Six 30”x60” training tables, 16 conference chairs, one 24”x75” credenza
Multi-Use/Conference Room-Large	Conference Room	Eight 30”x60” training tables, 20 conference chairs, one 24”x75” credenza
Reception Area-Small	Reception/waiting/dining	Two 3-seat upholstered arrangement, one 2-seat upholstered arrangement, 5 upholstered chairs, 4 side tables, 2 sofa tables, 1 coffee table, 3 round dining tables, 6 dining chairs, U-shaped reception station with work surface, 2 file pedestals, and overhead storage, transaction top, 2 task chairs.

SFAC FURNITURE CHART (See note 1)		
Description	**Comments**	**Furniture Required**
Reception Area-Large	Reception/waiting/dining	Two 3-seat upholstered arrangement, two 2-seat upholstered arrangement, 15 upholstered chairs, 11 side tables, 1 sofa table, 3 round dining tables, 10 dining chairs, L-shaped reception station, with work surface, 2 file pedestals, and overhead storage, transaction top, 2 task chairs.
Public Computer Access	Computer Room	6 task chairs
Courtyard-Small	Open-air dining	7 round tables, 28 chairs
Courtyard-Large	Open-air dining	10 round tables, 29 chairs
General Storage-Small	Storage	Minimum of 162 total linear feet of wire shelving; two 5-high lateral file cabinets and 1 lockable storage cabinet for main storage
General Storage-Large	Storage	Minimum of 90 total linear feet of wire shelving; two 5-high lateral file cabinets and 2 lockable storage cabinets for main storage
Distribution Center-Small	Storage	Minimum of 54 linear feet of wire shelving, two 5-drawer lateral file cabinets, 1 locking cabinet
Distribution Center-Large	Storage	Minimum of 90 linear feet of wire shelving, 3 locking storage cabinets, three 5-drawer lateral file cabinets, two 36” x 60” tables

(1) Coordination with drawings necessary to verify room list per building.

(2) Office layout applies to all hard wall offices. Coordinate with drawings, can include the following: Director, Family Support, Distribution Center, General Storage, Social Services Assistant, Volunteer, Pastoral, Transition Employment, DFAS, DFAS/Transition Employment, Military Benefits/ID Processing, Military Benefits, Education, VA, TSGLI, AW2, ACS I&R (Reception), ACS I & R (Info Expl) and/or Financial Counsel.

(3) Open Office workstations apply to NCOIC, Administration, Legal, C&Y Services, CPAC, two Volunteers and Open.

3.5. STRUCTURAL REQUIREMENTS

Design and construct as a complete system in accordance with APPLICABLE CRITERIA.

3.5.1. Live Loads: Design live loads shall be per the IBC but not lower than the following minimums:

(a) Elevated slabs 60 pounds per square foot (psf)

(b) Slabs on grade 150 psf

(c) Centralized laundry area 150 psf, but not less than actual equipment loads

3.6. MECHANICAL REQUIREMENTS

3.6.1. Plumbing

3.6.1.1. Not Used

3.6.1.2. Not Used

3.6.1.3. Not Used

3.6.1.4. Not Used

3.6.1.5. Not Used

3.6.1.6. WTUAS - Urinals shall be non-water using (waterless, water-free, etc.) type or shall be ultra-low flow type using less than 0.2 gallons per flush.

3.6.1.7. SFAC - Provide sink for built-in diaper changing station with goose neck faucet and wrist blade handles.

3.6.1.7.1. For Child Activity Room pre-toddler/toddler toilet area, provide one pediatric water closet (10 inches to rim above finished floor (AFF)). Water closet shall not use automatic flush valve. Provide floor drain in toilet area. Provide one wall hung child size lavatory mounted 17 inches AFF. Lavatory shall be mounted opposite from water closet. Provide one bubbler water fountain, with guarded stream drinking head, outside pre-toddler/toddler toilet area. Bubbler shall be mounted 17 inches AFF.

3.6.1.7.2. Not Used

3.6.1.7.3. Not Used

3.6.1.8. Not Used

3.6.2. Heating, Ventilating and Air-Conditioning (HVAC)

3.6.2.1. Not Used

3.6.2.2. Not Used

3.6.2.3. Not Used

3.6.2.4. Not Used

3.6.2.5. Not Used

3.6.2.6. WTUAS or SFAC - All air handling units shall be located in mechanical rooms accessible only through an exterior door. Mechanical rooms shall be sized for ease of service, maintenance, and replacement of HVAC equipment. Air filters shall be located in the mechanical room. Occupant control shall also include ability to select heating or cooling mode. HVAC system shall be able to provide for year round heating.

Each conference and multi-purpose room shall be zoned separately. Other space zoning shall be based on exterior envelope exposures. Where VAV systems are used, limit individual zones to a maximum of 2,500 cfm.

Air handling units shall run continuously during occupied hours. Restroom exhaust fans shall be interlocked with the air handling units. Similarly, outdoor ventilation air required by ASHRAE 62.1 shall be continuous during occupied hours.

3.6.2.7. SFAC - Provide continuous exhaust above diaper changing station at a rate of 100-150 cfm.

3.6.2.8. Not Used

3.6.3. Fire Protection

Fire suppression systems shall be designed in accordance with the latest edition of UFC 3-600-01. All facilities as a part of the complex shall be protected throughout by a complete automatic sprinkler system.

3.6.4. ENERGY CONSERVATION

3.6.4.1. Energy Performance

The building, including the building envelope, HVAC systems, service water heating, power, and lighting systems shall be designed to achieve an energy consumption that is at least 40% below the consumption of a baseline building meeting the minimum requirements of ANSI/ASHRAE/IESNA Standard 90.1-2007 (see paragraph 5.9 Energy Conservation) In addition, the building shall be designed and constructed to provide 30% of domestic hot water by use of solar hot water system.

3.6.4.2. Required Energy Conservation Features

All items listed in the required energy conservation features table shall be provided as a minimum. Additional energy conservation features may be required to meet the above energy performance. The contractor is responsible for determining and providing additional energy conservation features to meet the energy performance requirement

Compliance Documentation.

The required energy conservation features shown in the following tables contribute to the achievement of the above energy performance and are life cycle cost effective for a WT facility. Use of the required energy conservation features does not eliminate the requirement for energy analysis calculations documenting compliance. The D-B contractor must document compliance with the above energy performance utilizing the methodology described in ASHRAE 90.1, Appendix G as discussed in section 01 33 16 Design After Award.

Climate Zone 4A, Energy Conservation Features Table

Item	Component	Minimum Requirements
Roof	Attic	R-50
	Surface reflectance	0.27
Walls	Light Weight Construction	R-20
Exposed Floors	Mass	R-20
Slabs	Unheated	NR (2)
Doors	Swinging	U-0.70
	Non-Swinging	U-1.45
Infiltration		0.25 cfm/ft^2 @ 75 Pa (3)
Vertical Glazing	Window to Wall Ratio (WWR)	10% - 20%
	Thermal transmittance	U-0.45
	Solar heat gain coefficient (SHGC)	0.31
Interior Lighting	Lighting Power Density (LPD)	0.9 W/ft^2
	Ballast	Electronic ballast
HVAC	Air Conditioner	4-Pipe Fan Coil with central chiller and boiler plus DOAS (4) with 14.0 SEER DX coil (3.52 COP) and HHW coil on central boiler SAT control 55ºF – 62ºF with OAT 75º – 54ºF
	Gas Furnace	none
	ERV	70% - 75% sensible effectiveness
Economizer		no
Ventilation	Outdoor Air Damper	Motorized control
	Demand Control	NR
	Laundry Room	Decoupled (5)
Ducts	Friction Rate	0.08 in. w.c./100 feet
	Sealing	Seal class B

	Location	Interior only
	Insulation level	R-6 (6)
Service Water Heating	Gas storage	90% E_t

Notes for Energy Conservation Featrues Table:

(1) NOT USED

(2) NR means there is no requirement or recommendation for a component in this climate.

(3) Increased Building Air tightness. Building air leakage (measured in cfm/ft2) is the average volume of air(measured in cubic feet per minute) that passes through a unit area of the building envelope (measured in square feet) when the building is maintained at a specified internal pressure (measured in Pascals). Testing requirements are specified in Chapter 5..

(4) Dedicated Outdoor Air System. A central dedicated outdoor air system (DOAS) providing the following:

(a) Outside air for building indoor air quality and humidity control

(b) Make-up air for bathroom and kitchen exhausts

(c) Building pressurization to prevent infiltration which allows for reduction of heating/cooling and moisture loads on the system.

NOTE: The Central DOAS does not provide sensible heating or cooling. Sensible loads are provided by a complementing heating and cooling system

(5) **Decoupling exhaust and supply systems for laundry rooms**. To reduce unneeded energy use for heating and cooling of the make-up air and for air transportation of supply and exhausted air from the dryers, laundry exhaust and supply systems are separated in the efficient building model from the rest of the building exhaust and supply systems. Laundry exhaust system and corresponding make-up systems operate only when dryers are operating.

(6) The duct and pipe insulation values are from the ASHRAE Advanced Energy Design Guide for Small Offices.

All design features of this EPACT 2005 & EISA 2007 compliant WT not described above will be in accordance with the minimum requirements of ANSI/ASHRAE/IESNA Standard 90.1-2007. including conformance with paragraph 5.9.2, which requires purchase of Energy Star and FEMP designated products.

3.6.4.3. Schedules

The following facility schedules must be used in all facility energy simulations for purposes of documenting compliance with energy performance requirement.

WT Common Area Internal Load Schedules

Hr	Occupancy			Lighting			Washer/Dryer Use			Washer SHW		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1-6	0.00	0.00	0.00	0.30	0.30	0.30	0.00	0.00	0.00	0.00	0.00	0.00
7-10	0.20	0.20	0.20	0.30	0.30	0.30	0.00	0.00	0.00	0.00	0.00	0.00
11-18	0.00	0.00	0.00	0.30	0.30	0.30	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.80	0.80	0.80	0.00	0.00	0.00	0.00	0.00	0.00
20-21	0.20	0.20	0.20	0.80	0.80	0.80	0.50	0.50	0.50	0.50	0.50	0.50
22-23	0.40	0.40	0.40	0.80	0.80	0.80	1.00	1.00	1.00	1.00	1.00	1.00
24	0.20	0.20	0.20	0.80	0.80	0.80	0.50	0.50	0.50	0.50	0.50	0.50
Peak	5 occ/floor			1.0 W/ft^2 (10.8 W/m^2)			8.4 kW/floor			53.3 gal/hr/flr (202 L/hr/flr)		

WT Apartment Unit Internal Load Schedules

Hr	Occupancy			Lighting			Plug Loads			Service Hot Water		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1-5	0.80	0.75	0.75	0.20	0.20	0.20	0.20	0.20	0.20	0.00	0.00	0.00
6	0.70	0.65	0.75	0.40	0.30	0.20	0.20	0.20	0.20	0.10	0.10	0.10
7	0.60	0.60	0.70	0.70	0.50	0.30	0.40	0.35	0.20	0.40	0.40	0.40
8	0.50	0.50	1.00	0.50	0.50	0.50	0.40	0.40	0.40	0.20	0.20	0.20
9	0.25	0.25	0.00	0.20	0.20	0.20	0.30	0.40	0.40	0.00	0.00	0.00
10-17	0.20	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.00	0.00	0.00
18	0.30	0.30	0.30	0.50	0.50	0.50	0.50	0.50	0.50	0.10	0.10	0.10
19	0.50	0.30	0.30	0.70	0.70	0.70	0.50	0.50	0.50	0.10	0.10	0.10
20	0.50	0.50	0.50	0.70	0.70	0.70	0.60	0.50	0.50	0.10	0.10	0.10
21	0.70	0.50	0.50	0.70	0.70	0.70	0.60	0.50	0.50	0.00	0.00	0.00
22	0.70	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.00	0.00	0.00
23	0.80	0.75	0.75	0.40	0.40	0.40	0.40	0.50	0.50	0.00	0.00	0.00
24	0.80	0.75	0.75	0.20	0.20	0.20	0.20	0.20	0.20	0.00	0.00	0.00
Peak	2 occ/unit			1.1 W/ft^2 (10.8 W/m^2)			1.7 W/ft^2 (18 W/m^2)			40 gal/hr (114 L/hr)		

WT Apartment Unit Internal Load Schedules

Hr	Refrigerator			Range and Oven		
	Wk	Sat	Sun	Wk	Sat	Sun
1-6	1.00	1.00	1.00	0.01	0. 01	0. 01
7-16	1.00	1.00	1.00	0.04	0.04	0.04
17-18	1.00	1.00	1.00	0.05	0.05	0.05
19-20	1.00	1.00	1.00	0.11	0.11	0.11
21-23	1.00	1.00	1.00	0.10	0.10	0.10
24	1.00	1.00	1.00	0.03	0.03	0.03
Peak	76.36 W/unit			68.95 W/unit		

WT Apartment Unit Thermostat Set-Point Schedules

Hr	Heating (°F)			Heating (°C)			Cooling (°F)			Cooling (°C)		
□	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1-24	68	68	68	20	20	20	75	75	75	24	24	24

WT Unoccupied Zones (ie stairwells, mechanical rooms) Thermostat Set-Point Schedules

Hr	Heating (°F)			Heating (°C)		
□	Wk	Sat	Sun	Wk	Sat	Sun
1-24	55	55	55	12.8	12.8	12.8

3.7. ELECTRICAL AND TELECOMMUNICATIONS REQUIREMENTS

Select electrical characteristics of the power system to provide a safe, efficient, and economical distribution of power based upon the size and types of loads to be served. Use distribution and utilization voltages of the highest level that is practical for the load to be served. The effect of nonlinear loads such as computers, other electronic equipment and electronic ballasts shall be considered and accommodated as necessary. Voltage drop shall not

exceed the maximum allowed per ASHRAE 90.1. Transient voltage surge protection shall be provided on service equipment for WT Barracks, WTUASs, and SFACs.

3.7.1. Power

3.7.1.1. Power shall be provided for all installed equipment requiring power including all government furnished contractor installed equipment and all GFGI equipment. Power poles are not allowed. The following shall also be provided.

3.7.1.1.1. Provide 125-volt duplex receptacles per NFPA 70, in conjunction with the proposed equipment and furniture layouts, and as per other stated requirements elsewhere in the RFP.

3.7.1.1.2. Each CATV outlet shall have a 125-volt duplex receptacle mounted adjacent to it.

3.7.1.1.3. In addition to receptacles required elsewhere in the statement of work provide one 125-volt duplex receptacle per wall in all normally occupied spaces with the exception of WT barracks dwelling units.

3.7.1.1.4. For housekeeping purposes provide a minimum of one 125-volt duplex receptacle per corridor. No point along corridor wall bottom shall be more than 25 feet from a receptacle.

3.7.1.1.5. Provide 125-volt duplex receptacles adjacent to lavatories. Provide a minimum of one for every two adjacent lavatories. Each single lavatory shall also be provided a receptacle.

3.7.1.1.6. Provide a minimum of two 125-volt duplex receptacles in each mechanical room in addition to those required per NFPA 70. In addition, provide a minimum of one receptacle in each electrical room.

3.7.1.2. Not Used

3.7.1.3. WTUAS

3.7.1.3.1. Provide a minimum of two 125-volt duplex receptacles for each designated individual work space (cubicle) in all open office areas. One of which shall be adjacent to the telecommunications outlet.

3.7.1.3.2. Provide two 125-volt duplex receptacles for the CQ workstation adjacent to the telecommunications outlet. Receptacles shall be on a dedicated circuit.

3.7.1.3.3. For housekeeping purposes provide a minimum of one 125-volt duplex receptacle on each wall within reception/waiting room. No point along bottom of walls shall be more than 25 feet from a receptacle.

3.7.1.3.4. Provide a 125-volt duplex receptacle above countertop on either side of the sink in kitchenette. These two receptacles shall be on a dedicated circuit. All remaining receptacles in room shall be on another dedicated circuit.

3.7.1.3.5. Not Used

3.7.1.4. SFAC

3.7.1.4.1. Provide a 125-volt duplex receptacle adjacent to each data outlet in public computer access rooms.

3.7.1.4.2. Provide 125-volt duplex receptacles above countertop in nourishment center and child activity room such that no point along countertop is more than 4 feet from a receptacle. In addition, provide a 125-volt duplex receptacle above sign-in countertop in child activity room and above shelf for microwave in Nourishment Center. Receptacles above countertop and above shelf in Nourishment Center shall be on a dedicated circuit.

3.7.1.4.3. Provide two 125-volt duplex receptacles for the reception station adjacent to the telecommunications outlet. Receptacles shall be on a dedicated circuit.

3.7.1.4.4. Provide a minimum of four 125-volt duplex receptacles in courtyard area evenly spaced along perimeter walls.

3.7.1.4.5. Provide a minimum of two 125-volt duplex receptacles in the courtyard mounted at eave height for decorative lighting.

3.7.1.4.6. For housekeeping purposes provide a minimum of one 125-volt duplex receptacle on each wall within reception area. No point along bottom of reception area perimeter walls shall be more than 25 feet from a receptacle.

3.7.1.4.7. Provide a minimum of five 125-volt duplex receptacles along the wall in the older children's area within the child activity room. Mount receptacles 54 in. above finished floor. Locate each receptacle adjacent to a telecommunications outlet.

3.7.1.4.8. Provide a 125-volt duplex receptacle adjacent to the fireplace in the reception area in addition to the requirement stated in paragraph 3.7.1.4.6

3.7.1.4.9. Provide two 125-volt quadraplex receptacles on the back wall of the cam room mounted 36 in. above finished floor. Receptacles shall be on a dedicated circuit.

3.7.1.4.10. Not Used

3.7.1.4.11. Provide a minimum of four floor recess mounted 125-volt duplex receptacles in the reception area. Receptacle locations shall be coordinated with the furniture layout and placement finalized during design.

3.7.1.4.12. In addition to the receptacles required per the Technical Criteria for I3A in the distribution center, provide two dedicated circuits with a single power receptacle connected to each for copiers. Power requirements for these circuits will not be known until a copier is selected by the Installation during the design phase.

3.7.1.4.13. Provide two 125-volt duplex receptacles in the storage room behind the reception counter and in the storage room adjacent to the AW2 office. Receptacles shall be placed on opposite walls and located adjacent to a dual jack telecommunications outlet.

3.7.1.5. Not Used

3.7.2. Grounding

Provide grounding in accordance with NFPA 70 and the Technical Criteria for I3A.

3.7.3. Lighting

3.7.3.1. General.

3.7.3.1.1. Provide interior lighting controls in accordance with ASHRAE 90.1.

3.7.3.1.2. Provide an illuminance level of 30 foot-candles in mechanical and electrical rooms.

3.7.3.1.3. Compact fluorescent lamps of 12 watts or less shall not be used.

3.7.3.1.4. Electronic ballasts for linear fluorescent lamps shall be the high efficiency programmed start type.

3.7.3.1.5. Provided lighting levels shall be within +/- 10% of required lighting levels.

3.7.3.2. Not Used

3.7.3.3. WTUAS

3.7.3.3.1. Local manual controls shall supplement automatic controls in restrooms, offices, open work spaces, reception/waiting room, and specialized areas such as conference rooms.

3.7.3.3.2. Provide an illuminance level of 20 foot-candles in the reception and waiting area. Provide an illuminance level of 30 foot-candles on the CQ workstation in the reception/waiting room.

3.7.3.3.3. Provide an illuminance level of 10 foot-candles in supply and records rooms. Provide automatic occupancy sensor detection switching for fixtures.

3.7.3.3.4. Provide an illuminance level of 30 foot-candles in kitchenette. Provide automatic occupancy sensor detection switching for fixtures.

3.7.3.3.5. Not Used

3.7.3.4. SFAC

3.7.3.4.1. Local manual controls shall supplement automatic controls in restrooms, public computer access rooms, offices, reception area; and specialized areas such as multi-use/conference rooms.

3.7.3.4.2. Provide a minimum illuminance level of 1 foot-candle in courtyards. Decorative lighting fixtures are required. If poles are utilized they are not allowed to be over 10 feet tall. Provide manual switching from inside the SFAC.

3.7.3.4.3. Provide an illuminance level of 30 foot-candles in the child activity room. Lighting shall be compatible with security cameras to ensure area covered by each camera can be clearly seen on the reception monitor. Contractor shall coordinate camera type and location with the installation thru the contracting officer's representative.

3.7.3.4.4. Provide an illuminance level of 20 foot-candles in the reception area. Provide an illuminance level of 30 foot-candles on reception station within the reception area.

3.7.3.4.5. Provide an illuminance level of 30 foot-candles in the public computer access room and nourishment center.

3.7.3.4.6. Provide an illuminance level of 10 foot-candles in the distribution center.

3.7.3.4.7. Provide separately switched accent lighting on the interior side of the fireplace.

3.7.3.4.8. Provide an illuminance level of 50 foot-candles in the cam room.

3.7.3.4.9. Provide an illuminance level of 30 foot-candles in the storage room behind the reception counter and in the storage room adjacent to the AW2 office.

3.7.3.5. Not Used

3.7.4. Telecommunications System

3.7.4.1. Provide telecommunications outlets per applicable criteria based on functional purpose of the space within the building and in accordance with other provisions of this RFP. Provide voice and data connection capability to all workstations.

3.7.4.2. Not Used

3.7.4.3. WTUAS

3.7.4.3.1. Provide one dual 8-pin modular jack outlet in the CQ workstation, two in the copier and fax room; one in the message center and one at the front of the conference room.

3.7.4.3.2. Provide a dual 8-pin modular jack outlet at each designated individual work space (cubicle) in the open office area.

3.7.4.4. SFAC

3.7.4.4.1. Provide six single 8-pin modular jack outlets for data connectivity in the public computer access room evenly spaced above counter.

3.7.4.4.2. Provide a dual 8-pin modular jack outlet in the reception station and at the front of the conference/multi-use room.

3.7.4.4.3. Provide a dual 8-pin modular jack outlet above the sign-in countertop in the child activity room. Locate adjacent to duplex receptacle.

3.7.4.4.4. Provide a minimum of five single 8-pin modular jack (data) outlets along the wall in the older children's area within the child activity room. Locate each adjacent to a duplex receptacle.

3.7.4.4.5. Provide necessary LAN connection for kiosk.

3.7.4.4.6. Provide connectivity for two pay phones in vestibule. Coordinate requirements with local private telephone company.

3.7.4.4.7. Provide a minimum of four dual 8-pin modular jack outlets in the distribution center.

3.7.4.4.8. Provide two dual 8-pin modular jack outlets in the storage room behind the reception counter and in the storage room adjacent to the AW2 office. Locate adjacent to a duplex receptacle.

3.7.4.4.9. Not Used

3.7.4.5. Not Used

3.7.5. Video Teleconferencing

Provide an outlet that has both a fiber optic jack and a coaxial jack to provide video teleconferencing connectivity in each conference room. Outlet shall have a 125-volt duplex receptacle mounted adjacent to it in accordance with the Technical Criteria for I3A.

3.7.6. CATV

All CATV outlet boxes, connectors, cabling, and cabinets shall conform to applicable criteria unless noted otherwise. All horizontal cabling shall be homerun from the CATV outlet to the nearest telecommunications room unless noted otherwise. See paragraph 6.0 PROJECT SPECIFIC REQUIREMENTS for possible additional requirements.

3.7.6.1. Not Used

3.7.6.2. WTUAS

3.7.6.2.1. Provide connectivity in conference rooms.

3.7.6.2.2. Provide connectivity in reception/waiting room. Provide a minimum of two outlets.

3.7.6.3. SFAC

3.7.6.3.1. Provide connectivity in multi-use/conference room.

3.7.6.3.2. Provide connectivity in child activity room and reception/waiting room. Provide a minimum of two outlets in each room.

3.7.7. Mass Notification

MNS shall be integrated into the installation's area wide MNS (Giant Voice). See paragraph 6 for possible additional requirements.

3.7.8. Not Used

3.7.9. Observation Cameras Infrastructure (Cameras, CPU's and monitors not in contract)

The infrastructure shall be installed to support GFGI cameras, CPU'S and monitors. Cameras will be installed in child activity room and throughout the playground area to allow for observation of all areas within the room and playground. Cameras will also be installed within all storage areas accessible from within the child activity room. Location of GFGI cameras shall be coordinated with the installation thru the COR and approved by the Family and Morale Welfare and Recreation Command (FMWRC). CPU'S will be located on dedicated equipment racks within the camera room and observation monitors will be located in the reception/waiting room visible to both waiting personnel and the reception desk. A monitor will also be provided in the director's office. Infrastructure shall consist of conduit, pull wire and outlet boxes to allow for interconnection of all system components.

3.7.10. Sound System Infrastructure

Provide speakers, conduit, and wiring for a stand alone sound system within the reception area. Wiring and conduits shall be run back to the reception desk to be connected (by others) to a sound system provided by others. Provide 10' of slack for all wiring.

3.7.11. Audio/Visual System

Provide a dual 8-pin modular jack outlet at the front of each conference room and an empty 1" conduit (with pull wire) above the ceiling from each GFGI ceiling mounted projector location to a wall mounted outlet box located adjacent to the dual jack outlet.

3.8. FIRE ALARM REQUIREMENTS

3.8.1. All software, software locks, special tools and any other proprietary equipment required to maintain, add devices to or delete devices from the system, or test the Fire Alarm system shall become property of the Government and be furnished to the Contracting Officer's Representative prior to final inspection of the system.

3.8.2. The fire alarm system installation shall be supervised by a National Institute for Certification of Engineering Technologies (NICET) Level 3 (minimum) technician.

3.8.3. Not Used

4.0 APPLICABLE CRITERIA

Unless a specific document version or date is indicated, use criteria from the most current references as of the date of issue of the contract or task order, including any applicable addenda, unless otherwise stated in the task order. In the event of conflict between References and/or Applicable Military Criteria, apply the most stringent requirement, unless otherwise specifically noted in the contract or task order.

4.1. INDUSTRY CRITERIA

Applicable design and construction criteria references are listed in Table 1 below. This list is not intended to include all criteria that may apply or to restrict design and construction to only those references listed. See also Paragraph 3 for additional facility-specific applicable criteria.

Table 1: Industry Criteria

Air Conditioning and Refrigeration Institute (ARI)	
ARI 310/380	Packaged Terminal Air-Conditioners and Heat Pumps
ARI 440	Room Fan-Coil and Unit Ventilator
ANSI/ARI 430-99	Central Station Air Handling Units
ARI 445	Room Air-Induction Units
ARI 880	Air Terminals
Air Movement and Control Association (AMCA)	
AMCA 210	Laboratory Methods of Testing Fans for Rating
American Architectural Manufacturers Association (AAMA)	
AAMA 605	Voluntary Specification Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels
AAMA 607.1	Voluntary Guide Specifications and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum
AAMA 1503	Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections
American Association of State Highway and Transportation Officials (AASHTO)	
	Roadside Design Guide [guardrails, roadside safety devices]
	Standard Specifications for Transportation Materials and Methods of Sampling and Testing [Road Construction Materials]

	Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals
	Guide for Design of Pavement Structures, Volumes 1 and 2 [pavement design guide]
	A Policy of Geometric Design of Highways and Streets
American Bearing Manufacturers Association (AFBMA)	
AFBMA Std. 9	Load Ratings and Fatigue Life for Ball Bearings
AFBMA Std. 11	Load Ratings and Fatigue Life for Roller Bearings
American Boiler Manufacturers Association (ABMA)	
ABMA ISEI	Industry Standards and Engineering Information
American Concrete Institute	
ACI 302.2R	Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials
ACI 318	Building Code Requirements for Structural Concrete
ACI SP-66	ACI Detailing Manual
ACI 530	Building Code Requirements for Masonry Structures
ADA Standards for Accessible Design	
See US Access Board	ADA and ABA Accessibility Guidelines for Buildings and Facilities, Chapters 3-10.
American Institute of Steel Construction (AISC)	
	Manual of Steel Construction – 13th Edition (or latest version)
American Iron and Steel Institute	
AISI S100	North American Specification for the Design of Cold-Formed Steel Structural Members
American National Standards Institute 11 (ANSI)	

ANSI Z21.10.1	Gas Water Heaters Vol. 1, Storage water Heaters with Input Ratings of 75,000 Btu per Hour or less
ANSI Z124.3	American National Standard for Plastic Lavatories
ANSI Z124.6	Plastic Sinks
ANSI Z21.45	Flexible Connectors of Other Than All-Metal Construction for Gas Appliances
ANSI/IEEE C2-2007	National Electrical Safety Code
ANSI/AF&PA NDS-2001	National Design Specification for Wood Construction
American Society of Civil Engineers (ASCE)	
ASCE 7	Minimum Design Loads for Buildings and Other Structures
ASCE 37	Design and Construction of Sanitary and Storm Sewers, Manuals and Reports on Engineering Practice [sanitary sewer and storm drain design criteria]
ASCE/SEI 31-03	Seismic Evaluation of Existing Buildings [Existing Building Alteration/Renovation]
ASCE/SEI 41-06	Seismic Rehabilitation of Existing Buildings [Existing Building Alteration/Renovation]
American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)	
ASHRAE 90.1	ANSI/ASHRAE/IESNA 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE Guideline 0	The Commissioning Process
ASHRAE Guideline 1.1	The HVAC Commissioning Process
ASHRAE Handbooks	Fundamentals, HVAC Applications, Systems and Equipment, Refrigeration (Applicable, except as otherwise specified)
ASHRAE Standard 15	Safety Standard for Refrigeration Systems
ASHRAE Standard 62.1	Ventilation for Acceptable Indoor Air Quality
ASHRAE Standard 55	Thermal Environmental Conditions for Human Occupancy (Design portion is applicable)

American Society of Mechanical Engineers International (ASME)	
ASME BPVC SEC VII	Boiler and Pressure Vessel Code: Section VII Recommended Guidelines for the Care of Power Boilers
ASME A17.1	Safety Code for Elevators and Escalators
ASME B 31 (Series)	Piping Codes
American Water Works Association (AWWA)	
	Standards [standards for water line materials and construction]
American Welding Society	
	Welding Handbook
	Welding Codes and Specifications (as applicable to application, see International Building Code for example)
Architectural Woodwork Institute (AWI)	
Version 1.2	AWI Quality Standards 7th Edition
Associated Air Balance Council (AABC)	
AABC MN-1	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems
	AABC Associated Air Balance Council Testing and Balance Procedures
ASTM International	
ASTM C1060-90(1997)	Standard Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings
ASTM E 779 (2003)	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
ASTM E1827-96(2002)	Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
Builders Hardware Manufacturers Association (BHMA)	
ANSI/BHMA	American National Standards for Builders Hardware

Building Industry Consulting Service International	
	Telecommunications Distribution Methods Manual (TDMM)
	Customer-Owned Outside Plant Design Manual (CO-OSP)
Code of Federal Regulations (CFR)	
49 CFR 192	Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards
10 CFR 430	Energy Conservation Program for Consumer Products
Consumer Electronics Association	
CEA 709.1B	Control Network Protocol Specification
CEA 709.3	Free-Topology Twisted-Pair Channel Specification
CEA 852	Tunneling Component Network Protocols Over Internet Protocol Channels
Electronic Industries Association (EIA)	
ANSI/EIA/TIA 568	Structured Cabling Series
ANSI/EIA/TIA 569	Commercial Building Standard for Telecommunications Pathways and Spaces (includes ADDENDA)
ANSI/TIA/EIA-606	Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings
J-STD EIA/TIA 607	Commercial Building Grounding and Bonding Requirements for Telecommunications
Federal Highway Administration (FHWA)	
	Manual on Uniform Traffic Control Devices for Streets and Highways [signage and pavement markings for streets and highways]
FHWA-NHI-01-021	Hydraulic Engineering Circular No. 22, Second Edition, URBAN DRAINAGE DESIGN MANUAL
Illuminating Engineering Society of North America (IESNA)	
IESNA RP-1	Office Lighting

IESNA RP-8	Roadway Lighting
IESNA Lighting Handbook	Reference and Application
Institute of Electrical and Electronics Engineers Inc. (IEEE)	
	Standard for Use of the International System of Units (SI): the Modern Metric System
Standard 1100	Recommended Practice for Powering and Grounding Sensitive Electronic Equipment
International Code Council (ICC)	
IBC	International Building Code Note: All references in the International Building Code to the International Electrical Code shall be considered to be references to NFPA 70. All references in the International Building Code to the International Fuel Gas Code shall be considered to be references to NFPA 54 and NFPA 58. All references in the International Building Code to the International Fire Code and Chapter 9 shall be considered to be references to Unified Facilities Criteria (UFC) 3-600-01.
IMC	International Mechanical Code – Note: For all references to “HEATING AND COOLING LOAD CALCULATIONS”, follow ASHRAE 90.1 Note: For all references to “VENTILATION”, follow ASHRAE 62.1
IRC	International Residential Code
IPC	International Plumbing Code
IEC	Energy Conservation Code (IEC) –Applicable only to the extent specifically referenced herein. Refer to Paragraph 5, ENERGY CONSERVATION requirements.
IGC	International Gas Code - not applicable. Follow NFPA 54, National Fuel Gas Code and NFPA 58, Liquified Petroleum Gas Code.
International Organization for Standardization (ISO)	
ISO 6781:1983	Qualitative detection of thermal irregularities in building envelopes –

	infrared method
LonMark International (LonMark)	
LonMark Interoperability Guidelines	(available at www.lonmark.org), including: Application Layer Guidelines, Layer 1-6 Guidelines, and External Interface File (XIF) Reference Guide
LonMark Resource Files	(available at www.lonmark.org), including Standard Network Variable Type (SNVT) definitions
Metal Building Manufacturers Association (MBMA)	
	Metal Building Systems Manual
Midwest Insulation Contractors Association (MICA)	
	National Commercial and Industrial Insulation Standards Manual
National Association of Corrosion Engineers International (NACE)	
NACE RP0169	Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE RP0185	Extruded, Polyolefin Resin Coating Systems with Adhesives for Underground or Submerged Pipe
NACE RP0285	Corrosion Control of Underground Storage Tank Systems by Cathodic Protection
NACE RP0286	Electrical Isolation of Cathodically Protected Pipelines
National Electrical Manufacturers Association (NEMA)	
National Environmental Balancing Bureau (NEBB)	
	Procedural Standards Procedural Standards for Testing Adjusting Balancing of Environmental Systems
National Fire Protection Association (NFPA)	
NFPA 10	Standard for Portable Fire Extinguishers
NFPA 13	Installation of Sprinkler Systems
NFPA 13R	Residential Occupancies up to and Including Four Stories in Height Sprinkler Systems

NFPA 14	Standard for the Installation of Standpipes and Hose Systems
NFPA 20	Installation of Centrifugal Fire Pumps
NFPA 24 NFPA 25	Standard for the Installation of Private Fire Service Mains and Their Appurtenances [underground fire protection system design] Inspection, Testing And Maintenance Of Water-Based Fire Protection Systems
NFPA 30	Flammable and Combustible Liquids Code
NFPA 30A	Motor Fuel Dispensing Facilities and Repair Garages
NFPA 31	Installation of Oil Burning Equipment
NFPA 54	National Fuel Gas Code
NFPA 58	Liquefied Petroleum Gas Code
NFPA 70	National Electrical Code
NFPA 72	National Fire Alarm Code
NFPA 76	Fire Protection of Telecommunications Facilities
NFPA 80	Standard for Fire Doors and Fire Windows
NFPA 90a	Installation of Air Conditioning and Ventilating Systems
NFPA 96	Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
NFPA 101	Life Safety Code
NFPA 780	Standard for the Installation of Lightning Protection Systems
National Roofing Contractor's Association (NRCA)	
	Roofing and Waterproofing Manual
National Sanitation Foundation, International	
NSF/ANSI Std. 2, 3, 4, 5, 6, 7, 8, 12, 13, 18, 20, 21, 25, 29, 35, 36, 37, 51, 52, 59,	Food Equipment Standards

169	
ANSI/UL Std. 73, 197, 471, 621, 763	Food Equipment Standards
CSA Std. C22.2 No. 109, 120, 195	Food Equipment Standards
Occupational Safety and Health Administration (OSHA)	
Title 29, Part 1926	OSHA Construction Industry Standards, Title 29, Code of Federal Regulations, Part 1926, Safety and Health Regulations for Construction
Plumbing and Drainage Institute (PDI)	
PDI G 101	Testing and Rating Procedure for Grease Interceptors with Appendix of Sizing and Installation Data
PDI WH201	Water Hammer Arrestors
Precast Concrete Institute	
PCI Design Handbook	Precast and Prestressed Concrete
Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)	
SMACNA HVAC Duct Construction Standards	HVAC Duct Construction Standards - Metal and Flexible
SMACNA Architectural Manual	Architectural Sheet Metal Manual
SMACNA HVAC TAB	HVAC Systems - Testing, Adjusting and Balancing
State/Local Regulations	
	State Department of Transportation Standard Specifications for Highway and Bridge Construction
	Sedimentation and Erosion Control Design Requirements
	Environmental Control Requirements
	Storm Water Management Requirements
Steel Door Institute (SDI)	

ANSI A250.8/SDI 100	Standard Steel Doors and Frames
Steel Deck Institute	
	SDI Diaphragm Design Manual
Steel Joist Institute	
	Catalog of Standard Specifications and Load Tables for Steel Joists and Joist Girders
Underwriters Laboratories (UL)	
UL 96A	Installation Requirements for Lightning Protection Systems
UL 300	Standard for Safety for Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Areas
UNITED STATES ACCESS BOARD: U.S. ARCHITECTURAL AND TRANSPORTATION BARRIERS COMPLIANCE BOARD	
ADA and ABA Accessibility Guidelines for Buildings and Facilities	ABA Accessibility Standard for DoD Facilities Derived from the ADA and ABA Accessibility Guidelines: Specifically includes: ABA Chapters 1 and 2 and Chapters 3 through 10. Use this reference in lieu of IBC Chapter 11. Excluded are: (a) Facilities, or portions of facilities, on a military installation that are designed and constructed for use exclusively by able-bodied military personnel (See Paragraph 3 for any reference to this exclusion). (b) Reserve and National Guard facilities, or portions of such facilities, owned by or under the control of the Department of Defense, that are designed and constructed for use exclusively by able-bodied military personnel. (See paragraph 3 for any reference to this exclusion).
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES	
	FDA National Food Code
U.S. GREEN BUILDING COUNCIL (USGBC)	
LEED-NC	Green Building Rating System for New Construction & Major Renovations
	Application Guide for Multiple Buildings and On-Campus Building Projects

4.2. MILITARY CRITERIA

The project shall conform to the following criteria. Certain design impacts and features due to these criteria are noted for the benefit of the offeror. However, all requirements of the referenced criteria will be applicable, whether noted or not, unless otherwise specified herein.

4.2.1. Energy Policy Act of 2005 (Public Law 109-58) (applies only to the extent specifically implemented in the contract, which may or may not directly cite or reference EPACT)

4.2.2. Executive Order 12770: Metric Usage In Federal Government

(a) Metric design and construction is required except when it increases construction cost. Offeror to determine most cost efficient system of measurement to be used for the project.

4.2.3. TB MED 530: Occupational and Environmental Health Food Sanitation

4.2.4. Unified Facilities Criteria (UFC) 3-410-01FA: Heating, Ventilating, and Air Conditioning - applicable only to the extent specified in paragraph 5, herein.

4.2.5. Deleted.

4.2.6. UFC 3-600-01 Design: Fire Protection Engineering for Facilities. Use the latest edition of the IBC in coordination with this UFC. Use Chapters 3, 6, 7, 33 and UFC 3-600-01. If any conflict occurs between these Chapters and UFC 3-600-01, the requirements of UFC 3-600-01 take precedence. Use UFC 3-600-01 in lieu of IBC Chapters 4, 8,9,10.

4.2.7. UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings

4.2.8. UFC 4-023-03 Design of Buildings to Resist Progressive Collapse (Use most recent version, regardless of references thereto in other publications)

(a) Note the option to use tie force method or alternate path design for Occupancy Category II.

4.2.9. UFC 4-021-01 Design and O&M: Mass Notification Systems

4.2.10. Technical Criteria for Installation Information Infrastructure Architecture (I3A)

(a) Email: DetrickISECI3Aguide@conus.army.mil

4.2.11. U.S. Army Information Systems Engineering Command (USAISEC) TG for the Integration of SECRET Internet Protocol (IP) Router Network (SIPRNET). See Paragraph 3 for applicability to specific facility type. May not apply to every facility. This is mandatory criteria for those facilities with SIPRNET.

5.0 GENERAL TECHNICAL REQUIREMENTS

This paragraph contains general technical requirements. See also Paragraph 3 for facility-specific technical requirements. Residential or similar grade finishes and materials are not acceptable for inclusion in these buildings, unless otherwise specifically allowed.

5.1. SITE PLANNING AND DESIGN

5.1.1. STANDARDS AND CODES: The site planning and design shall conform to APPLICABLE CRITERIA and to paragraph 6, PROJECT SPECIFIC REQUIREMENTS.

5.1.2. SITE PLANNING OBJECTIVES: Group buildings in configurations that create a sense of community and promote pedestrian use. See paragraph 3 for additional site planning requirements relating to building functions.

5.1.2.1. Provide enclosures and or visual screening devices for Outdoor Utility such as dumpsters, emergency generators, transformers, heating, ventilation, and air conditioning units from streetscape and courtyard views to limit visual impact. Enclosures shall be compatible with the building they serve and accessible by vehicle. The location of dumpsters can have a significant visual impact and should be addressed as part of an overall building design and incorporated in site planning.

5.1.2.2. Where included in the project, dumpster pads shall be concrete (minimum of 8 inches thick on 4 inch base course, unless site conditions dictate more conservative requirements) and directly accessible by way of a paved service drive or parking lot with adequate overhead clearance for collection vehicles. Provide space at dumpster areas for recycling receptacles. Coordinate with Installation on recycling receptacle types, sizes and access requirements and provide space at dumpster areas to accommodate them.

5.1.2.3. Vehicular Circulation. Apply design vehicle templates provided by the American Association of State Highway and Transportation Officials (AASHTO) to the site design. The passenger car class includes passenger cars and light trucks, such as vans and pick-ups. The passenger car template is equivalent to the non-organizational – privately owned vehicle (POV). The truck class template includes single-unit trucks, recreation vehicles, buses, truck tractor-semi-trailer combinations, and trucks or truck tractors with semi-trailers in combination with full trailers. Provide vehicle clearances required to meet traffic safety for emergency vehicles, service vehicles, and moving vans. Provide required traffic control signage Site entrances and site drive aisles shall maximize spacing between drives, incorporate right-angle turns, and limit points of conflict between traffic. Design Services Drives to restrict access to unauthorized vehicles by removable bollards, gates, or other barriers to meet Anti-Terrorism/Force Protection (ATFP) requirements. Orient service drives to building entrances other than the primary pedestrian entry at the front of the building.

5.1.2.4. Provide Emergency Vehicle Access around the facility and shall be in accordance with AT/FP requirements. Maintain a 33-foot clear zone buffer for emergency vehicles, designed to prevent other vehicles from entering the AT/FP standoff to the building.

5.1.2.5. Clear and grub all trees and vegetation necessary for construction; but, save as many trees as possible. Protect trees to be saved during the construction process from equipment.

5.1.2.6. Stormwater Management. Employ design and construction strategies (Best Management Practices) that reduce stormwater runoff, reduce discharges of polluted water offsite and maintain or restore predevelopment hydrology with respect to temperature, rate, volume and duration of flow to the maximum extent practicable. See paragraph 6, PROJECT SPECIFIC requirements for additional information.

5.1.3. EXTERIOR SIGNAGE: Provide exterior signage in accordance with Appendix H, Exterior Signage. Provide exterior NO SMOKING signage that conveys building and grounds smoking policy.

5.1.4. EXISTING UTILITIES: Base utilities maps and capacities for this site are included as part of this RFP. See paragraph 6 for more detailed information.

5.2. SITE ENGINEERING

5.2.1. STANDARDS AND CODES: The site engineering shall conform to APPLICABLE CRITERIA.

5.2.2. SOILS:

5.2.2.1. A report has been prepared to characterize the subsurface conditions at the project site and is **appended to these specifications.** The report provides a general overview of the soil and geologic conditions with detailed descriptions at discrete boring locations. The Contractor's team shall include a licensed geotechnical engineer to interpret the report and develop earthwork and foundation recommendations and design parameters in which to base the contractor's design. If any additional subsurface investigation or laboratory analysis is required to better characterize the site or develop the final design, the Contractor shall perform it under the direction of a licensed geotechnical engineer. There will be no separate payment for the cost of additional tests. If differences between the Contractor's additional subsurface investigation and the government provided soils report or the reasonably expected conditions require material revisions in the design, an equitable adjustment may be made, in accordance with the provisions of the Differing Site Conditions clause. The basis for the adjustment would be the design and construction appropriate for the conditions described in the Government furnished report or the reasonably expected conditions, in comparison with any changes required by material differences in the actual conditions encountered, in accordance with the terms of contract clause Differing Site Conditions.

5.2.2.2. The contractor's licensed geotechnical engineer shall prepare a final geotechnical evaluation report, to be submitted along with the first foundation design submittal, as described in Section 01 33 16, *Design After Award*.

5.2.3. VEHICLE PAVEMENTS: (as applicable to the project)

5.2.3.1. Design procedures and materials shall conform to one of the following: 1) the USACE Pavement Transportation Computer Assisted Structural Engineering (PCASE) program, 2) American Association of State Highway and Transportation Officials (AASHTO) or, 3) the applicable state Department of Transportation standards in which the project is located. See paragraph 5.2.2.2 and Section 01 33 16 for required information for the Contractor's geotechnical evaluation report. The minimum flexible pavement section shall consist of 2 inches of asphalt and 6 inches of base or as required by the pavement design, whichever is greater, unless specifically identified by the Government to be a gravel road. Design roads and parking areas for a life expectance of 25 years with normal maintenance. Parking area for tactical vehicles (as applicable to the project) shall be Portland Cement Concrete (PCC) rigid pavement design. For concrete pavements, submit joint layout plan for review and concurrence. Design pavements for military tracked vehicles (as applicable to the project) IAW USACE PCASE. Traffic estimates for each roadway area will be as shown on the drawings or listed in Section 01 10 00 Paragraph 6.4.4. Pavement markings and traffic signage shall comply with the Installation requirements and with the Manual on Uniform Traffic Control Devices.

5.2.3.2. Parking Requirements.

(a) All handicap POV parking lots (where applicable in the facility specific requirements) shall meet the ADA and ABA Accessibility Guidelines for accessible parking spaces.

(b) Design POV parking spaces for the type of vehicles anticipated, but shall be a minimum of 9 ft by 18 ft for POVs, except for two wheel vehicles.

5.2.3.3. Sidewalks. Design the network of walks throughout the complex (where applicable) to facilitate pedestrian traffic among facilities, and minimize the need to use vehicles. Incorporate sidewalks to enhance the appearance of the site development, while creating a sense of entry at the primary patron entrances to the buildings. Minimum sidewalk requirements are in Paragraph 3, where applicable.

5.2.4. CATHODIC PROTECTION: Provide cathodic protection systems for all underground metallic systems and metallic fittings/portions of non-metallic, underground systems, both inside and outside the building 5 foot line that are subject to corrosion. Coordinate final solutions with the installation to insure an approach that is consistent with installation cathodic protection programs.

5.2.5. UTILITIES: See paragraph 6.4.6 for specific information on ownership of utilities and utility requirements. Meter all utilities (gas, water, and electric, as applicable) to each facility. For Government owned utilities, install meters that are wireless data transmission capable as well as have a continuous manual reading option. All meters will be capable of at least hourly data logging and transmission and provide consumption data for gas, water, and electricity. Gas and electric meters will also provide demand readings based on consumption over a maximum of

any 15 minute period. Configure all meters to transmit at least daily even if no receiver for the data is currently available at the time of project acceptance. For privatized utilities, coordinate with the privatization utility(ies) for the proper meter base and meter installation.

5.2.6. PERMITS: The CONTRACTOR shall be responsible for obtaining all permits (local, state and federal) required for design and construction of all site features and utilities.

5.2.7. IRRIGATION. Landscape irrigation systems, if provided, shall comply with the following:

5.2.7.1. Irrigation Potable Water Use Reduction. Reduce irrigation potable water use by 100 percent using LEED credit WE1.1 baseline (no potable water used for irrigation), except where precluded by other project requirements.

5.2.8. EPA WaterSense Products and Contractors. Except where precluded by other project requirements, use EPA WaterSense labeled products and irrigation contractors that are certified through a WaterSense labeled program where available.

5.3. ARCHITECTURE AND INTERIOR DESIGN:

This element will be evaluated per APPLICABLE CRITERIA under the quality focus.

5.3.1. STANDARDS AND CODES: The architecture and interior design shall conform to APPLICABLE CRITERIA.

5.3.2. GENERAL: Overall architectural goal is to provide a functional, quality, visually appealing facility that is a source of pride for the installation and delivered within the available budget and schedule.

5.3.3. COMPUTATION OF AREAS: See APPENDIX Q for how to compute gross and net areas of the facility(ies).

5.3.4. BUILDING EXTERIOR: Design buildings to enhance or compliment the visual environment of the Installation. Where appropriate, reflect a human scale to the facility. Building entrance should be architecturally defined and easily seen. When practical, exterior materials, roof forms, and detailing shall be compatible with the surrounding development and adjacent buildings on the Installation and follow locally established architectural themes. Use durable materials that are easy to maintain. Exterior colors shall conform to the Installation requirements. See paragraph 6.

5.3.4.1. Building Numbers: Each building shall have exterior signage permanently attached on two faces of the building indicating the assigned building number or address. Building number signage details and locations shall conform to Appendix H, Exterior Signage.

5.3.5. BUILDING INTERIOR

5.3.5.1. Space Configuration: Arrange spaces in an efficient and functional manner in accordance with area adjacency matrices.

5.3.5.2. Surfaces: Appearance retention is the top priority for building and furniture related finishes. Provide low maintenance, easily cleaned room finishes that are commercially standard for the facility occupancy specified, unless noted otherwise.

5.3.5.3. Color: The color, texture and pattern selections for the finishes of the building shall provide an aesthetically pleasing, comfortable, easily maintainable and functional environment for the occupants. Coordination of the building colors and finishes is necessary for a cohesive design. Color selections shall be appropriate for the building type. The use of color, texture and pattern shall be used to path or way find through the building. Trendy colors that will become dated shall be limited to non-permanent finishes such as carpet and paint. Finishes should be selected with regards to aesthetics, maintenance, durability, life safety and image. Limit the number of similar colors for each material. Color of Ceramic and porcelain tile grout shall be medium range color to help hide soiling. Plastic laminate and solid surface materials shall have patterns that are mottled, flecked or speckled. Finish colors of fire extinguisher cabinets, receptacle bodies and plates, fire alarms / warning lights, emergency lighting, and other miscellaneous items shall be coordinated with the building interior. Color of equipment items on ceilings (speakers, smoke detectors, grills, etc.) shall match the ceiling color.

5.3.5.4. Circulation: Circulation schemes must support easy way finding within the building.

5.3.5.5. Signage: Provide interior signage for overall way finding and life safety requirements. A comprehensive interior plan shall be from one manufacturer. Include the following sign types: (1) Lobby Directory, (2) Directional Signs; (3) Room Identification Signs; (4) Building Service Signs; (5) Regulatory Signs; (6) Official and Unofficial Signs (7) Visual Communication Boards (8) NO SMOKING signage that conveys building smoking policy. Use of emblems or logos may also be incorporated into the signage plan.

5.3.5.6. Window Treatment: Interior window treatments with adjustable control shall be provided in all exterior window locations for control of day light coming in windows or privacy at night. Uniformity of treatment color and material shall be maintained to the maximum extent possible within a building.

5.3.6. COMPREHENSIVE INTERIOR DESIGN

5.3.6.1. Comprehensive Interior Design includes the integration of a Structural Interior Design (SID) and a Furniture, Fixtures and Equipment (FF&E) design and package. SID requires the design, selection and coordination of interior finish materials that are integral to or attached to the building structure. Completion of a SID involves the selection and specification of applied finishes for the building's interior features including, but not limited to, walls, floors, ceilings, trims, doors, windows, window treatments, built-in furnishings and installed equipment, lighting, and signage. The SID package includes finish schedules, finish samples and any supporting interior elevations, details or plans necessary to communicate the building finish design and build out. The SID also provides basic space planning for the anticipated FF&E requirements in conjunction with the functional layout of the building and design issues such as life safety, privacy, acoustics, lighting, ventilation, and accessibility. See Section 01 33 16 for SID design procedures.

The FF&E design and package includes the design, selection, color coordination and of the required furnishing items necessary to meet the functional, operational, sustainability, and aesthetic needs of the facility coordinated with the interior finish materials in the SID. The FF&E package includes the specification, procurement documentation, placement plans, ordering and finish information on all freestanding furnishings and accessories, and a cost estimate. Coordinate the selection of furniture style, function and configuration with the defined requirements. Examples of FF&E items include, but are not limited to workstations, seating, files, tables, beds, wardrobes, draperies and accessories as well as marker boards, tack boards, and presentation screens. Criteria for furniture selection include function and ergonomics, maintenance, durability, sustainability, comfort and cost. See Section 01 33 16 for FFE design procedures.

5.4. STRUCTURAL DESIGN

5.4.1. STANDARDS AND CODES: The structural design shall conform to APPLICABLE CRITERIA.

5.4.2. GENERAL: The structural system needs to be compatible with the intended functions and components that allows for future flexibility and reconfigurations of the interior space. Select an economical structural system based upon facility size, projected load requirements and local availability of materials and labor. Base the structural design on accurate, site specific geotechnical information and anticipated loads for the building types and geographical location. Consider climate conditions, high humidity, industrial atmosphere, saltwater exposure, or other adverse conditions when selecting the type of cement and admixtures used in concrete, the concrete cover on reinforcing steel, the coatings on structural members, expansion joints, the level of corrosion protection, and the structural systems. Analyze, design and detail each building as a complete structural system. Design structural elements to preclude damage to finishes, partitions and other frangible, non-structural elements to prevent impaired operability of moveable components; and to prevent cladding leakage and roof ponding. Limit deflections of structural members to the allowable of the applicable material standard, e.g., ACI, AISC, Brick Industry Association, etc. When modular units or other pre-fabricated construction is used or combined with stick-built construction, fully coordinate and integrate the overall structural design between the two different or interfacing construction types. If the state that the project is located in requires separate, specific licensing for structural engineers (for instance, such as in Florida, California and others), then the structural engineer designer of record must be registered in that state.

5.4.3. LOADS: See paragraph 3 for facility specific (if applicable) and paragraph 6 for site and project specific structural loading criteria. Unless otherwise specified in paragraph 6, use Exposure Category C for wind. If not specified, use Category C unless the Designer of Record can satisfactorily justify another Exposure Category in its

design analysis based on the facility Master Plan. Submit such exceptions for approval as early as possible and prior to the Interim Design Submittal in Section “Design After Award”. In addition to gravity, seismic and lateral loads, design the ancillary building items, e.g. doors, window jambs and connections, overhead architectural features, equipment bracing, for the requirements of UFC 4-010-01, DOD Minimum Antiterrorism Standards for Buildings. Ensure and document that the design of glazed items includes, but is not limited to, the following items under the design loads prescribed in UFC 4-010-01:

(a) Supporting members of glazed elements, e.g. window jamb, sill, header

(b) Connections of glazed element to supporting members, e.g. window to header

(c) Connections of supporting members to each other, e.g. header to jamb

(d) Connections of supporting members to structural system, e.g. jamb to foundation.

5.4.4. TERMITE TREATMENT: (Except Alaska) Provide termite prevention treatment in accordance with Installation and local building code requirements, using licensed chemicals and licensed applicator firm.

5.5. THERMAL PERFORMANCE

5.5.1. STANDARDS AND CODES: Building construction and thermal insulation for mechanical systems shall conform to APPLICABLE CRITERIA.

5.5.2. BUILDING ENVELOPE SEALING PERFORMANCE REQUIREMENT. Design and construct the building envelope for office buildings, office portions of mixed office and open space (e.g., company operations facilities), dining, barracks and instructional/training facilities with a continuous air barrier to control air leakage into, or out of, the conditioned space. Clearly identify all air barrier components of each envelope assembly on construction documents and detail the joints, interconnections and penetrations of the air barrier components. Clearly identify the boundary limits of the building air barriers, and of the zone or zones to be tested for building air tightness on the drawings.

5.5.2.1. Trace a continuous plane of air-tightness throughout the building envelope and make flexible and seal all moving joints.

5.5.2.2. The air barrier material(s) must have an air permeance not to exceed 0.004 cfm / sf at 0.3” wg (0.02 L/s.m2 @ 75 Pa) when tested in accordance with ASTM E 2178

5.5.2.3. Join and seal the air barrier material of each assembly in a flexible manner to the air barrier material of adjacent assemblies, allowing for the relative movement of these assemblies and components.

5.5.2.4. Support the air barrier so as to withstand the maximum positive and negative air pressure to be placed on the building without displacement, or damage, and transfer the load to the structure.

5.5.2.5. Seal all penetrations of the air barrier. If any unavoidable penetrations of the air barrier by electrical boxes, plumbing fixture boxes, and other assemblies are not airtight, make them airtight by sealing the assembly and the interface between the assembly and the air barrier or by extending the air barrier over the assembly.

5.5.2.6. The air barrier must be durable to last the anticipated service life of the assembly.

5.5.2.7. Do not install lighting fixtures with ventilation holes through the air barrier

5.5.2.8. Provide a motorized damper in the closed position and connected to the fire alarm system to open on call and fail in the open position for any fixed open louvers such as at elevator shafts.

5.5.2.9. Damper and control to close all ventilation or make-up air intakes and exhausts, atrium smoke exhausts and intakes, etc when leakage can occur during inactive periods.

5.5.2.10. Compartmentalize garages under buildings by providing air-tight vestibules at building access points.

5.5.2.11. Compartmentalize spaces under negative pressure such as boiler rooms and provide make-up air for combustion.

5.5.2.12. Performance Criteria and Substantiation: Submit the qualifications and experience of the testing entity for approval. Demonstrate performance of the continuous air barrier for the opaque building envelope by the following tests:

(a) Test the completed building and demonstrate that the air leakage rate of the building envelope does not exceed 0.25cfm/ft2 at a pressure differential of 0.3" w.g.(75 Pa) in accordance with ASTM's E 779 (2003) or E-1827-96 (2002). Accomplish tests using either pressurization or depressurization or both. Divide the volume of air leakage in cfm @ 0.3" w.g. (L/s @ 75 Pa) by the area of the pressure boundary of the building, including roof or ceiling, walls and floor to produce the air leakage rate in cfm/ft2 @ 0.3" w.g. (L/s.m2 @ 75 Pa). Do not test the building until verifying that the continuous air barrier is in place and installed without failures in accordance with installation instructions so that repairs to the continuous air barrier, if needed to comply with the required air leakage rate, can be done in a timely manner.

(b) Test the completed building using Infrared Thermography testing. Use infrared cameras with a resolution of 0.1deg C or better. Perform testing on the building envelope in accordance with ISO 6781:1983 and ASTM C1060-90(1997). Determine air leakage pathways using ASTM E 1186-03 Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems, and perform corrective work as necessary to achieve the whole building air leakage rate specified in (a) above.

(c) Notify the Government at least three working days prior to the tests to provide the Government the opportunity to witness the tests. Provide the Government written test results confirming the results of all tests.

5.6. PLUMBING

5.6.1. STANDARDS AND CODES: The plumbing system shall conform to APPLICABLE CRITERIA.

5.6.2. PRECAUTIONS FOR EXPANSIVE SOILS: Where expansive soils are present, the design for underslab piping systems and underground piping serving chillers, cooling towers, etc, shall include features to control forces resulting from soil heave. Some possible solutions include, but are not necessarily limited to, features such as flexible expansion joints, slip joints, horizontal offsets with ball joints, or multiple bell and spigot gasketed fittings. For structurally supported slabs, piping should be suspended from the structure with adequate space provided below the pipe for the anticipated soil movement.

5.6.3. HOT WATER SYSTEMS: For Hot Water heating and supply, provide a minimum temp of 140 Deg F in the storage tank and a maximum of 110 Deg F at the fixture, unless specific appliances or equipment specifically require higher temperature water supply.

5.6.4. SIZING HOT WATER SYSTEMS: Unless otherwise specified or directed in paragraph 3, design in accordance with ASHRAE Handbook Series (appropriate Chapters), ASHRAE Standard 90.1, and the energy conservation requirements of the contract. Size and place equipment so that it is easily accessible and removable for repair or replacement.

5.6.5. JANITOR CLOSETS: In janitor spaces/room/closets, provide at minimum, a service sink with heavy duty shelf and wall hung mop and broom rack(s).

5.6.6. FLOOR DRAINS: As a minimum, provide floor drains in mechanical rooms and areas, janitor spaces/rooms/closets and any other area that requires drainage from fixtures or equipment, drain downs, condensate, as necessary.

5.6.7. URINALS: Urinals shall be vitreous china, wall-mounted, wall outlet, non-water using, with integral drain line connection, and with sealed replaceable cartridge or integral liquid seal trap. Either type shall use a biodegradable liquid to provide the seal and maintain a sanitary and odor-free environment. Install, test and maintain in accordance with manufacturer's recommendations. Slope the sanitary sewer branch line for non-water use urinals a minimum of 1/4 inch per foot. Do not use copper tube or pipe for drain lines that connect to the urinal. Manufacturer shall provide an operating manual and on-site training to installation operations personnel for the proper care and maintenance of the urinal. For complexes, non-water using urinals are not required for barracks type spaces.

5.6.8. BUILDING WATER USE REDUCTION. Reduce building potable water use in each building 30 percent using IPC fixture performance requirements baseline.

5.6.9. Do not use engineered vent or Sovent® type drainage systems.

5.6.10. Where the seasonal design temperature of the cold water entering a building is below the seasonal design dew point of the indoor ambient air, and where condensate drip will cause damage or create a hazard, insulate plumbing piping with a vapor barrier type of insulation to prevent condensation. Do not locate water or drainage piping over electrical wiring or equipment unless adequate protection against water (including condensation) damage is provided. Insulation alone is not adequate protection against condensation. Follow ASHRAE Fundamentals Chapter 23, Insulation for Mechanical Systems, IMC paragraph 1107 and International Energy Conservation Code for pipe insulation requirements.

5.7. ELECTRICAL AND TELECOMMUNICATIONS SYSTEMS

5.7.1. STANDARDS AND CODES: The electrical systems for all facilities shall conform to APPLICABLE CRITERIA.

5.7.2. MATERIALS AND EQUIPMENT: Materials, equipment and devices shall, as a minimum, meet the requirements of Underwriters Laboratories (UL) where UL standards are established for those items. Wiring for branch circuits shall be copper. Motors larger than one-half horsepower shall be three phase. All electrical systems shall be pre-wired and fully operational unless otherwise indicated. Wall mounted electrical devices (power receptacles, communication outlets and CATV outlets) shall have matching colors, mounting heights and faceplates.

5.7.3. POWER SERVICE: Primary service from the base electrical distribution system to the pad-mounted transformer and secondary service from the transformer to the building service electrical equipment room shall be underground. See paragraph 6 for additional site electrical requirements.

5.7.3.1. Spare Capacity: Provide 10% space for future circuit breakers in all panelboards serving residential areas of buildings and 15% spaces in all other panelboards.

5.7.4. TELECOMMUNICATION SERVICE: The project's facilities must connect to the Installation telecommunications (voice and data) system through the outside plant (OSP) telecommunications underground infrastructure cabling system per the I3A Criteria. Connect to the OSP cabling system from each facility main cross connect located in the telecommunications room.

5.7.5. LIGHTING: Comply with the recommendations of the Illumination Engineering Society of North America (IESNA), the National Energy Policy Act and Energy Star requirements for lighting products..

5.7.5.1. Interior Lighting:

(a) Reflective Surfaces: Coordinate interior architectural space surfaces and colors with the lighting systems to provide the most energy-efficient workable combinations.

(b) High Efficiency Fluorescent Lighting: Utilize NEMA premium electronic ballasts and energy efficient fluorescent lamps with a Correlated Color Temperature (CCT) of 4100K. Linear fluorescent and compact fluorescent fixtures shall have a Color Rendering Index of (CRI) of 87 or higher. Fluorescent lamps shall be the low mercury type qualifying as non-hazardous waste upon disposal. Do not use surface mounted fixtures on acoustical tile ceilings. Provide an un-switched fixture with emergency ballast shall be provided at each entrance to the building.

(c) Solid State Lighting: Fixtures shall provide lighting with a minimum Correlated Color Temperature (CCT) of 4100K and shall have a Color Rendering Index of (CRI) of 75 or higher. Verify performance of the light producing solid state components by a test report in compliance with the requirements of IESNA LM 80. Verify performance of the solid state light fixtures by a test report in compliance with the requirements of IESNA LM 79. Provide lab results by a NVLAP certified laboratory. The light producing solid state components and drivers shall have a life expectancy of 50,000 operating hours while maintaining at least 70% of original illumination level. Provide a complete five year warranty for fixtures.

(d) Metal Halide Lighting (where applicable): Metal Halide lamp fixtures in the range of 150-500 Watts shall be pulse start type and have a minimum efficiency rating of 88%.

(e) Lighting Controls: ANSI/ASHRAE/IESNA 90.1 has specific lighting controls requirements. Provide a high level of lighting system control by individual occupants or by specific groups in multi-occupant spaces (classrooms, conference rooms) to promote the productivity, comfort and well being of the building occupants. In office spaces, the preferred lighting should be a 30 FC ambient lighting level with occupancy sensor controlled task lighting in the work spaces to provide a composite lighting level of 50 FC on the working surfaces. Consider incorporating daylighting techniques for the benefit of reducing lighting energy requirements while improving the quality of the indoor spaces. If daylight strategies are used, additional coordination is required with the architect and mechanical engineer. Additionally, incorporate electric lighting controls to take advantage of the potential energy savings.

(f) Exterior Lighting: See paragraph 6.9 for site specific information, if any, on exterior lighting systems. Minimize light pollution and light trespass by not over lighting and use cutoff type exterior luminaries.

5.7.6. TELECOMMUNICATION SYSTEM: All building telecommunications cabling systems (BCS) and OSP telecommunications cabling system shall conform to APPLICABLE CRITERIA to include I3A Technical Criteria. An acceptable BCS encompasses, but is not limited to, copper and fiber optic (FO) entrance cable, termination equipment, copper and fiber backbone cable, copper and fiber horizontal distribution cable, workstation outlets, racks, cable management, patch panels, cable tray, cable ladder, conduits, grounding, and labeling.. Items included under OSP infrastructure encompass, but are not limited to, manhole and duct infrastructure, copper cable, fiber optic cable, cross connects, terminations, cable vaults, and copper and FO entrance cable.

5.7.6.1. Design, install, label and test all telecommunications systems in accordance with the I3A Criteria and ANSI/TIA/EIA 568, 569, and 606 standards. A Building Industry Consulting Services International (BICSI) Registered Communications Distribution Designer (RCDD) with at least 2 yrs related experience shall develop and stamp telecommunications design, and prepare the test plan. See paragraph 5.8.2.5 for design of environmental systems for Telecommunications Rooms.

5.7.6.2. The installers assigned to the installation of the telecommunications system or any of its components shall be regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. Key personnel; i.e., supervisors and lead installers assigned to the installation of this system or any of its components shall be BICSI Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification for each of the key personnel. In lieu of BICSI certification, supervisors and installers shall have a minimum of 5 years experience in the installation of the specified copper and fiber optic cable and components. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products.

5.7.6.3. Perform a comprehensive end to end test of all circuits to include all copper and fiber optic cables upon completion of the BCS and prior to acceptance of the facility. The BCS circuits include but are not limited to all copper and fiber optic(FO) entrance cables, termination equipment, copper and fiber backbone cable, copper and fiber horizontal distribution cable, and workstation outlets. Test in accordance with ANSI/EIA/TIA 568 standards. Use test instrumentation that meets or exceeds the standard. Submit the official test report to include test procedures, parameters tested, values, discrepancies and corrective actions in electronic format. Test and accomplish all necessary corrective actions to ensure that the government receives a fully operational, standards based, code compliant telecommunications system.

5.7.7. LIGHTNING PROTECTION SYSTEM: Provide a lightning protection system where recommended by the Lightning Risk Assessment of NFPA 780, Annex L.

5.8. HEATING, VENTILATING, AND AIR CONDITIONING

5.8.1. STANDARDS AND CODES: The HVAC system shall conform to APPLICABLE CRITERIA.

5.8.2. DESIGN CONDITIONS.

5.8.2.1. Outdoor and indoor design conditions shall be in accordance with UFC 3-410-01FA. Outdoor air and exhaust ventilation requirements for indoor air quality shall be in accordance with ASHRAE 62.1. All Buildings with minimum LEED Silver requirement (or better) will earn LEED Credit EQ 7.1, Thermal Comfort-Design.

5.8.2.2. Design systems in geographical areas that meet the definition for high humidity in UFC 3-410-01FA in accordance with the special criteria for humid areas therein.

5.8.2.3. Cooling equipment may be oversized by up to 15 percent to account for recovery from night setforward. Heating equipment may be oversized by up to 30 percent to account for recovery from night setback. Design single zone systems and multi-zone systems to maintain an indoor design condition of 50% relative humidity for cooling only. For heating only where the indoor relative humidity is expected to fall below 20% for extended periods, add humidification to increase the indoor relative humidity to 30%. Provide ventilation air from a separate dedicated air handling unit (DOAU) for facilities using multiple single zone fan-coil type HVAC systems. Do not condition outside air through fan coil units. Avoid the use of direct expansion cooling coils in air handling units with constant running fans that handle outside air.

5.8.2.4. Locate all equipment so that service, adjustment and replacement of controls or internal components are readily accessible for easy maintenance.

5.8.2.5. Environmental Requirements for Telecommunications Rooms,(including SIPRNET ROOMS, where applicable for specific facility type). Comply with ANSI/EIA/TIA 569 and the I3A.

5.8.2.6. Fire dampers: dynamic type with a dynamic rating suitable for the maximum air velocity and pressure differential to which the damper is subjected. Test each fire damper with the air handling and distribution system running.

5.8.3. BUILDING AUTOMATION SYSTEM. The Building Automation System (BAS) shall be a single complete non-proprietary Direct Digital Control (DDC) system for control of the heating, ventilating and air conditioning (HVAC) and other building systems. The BAS shall be based on an Open implementation of BACnet using ASHRAE 135-2004 exclusively as the communications protocol for communication between DDC Hardware devices to allow multi-vendor interoperability. The building BAS shall include integration to a basewide supervisory monitoring and control (M&C) system.

5.8.3.1. The system shall be Open in that it is designed and installed such that the Government or its agents are able to perform repair, replacement, upgrades, and expansions of the system without further dependence on the original hardware vendor or their agents. This includes, but is not limited to the following:

- Hardware shall be installed such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.
- Necessary documentation (including rights to documentation and data), configuration information, configuration tools, application programs (with comments explaining program logic), application source code for programmable controllers, drivers, and other software shall be licensed to and remain with the Government such that the Government or its agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor.

5.8.3.2. All DDC Hardware shall:

- Be connected to a ASHRAE 135 MS/TP control network.
- Implement all required functionality of the application network interface via BACnet objects, properties, and services
- Shall conform to basewide addressing schemes, particularly with regard to Device ID.
- Minimize the use of proprietary BACnet objects and properties
- Not use any of the following BACnet services for application control functionality or communication:
  - AtomicFile or AtomicFileWrite
  - ConfirmedTextMessage or UnconfirmedTextMessage
  - ConfirmedPrivateTransfer or UnconfirmedPrivateTransfer
- Communicate over the control network via ASHRAE 135 exclusively.
- Conform to the BACnet Testing Lab's Device Implementation Guidelines.
- Be capable of responding to Who-Is/I-Am and Who-Has/I-Have service requests.
- All settings and parameters used by the application shall be fully configurable:
  - to the greatest extent possible, via properties of BACnet objects that can be written to via BACnet services.
  - via properties of BACnet objects that can be written to via BACnet services for the following

- Setpoint
- Alarm limit
- Schedule modification
- Trend modification
  - All other settings and parameters that can not be written to via BACnet services shall be fully configurable via either:
- Properties of BACnet objects that can be written to with a configuration tool, or
- Hardware settings on the controller itself to support the application.
- Provide BACnet objects, properties, and services required to support the application and supervisory monitoring and control functionality including:
  - System start/stop and overrides.
  - Scheduling
  - Alarming
  - Trending
- To the greatest extent practical, not rely on the control network to perform the application
- Be BTL Listed

5.8.3.3. Include any device capable of communicating over IEEE 802.3 (Ethernet) in a DIACAP and Certificate of Networthiness (CoN) for this installation, regardless of whether the Ethernet connection is active at time of installation. Do not use devices with Ethernet connection capability not included in a DIACAP or without a DIACAP or without a CoN shall not be used.

5.8.3.4. Gateways may be used provided that each gateway communicates with and performs protocol translation for control hardware controlling one and only one package unit.

5.8.3.5. Not Used

5.8.3.6. Perform all necessary actions needed to fully integrate the ASHRAE 135-based building control system to the UMCS. These actions include but are not limited to:

- Install BACnet MS/TP-to-IP routers and/or BACnet/IP Broadcast Management Devices (BBMD) in accordance with ASHRAE 135 Annex J as needed to connect the building control network to the UMCS IP network. Devices shall be capable of configuration via DHCP and Write-Broadcast-Distribution-Table messages but shall not rely on these services for configuration. All communication between the UMCS and building networks shall be via BACnet/IP and in accordance with ASHRAE 135. Any IP network work including access to existing networks shall be coordinated with the installation Network Enterprise Center (NEC).
- Configure M&C Software functionality including: graphical pages for System Graphic Displays including overrides, alarm handling, scheduling, trends for critical values needing long-term or permanent monitoring via trends, and demand limiting.
- Configure M&C software to provide hierarchically arranged screens to allow operator to configure (via BACnet services to the appropriate objects) all devices on the installation BACnet internetwork. The following adjustments shall be supported:
  - Setpoints
  - Alarm limits
  - Schedules
  - Trends

This requirement is separate from and in addition to the requirement to provide all necessary programming and configuration software.

5.8.3.7. Perform all necessary actions needed to integrate legacy systems to the UMCS. Configure M&C Software functionality including: graphical pages for System Graphic Displays including overrides, alarm handling, scheduling, trends for critical values needing long-term or permanent monitoring via trends, and demand limiting. Integration may be via drivers in the M&C Software or hardware gateways may be provided. Where hardware gateways are provided, include all hardware, software, software licenses, and configuration tools required for gateway operation, modification, and maintenance. Configure software driver or a hardware gateway to support M&C software functionality as listed above.

5.8.3.8. Provide the following to the Government for review prior to acceptance of the system:

- The latest version of all software including source code for application software (for programmable controllers), software licenses, and user manuals required to program, configure and operate the system.
- Points Schedule drawing that shows every DDC Hardware device. The Points Schedule shall contain the following information as a minimum for each device:
  - Device ID and network address (MS/TP network and MAC address, or IP address).
  - Input and Output Objects including Name, Type, Description, and relevant supported or required Properties.
  - Hardware I/O, including Type (AI, AO, BI, BO) and Description.
  - Alarm information including alarm limits and BACnet device IDs, object IDs, and property information.
  - Supervisory control information including BACnet device IDs, object IDs, and properties for trending and overrides.
  - Objects and Properties needed for device configuration.
  - Device IDs and objects (where applicable) of remote devices and objects that communicate with the given Device (e.g. clients and servers for BACnet services used by the given device).
  - Example Points Schedules are available at: https://eko.usace.army.mil/fa/besc/
- Riser diagram of the network showing all network cabling and hardware. Label hardware with BACnet Device IDs, BACnet network addresses, network names, and locations.
- A consolidated list of all Device IDs.
- Control System Schematic diagram and Sequence of Operation for each controlled system.
- Operation and Maintenance Instructions including procedures for system start-up, operation and shut-down, a routine maintenance checklist, and a qualified service organization list.
- Quality Control (QC) checklist (below) completed by the Contractor's Chief Quality Control (QC) Representative

Table 5-1: QC Checklist

5.8.3.9. Perform a Performance Verification Test (PVT) under Government supervision prior to system acceptance. During the PVT, demonstrate that the system performs as specified, including but not limited to demonstrating that the system is Open and correctly performs the Sequences of Operation.

5.8.3.10. Provide a 1 year unconditional warranty on the installed system and on all service call work. The warranty shall include labor and material necessary to restore the equipment involved in the initial service call to a fully operable condition.

5.8.3.11. Provide training at the project site on the installed building system . Upon completion of this training each student, using appropriate documentation, should be able to start the system, operate the system, recover the system after a failure, perform routine maintenance and describe the specific hardware, architecture and operation of the system.

5.8.4. TESTING, ADJUSTING AND BALANCING. Test and balance air and hydronic systems, using a firm certified for testing and balancing by the Associated Air Balance Council (AABC), National Environmental Balancing Bureau (NEBB), or the Testing Adjusting, and Balancing Bureau (TABB). The prime contractor shall hire the TAB firm directly, not through a subcontractor. Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB TABES, or SMACNA HVACTAB unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard shall be considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practicable to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the manufacturer's recommendations. All quality assurance provisions of the TAB Standard such as performance guarantees shall be part of this contract. For systems or system components not covered in the TAB Standard, the TAB Specialist shall develop TAB procedures. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are mandatory.

5.8.5. COMMISSIONING: Commission all HVAC systems and equipment, including controls, and all systems requiring commissioning for LEED Enhanced commissioning, in accordance with ASHRAE Guideline 1.1, ASHRAE

Guideline 0 and LEED. Do not use the sampling techniques discussed in ASHRAE Guideline 1.1 and in ASHRAE Guideline 0. Commission 100% of the HVAC controls and equipment. Hire the Commissioning Authority (CA), certified as a CA by AABC, NEBB, or TABB, as described in Guideline 1.1. The CA will be an independent subcontractor and not an employee of the Contractor nor an employee or subcontractor of any other subcontractor on this project, including the design professionals (i.e., the DOR or their firm(s)). The CA will communicate and report directly to the Government in execution of commissioning activities. The Contracting Officer's Representative will act as the Owner's representative in performance of duties spelled out under OWNER in Annex F of ASHRAE Guideline 0. All buildings with Minimum LEED Silver (or better) requirement will earn LEED Credit EA3 Enhanced Commissioning.

5.9. ENERGY CONSERVATION

5.9.1. The building including the building envelope, HVAC systems, service water heating, power, and lighting systems shall meet the Mandatory Provisions and the Prescriptive Path requirements of ASHRAE 90.1. Substantiation requirements are defined in Section 01 33 16, Design After Award.

5.9.2. Design all building systems and elements to meet the minimum requirements of ANSI/ASHRAE/IESNA 90.1. Design the buildings, including the building envelope, HVAC systems, service water heating, power, and lighting systems to achieve an energy consumption that is at least 40% below the consumption of a baseline building meeting the minimum requirements of ANSI/ASHRAE/IESNA Standard 90.1. Energy calculation methodologies and substantiation requirements are defined in Section 01 33 16, Design After Award.

5.9.3. Purchase Energy Star products, except use FEMP designated products where FEMP is applicable to the type product. The term "Energy Star product" means a product that is rated for energy efficiency under an Energy Star program. The term "FEMP designated product" means a product that is designated under the Federal Energy Management Program of the Department of Energy as being among the highest 25 percent of equivalent products for energy efficiency. When selecting integral sized electric motors, choose NEMA PREMIUM type motors that conform to NEMA MG 1, minimum Class F insulation system. Motors with efficiencies lower than the NEMA PREMIUM standard may only be used in unique applications that require a high constant torque speed ratio (e.g., inverter duty or vector duty type motors that conform to NEMA MG 1, Part 30 or Part 31).

5.9.4. Solar Hot Water Heating. Provide at least 30% of the domestic hot water requirements through solar heating methodologies, unless the results of a Life Cycle Cost Analysis (LCCA) developed utilizing the Building Life Cycle Cost Program (BLCC) which demonstrates that the solar hot water system is not life cycle cost effective in comparison with other hot water heating systems. The type of system will be established during the contract or task order competition and award phase, including submission of an LCCA for government evaluation to justify non-selection of solar hot water heating. The LCCA uses a study period of 25 years and the Appendix K utility cost information. The LCCA shall include life cycle cost comparisons to a baseline system to provide domestic hot water without solar components, analyzing at least three different methodologies for providing solar hot water to compare against the baseline system.

5.9.5. Process Water Conservation. When potable water is used to improve a building's energy efficiency, employ lifecycle cost effective water conservation measures, except where precluded by other project requirements.

5.9.6. Renewable Energy Features. The Government's goal is to implement on-site renewable energy generation for Government use when lifecycle cost effective. See Paragraph 6, PROJECT SPECIFIC REQUIREMENTS for renewable energy requirements for this project.

5.10. FIRE PROTECTION

5.10.1. STANDARDS AND CODES Provide the fire protection system conforming to APPLICABLE CRITERIA.

5.10.2. Inspect and test all fire suppression equipment and systems, fire pumps, fire alarm and detection systems and mass notification systems in accordance with the applicable NFPA standards. The fire protection engineer of record shall witness final tests. The fire protection engineer of record shall certify that the equipment and systems are fully operational and meet the contract requirements. Two weeks prior to each final test, the contractor shall notify, in writing, the installation fire department and the installation public work representative of the test and invite them to witness the test.

5.10.3. Fire Extinguisher Cabinets: Provide fire extinguisher cabinets and locations for hanging portable fire extinguishers in accordance with NFPA 10 Standard for Portable Fire Extinguishers.

5.10.4. Fire alarm and detection system: Required fire alarm and detection systems shall be the addressable type. Fire alarm initiating devices, such as smoke detectors, heat detectors and manual pull stations shall be addressable. When the system is in alarm condition, the system shall annunciate the type and location of each alarm initiating device. Sprinkler water flow alarms shall be zoned by building and by floor. Supervisory alarm initiating devices, such as valve supervisory switches, fire pump running alarm, low-air pressure on dry sprinkler system, etc. shall be zoned by type and by room location.

5.10.5. Fire Protection Engineer Qualifications: In accordance with UFC 3-600-01, FIRE PROTECTION ENGINEERING FOR FACILITIES**,** the fire protection engineer of record shall be a registered professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveys (NCEES), or a registered P.E. in a related engineering discipline with a minimum of 5 years experience, dedicated to fire protection engineering that can be verified with documentation.

5.11. SUSTAINABLE DESIGN

5.11.1. STANDARDS AND CODES: Sustainable design shall conform to APPLICABLE CRITERIA. See paragraph 6, PROJECT-SPECIFIC REQUIREMENTS for which version of LEED applies to this project. The LEED-NC Application Guide for Multiple Buildings and On-Campus Building Projects (AGMBC) applies to all projects. Averaging may be used for LEED compliance as permitted by the AGMBC but is restricted to only those buildings included in this project. Each building must individually comply with the requirements of paragraphs ENERGY CONSERVATION and BUILDING WATER USE REDUCTION.

5.11.2. LEED RATING, REGISTRATION, VALIDATION AND CERTIFICATION: See Paragraph PROJECT-SPECIFIC REQUIREMENTS for project minimum LEED rating/achievement level, for facilities that are exempt from the minimum LEED rating, for LEED registration and LEED certification requirements and for other project-specific information and requirements.

5.11.2.1. Innovation and Design Credits. LEED Innovation and Design (ID) credits are acceptable only if they are supported by formal written approval by GBCI (either published in USGBC Innovation and Design Credit Catalog or accompanied by a formal ruling from GBCI). LEED ID credits that require any Owner actions or commitments are acceptable only when Owner commitment is indicated in paragraph PROJECT-SPECIFIC REQUIREMENTS or Appendix LEED Project Credit Guidance

5.11.3. OPTIMIZE ENERGY PERFORMANCE. : Project must earn, as a minimum, the points associated with compliance with paragraph ENERGY CONSERVATION. LEED documentation differs from documentation requirements for paragraph ENERGY CONSERVATION and both must be provided. For LEED-NC v2.2 projects you may substitute ASHRAE 90.1 2007 Appendix G in its entirety for ASHRAE 90.1 2004 in accordance with USGBC Credit Interpretation Ruling dated 4/23/2008.

5.11.4. COMMISSIONING. See paragraph 5.8.5 COMMISSIONING for commissioning requirements. USACE templates for the required Basis of Design document and Commissioning Plan documents are available at http://en.sas.usace.army.mil (click on Engineering Criteria) and may be used at Contractor's option.

5.11.5. DAYLIGHTING. Except where precluded by other project requirements, do the following in at least 75 percent of all spaces occupied for critical visual tasks: achieve a 2 percent glazing factor (calculated in accordance with LEED credit EQ8.1) OR earn LEED Daylighting credit, provide appropriate glare control and provide either automatic dimming controls or occupant-accessible manual lighting controls.

5.11.6. LOW-EMITTING MATERIALS. Except where precluded by other project requirements, use materials with low pollutant emissions, including but not limited to composite wood products, adhesives, sealants, interior paints and finishes, carpet systems and furnishings,

5.11.7. CONSTRUCTION INDOOR AIR QUALITY MANAGEMENT. Except where precluded by other project requirements, earn LEED credit EQ 3.1 Construction IAQ Management Plan, During Construction and credit EQ 3.2 Construction IAQ Management Plan, Before Occupancy.

5.11.8. RECYCLED CONTENT. In addition to complying with section RECYCLED/RECOVERED MATERIALS, earn LEED credit MR4.1, Recycled Content, 10 percent except where precluded by other project requirements.

5.11.9. BIOBASED AND ENVIRONMENTALLY PREFERABLE PRODUCTS. Except where precluded by other project requirements, use materials with biobased content, materials with rapidly renewable content, FSC certified wood products and products that have a lesser or reduced effect on human health and the environment over their lifecycle to the maximum extent practicable.

5.11.10. FEDERAL BIOBASED PRODUCTS PREFERRED PROCUREMENT PROGRAM (FB4P). The Farm Security and Rural Investment Act (FSRIA) of 2002 required the U.S. Department of Agriculture (USDA) to create procurement preferences for biobased products that are applicable to all federal procurement (to designate products for biobased content). For all designated products that are used in this project, meet USDA biobased content rules for them except use of a designated product with USDA biobased content is not required if the biobased product (a) is not available within a reasonable time, (b) fails to meet performance standard or (c) is available only at an unreasonable price. For biobased content product designations, see http://www.biopreferred.gov/ProposedAndFinalItemDesignations.aspx.

5.12. CONSTRUCTION AND DEMOLITION (C&D) WASTE MANAGEMENT: Achievement of 50% diversion, by weight, of all non-hazardous C&D waste debris is required. Reuse of excess soils, recycling of vegetation, alternative daily cover, and wood to energy are not considered diversion in this context, however the Contractor must tracked and report it. A waste management plan and waste diversion reports are required, as detailed in Section 01 57 20.00 10, ENVIRONMENTAL PROTECTION.

5.13. SECURITY (ANTI-TERRORISM STANDARDS): Unless otherwise specified in Project Specific Requirements, only the minimum protective measures as specified by the current Department of Defense Minimum Antiterrorism Standards for Buildings, UFC 4-010-01, are required for this project. The element of those standards that has the most significant impact on project planning is providing protection against explosives effects. That protection can either be achieved using conventional construction (including specific window requirements) in conjunction with establishing relatively large standoff distances to parking, roadways, and installation perimeters or through building hardening, which will allow lesser standoff distances. Even with the latter, the minimum standoff distances cannot be encroached upon. These setbacks will establish the maximum buildable area. All standards in Appendix B of UFC 4-010-01 must be followed and as many of the recommendations in Appendix C that can reasonably be accommodated should be included. The facility requirements listed in these specifications assume that the minimum standoff distances can be met, permitting conventional construction. Lesser standoff distances (with specific minimums) are not desired, however can be provided, but will require structural hardening for the building. See Project Specific Requirements for project specific siting constraints. The following list highlights the major points but the detailed requirements as presented in Appendix B of UFC 4-010-01 must be followed.

(a) Standoff distance from roads, parking and installation perimeter; and/or structural blast mitigation

(b) Blast resistant windows and skylights, including glazing, frames, anchors, and supports

(c) Progressive collapse resistance for all facilities 3 stories or higher

(d) Mass notification system (shall also conform to UFC 4-021-01, Mass Notification Systems)

(e) For facilities with mailrooms (see paragraph 3 for applicability) – mailrooms have separate HVAC systems and are sealed from rest of building

6.0 PROJECT SPECIFIC REQUIREMENTS

6.1. GENERAL

The requirements of this paragraph augment the requirements indicated in Paragraphs 3 through 5.

6.2. APPROVED DEVIATIONS

The following are approved deviations from the requirements stated in Paragraphs 3 through 5 that only apply to this project.

6.2.1. The facility renderings referenced elsewhere in this RFP WILL NOT be provided.

There are no other approved deviations for this project.

6.3. SITE PLANNING AND DESIGN

6.3.1. General:

Refer to the Site Plans (See Appendix J) for proposed locations of improvements to be included under this scope of work. The site plan shown is provided as an alternative.

The existing site is bounded by 25th Street, Sternberg and Madison Avenues. An asphalt parking lot with a capacity of 94 vehicles is located in the northwest corner of the site. Several oak tres are located near the northern part of the site with the remaining site consisting of medium to tall grass with a shallow swale traversing through the site in a southeasterly direction. The swale deepens at the southern end of the site where a 36-inch headwall is located which eventually empties into the Warrick River. The watercourse below the headwall is classified as a perennial stream and is bounded by a 100 foot stream buffer. The terrain throughout the site, with the exception of the extreme southern end, can be classified as having flat slopes.

6.3.2. Site Structures and Amenities

6.3.2.1 Dumpster Screening. The D/B Contractor is responsible for the design and construction of required dumpster pads. Dumpster pads shall be sized to accomodate both trash and recycling dumpsters. Dumpster stations shall be located outside the 82 foot Force Protection Zone. The D/B Contractor is responsible for the screening at the dumpster pad locations. Dumpster screening shall be compatible with the building it serves.

6.3.2.2 Walks. The D/B Contractor shall provide pedestrian walks within the designated construction areas.

(a) Sidewalks shall be a minimum of 8 feet at the building entrance. Other building access sidewalks and walkways serving the facility shall be 6 feet in width.

6.3.2.3 Service Drive. The D/B Contractor shall construct a service drive along Madison Avenue as shown in the Site Plan(s) found in Appendix J. The service drive shall allow for connectivity from Sternberg Avenue by the barracks Contractor. The pavement shall be designed to support emergency response vehicles and fire tanker trucks and shall be designed for a 20-year pavement life. The service drive shall meet the Anti-Terrorism Force Protection Requirements.

(a) Minimum access drive shall be 18 feet.

6.3.2.4 Vehicle Pavements. Design procedures and materials shall conform to VDOT standards. Provide underdrain system for pavement designs over cohesive soil subgrades. Regardless of the pavement design, a minimum flexible pavement section shall consist of 3 inches of bituminous concrete and 8 inches of stone base. Pavement markings and traffic signage shall comply with the installation requirements and with the Manual on Uniform Traffic Control Devices. Ingress/egress routes routes for provisions delivery trucks and refuse collection compaction trucks shall be designed for a 20-year service life.

6.3.2.5 Parking requirements. A new parking lot servicing the facility shall be constructed. The number of parking spaces provided shall accomodate Staff parking and Visitor parking. Parking lot shall be sized to support a total of 57 parking spaces. Two of the spaces shall be handicapped spaces. In addition, two spaces shall be provided for the COF and SFAC buildings that can be accessed via the service drive for drop-off/pickup as shown in the Site Plan(s) found in Appendix J.

(a) Handicap parking shall meeet the ADA accessibility Guidelines for accesible parking spaces. Handicap spaces shall be 13 feet wide x 18 feet deep.

(b) Parking spaces shall be a minimum of 9 feet x 18 feet.

Site development shall include, but not be limited to:

(a) Where applicable, handicap parking stalls, ramps, and signage shall be provided and shall meet the requirements of criteria listed in Paragraph 4.

(b) A concrete dumpster pad shall be provided and shall extend a minimum of 20 feet in front of dumpster to accommodate the trash truck front wheels. Dumpster screen wall enclosures will be provided. The screen wall enclosures will visually match or be constructed of materials to match the new facility exterior walls. The color will match the new facility exterior wall. The enclosure shall be capable of storing one trash container and one recycling container. A gate keeper, capable of holding the gates in an open position, and a locking mechanism will be integrated into the gate design. Gates will have a minimum width of 12 feet. Dumpster locations will comply with criteria listed in Paragraph 4.

(c) Recycling space shall be incorporated into the site designs.

(d) Provide exterior signage, building numbers (provided by the DPW Real Property Office to the USACE Project Manager), parking, and street signs in accordance with Appendix H.

(e) Walks: Exterior concrete pavement walks will be constructed as needed to accommodate the final project layout and will be shown on the site plan. Building entrances, main and secondary, shall be provided with a concrete pad and connecting walk. Minimum sidewalk width shall be 5 feet.

(f) Building Aprons and Parking Areas: Pavement design for parking lots and roadways will be designed in accordance with Applicable Criteria, previous chapters, Virginia Department of Transportation and geotechnical study. Applicable Criteria, previous chapters Virginia Department of Transportation and geotechnical study.

(g) The construction site will be enclosed by fencing throughout the duration of work to warn people passing near or trying to pass through the site. Barricades and signs shall be posted at project areas while work is in progress to ensure safety of personnel entering or working in the area. Upon completion of construction, all construction area and safety fence, barricades and signs will be removed from the Installation by the Contractor.

(h) Service Drives: The Contractor shall provide service drives to the building. The drives shall be located and installed in accordance with UFC 4-010-01. The pavement design shall be as required by paragraph 5.2.3 VEHICLE PAVEMENTS. Minimum access drive width shall be 14 feet. Minimum turning radius shall be designed as required for emergency access vehicles.

(i) Fire Access Lanes: The Contractor shall provide fire access roads in accordance with UFC 3-600-01 and NFPA 1.

(j) Contractor shall perform all telecommunication (outside plant) work as described in Section 6.9.4(g) thru 6.9.4 (aa) within 180 days from the Notice to

Proceed (NTP).

6.3.3. Site Functional Requirements:

6.3.3.1. Stormwater Management (SWM) Systems.

6.3.3.1 Stormwater Management (SWM) Systems

(a) During the design of the site, Fort Eustis's storm water management measures are to be taken into consideration per Virginia Pollution Discharge Elimination System (VPDES). The site design is to incorporate strategies including a combination of structural practices, standards, and specifications that are appropriate for the site. The design shall consider long-term operation and maintenance of BMP's. Water quality protection will be considered in accordance with the Federal Clean Water Act, Virginia Code §§ 62.1-44.15 through 44.30, and Virginia Administrative Code 9 VAC 25-30-10 et seq.

(b) The DB Contractor shall ensure that work does not interrupt the flow of storm water nor interfere with the daily operations of the Installation.

(c) The D/B Contractor shall design the stormwater system to provide for additional capacity for the barracks facility as shown in the Site Plan(s). found in Appendix J.

(d) Fort Eustis DPW is developing comprehensive storm water management policies that include, among other things, the following requirements:

1. Site designs shall minimize the generation of storm water and maximize pervious areas for storm water treatment. Structural and nonstructural infiltration BMPs shall be encouraged to provide storm water quality and quantity control and groundwater recharge.

2. Natural channel characteristics shall be preserved to the maximum extent practicable.

3. The use of low-impact development (LID) site planning and integrated management practices shall be encouraged to control storm water runoff at the source and more closely approximate predevelopment runoff conditions.

(e) State and Federal design manuals that address proper storm water management design techniques, including the following:

1. Virginia Stormwater Management Handbook, Volumes I and II, prepared by the Virginia Department of Conservation and Recreation dated 1999, as amended.

2. VDOT Drainage Manual, prepared by the Hydraulics Section of the Virginia Department of Transportation dated 2002, as amended.

3. Virginia Erosion and Sediment Control Handbook, prepared by the Virginia Department of Conservation and Recreation dated 1992, as amended.

4. Low Impact Development Design Strategies: An Integrated Design Approach, United States Environmental Protection Agency, Office of Water, EPA 841-B-00-003 dated June 1999, as amended.

5. Low Impact Development Hydrologic Analysis, United States Environmental Protection Agency, Office of Water, EPA 841-B-00-002 dated June 1999, as amended.

The manuals referenced here should be used by designers to ensure that standard, acceptable design practices are used to develop their storm water management designs.

6.3.3.2. Erosion and Sediment Control

6.3.3.2 A Storm Water Pollution Prevention Plan that uses BMP's for erosion and sediment control will be developed in accordance with the Virginia Stormwater Management Handbook and Fort Eustis's integrated stormwater pollution prevention plan.

Contractor shall install stabilized construction entrances in accordance with the Virginia Erosion and Sediment Control Handbook. Contractor shall also minimize tracking soil onto adjacent roadways. Contractor shall sweep roadways as necessary to remove tracked soil and dust.

6.3.3.3. Vehicular Circulation.

6.3.3.3 Refer to the Site Plan(s). See Appendix J for proposed locations of improvements to the existing vehicle circulation to be included under the Scope of Work.

6.4. SITE ENGINEERING

6.4.1. Existing Topographical Conditions

See Existing Conditions Plans in Appendix J. Any discrepancies which are found in the furnished plans shall be brought to the attention of the Contracting Officer.

The site for the COF/SFAC complex is located along Sternberg and Madison Avenues south of 25th

Street. Several oak trees are located near the proposed location for the SFAC building with the remaining site

consisting of medium to tall grass and trees lining the perimeter of the ditch located approximately midway

through the site. Electrical distribution and water are available along the perimeter of Sternberg Avenue and

Madison Avenue. An existing 36- inch storm drain that currently runs under the proposed location of the Company

Operations Facility will have to be diverted. An 8" sanitary sewer line runs northwesterly across the site just south

of the SFAC building. A water line of unknown size runs southeasterly across the site. Fiber optic cable and

copper for telecommunications is not currently at the site, but within reasonable distance.

6.4.2. Existing Geotechnical conditions: See Appendix A for a preliminary geotechnical report.

6.4.2.1. Preliminary Geotechnical Engineering Report

A Preliminary Geotechnical Report was prepared by the Government and is included in Appendix A. For further information regarding the included geotechnical report and the Contractors requirements for completing a post-award final geotechnical evaluation report, see Section 01 10 00 Paragraph 5.2.2.1 and Section 01 33 16, *Design After Award*, Paragraph 3.5.3.

It is possible that site specific subsurface conditions encountered by the Offeror will differ from those appended herein. Therefore, it is the responsibility of the Offeror to establish a meeting with the COR immediately following the completion and evaluation of his site specific geotechnical exploration to outline any differences encountered that are not consistent with the information provided herein. Should those differences require changes in the foundation type, pavement and earthwork requirements proposed with the bid that result in more cost, these differences shall be clearly outlined for the meeting.

6.4.2.2 Certification

The Offeror and his or her professional geotechnical engineer consultant shall certify in writing that the design of the project has been developed consistent with the site specific geotechnical conditions, the recommendations presented in the Contractor’s final Geotechnical Report and with all applicable review comments. The certification shall be stamped by the consulting professional geotechnical engineer, who shall take an active role in the preparation of the related plans and specifications.

6.4.3. Fire Flow Tests See Appendix D for results of fire flow tests to use for basis of design for fire flow and domestic water supply requirements.

The fire flow test report provided in Appendix D of this RFP is for the use of the proposer in preparing the proposal for this project. Final design of the fire protection system shall be based on a final fire flow test by the contractor as required in Section 01 33 16, paragraph 3.5.3 of this RFP.

6.4.4. Pavement Engineering and Traffic Estimates:

eBuilding Aprons and Parking Areas: Pavement design for parking lots and roadways will be designed in accordance with UFC 3-250-01FA and geotechnical study. Concrete pavements shall be in accordance with UFC 3-250-04FA.

Pavement Design. Design procedures and materials shall conform to VDOT standards. Provide underdrain systems for pavement designs over cohesive soil subgrades. Regardless of the pavement design, a minimum flexible pavement section shall consist of 3 inches of bituminous concrete and 8 inches of stone base. Concrete pavement for Fire Truck access shall be a minimum of 10 inches thick with VDOT stone base course of 6 inches thick. Concrete curb and curb/gutter shall be required at the perimeter of all streets, roads, parking areas, and interior islands except as shown on the Site Plan can be found in Appendix J.

(a) Organizational vehicle traffic areas will support tracked vehicles and other organizational vehicle traffic.

Non-organizational vehicle traffic areas include streets and parking lots for privately owned passenger vehicles and standard truck traffic. The Design Build Contractor's geotechnical report will contain flexible and rigid pavement designs, including design California Bearing Ratio (CBR) and the modulus of subgrade reaction and the required compaction effort for subgrades. Pavements for non organizational traffic areas will be designed for the anticipated vehicle traffic of the heaviest wheeled vehicle and in accordance with Applicable Criteria, Virginia Department of Transportation and using the PCASE program. The pavement design will be based on a minimum of 20 years of projected traffic.

(b) Materials and construction will conform to the most recent edition of the VDOT Road and Bridge Specifications book.

(c) The subgrade will be prepared and compacted in accordance with the geotechnical report and the most recent edition of the VDOT Road and Bridge Specifications book. The geotechnical report contained within Appendix A is for information only. The Contractor shall provide a final geotechnical report for the basis of design.

(d) Pavement joint construction and design will conform to Applicable Criteria, Virginia Department of Transportation and the most recent edition of the VDOT Road and Bridge Specifications book.

(e) The Contractor's geotechnical report shall provide design for pavement under-drain system, if needed.

(f) Details of construction for vehicular pavement and associated appurtenances (drainage structures, curbs, curb and gutter, entrances, etc shall be in accordance with VDOT Road and Bridge Standards (latest edition).

6.4.5. Traffic Signage and Pavement Markings

Traffic signage and striping will be provided for all new parking areas. Signage and striping will be designed in accordance with Manual on Uniform Traffic Control Devices for Streets and Highways. Parking areas will be striped with non-reflectorized paint.

6.4.6. Base Utility Information

[Not Supplied - PS_SiteEngineering_BaseUtilIty : SITE_BASE]

6.4.7.1 ELECTRICAL SERVICE
(a) The electrical infrastructure system at Fort Eustis has been privatized and is owned by Dominion Virginia Power (DVP). DVP point of contact for this project is Mr. Steve Buell (757) 434-6195 or email at steve.buell@dom.com.

(b) The DB Contractor will coordinate all electrical service connections with the Dominion Virginia Power privatized utility group. Submission of load letters and documentation supporting the site location of transformers and meter equipment will also be coordinated and approved.

(c) The DB Contractor is responsible for the design and construction of the electrical systems from the five-foot building line into and within each building. All electrical systems shall be designed constructed in accordance with UFC and Local, State, and Federal standards as listed in Paragraph 4. Local and State standards will dictate unless the Federal standards are more stringent.

(d) The DB Contractor shall design the exterior building lighting system including walkway and parking lot lighting for each facility. The DB Contractor shall provide and install lighting fixtures that are mounted on/attached to the building for each facility. DVP will provide and install lighting fixtures located along walkways and parking areas and located within parking areas.

(e) The Contractor shall refer to the Electrical Distribution paragraph 6.9.1 for the Electrical Service information for the Company HQ and Soldier and Family Assist Center (SFAC) facilities.

6.4.7.2 WATER SYSTEM
(a) The Water System at Ft. Eustis has been privatized and is owned by Old Dominion Utility Services Inc. (ODUS). ODUS point of contact for this project is Julie M. Ball at (757) 431-2966 ext. 28.

(b) ODUS will be responsible for the design and construction of the water distribution system to the building tap/meter point five feet outside the building line including fire supply lines and service lines. Payment to ODUS for design and construction of the water distribution system will be paid by the Government from construction funds this project.

(c) The Design Build Contractor is responsible for the design and construction of the building water system inside of the five-foot line around the building, including the connection to the main distribution system provided by ODUS. The DB Contractor shall coordinate capacities and connection points with the Contracting Officer and with ODUS.

(d) All water lines will comply with applicable Local, State (Virginia Department of Health) and Federal UFC standardsas listed in paragraph 4. Local and State standards will dictate unless the Federal standards are more stringent.

(e) All new water lines and any existing lines which do not remain fully pressurized during construction or connection will be disinfected. The disinfection will be in accordance with the American Water Works Association AWWA C651 and will not be complete until two consectutive days of bacteriological samples show no contamination. All bacteriological lead and copper will be performed by Environmental Protection Agency (EPA) certified laboratories.

6.4.7.3 SANITARY SEWER SYSTEM
(a) The Sanitary Sewer System at Ft. Eustis has been privatized and is owned by Old Dominion Utility Services Inc. (ODUS). ODUS point of contact for this project is Julie M. Ball at (757) 431-2966 ext. 28

(b) A sanitary sewer system, outside the five-foot building line, will be designed and constructed by ODUS to convey wastewater to the Fort Eustis wastewater collection system. The point of connections with the existing

sewer system shall be determined by ODUS through coordination with the Fort Eustis Directorate of Public Works/Directorate of Logistics (DPW) point of contact, Mr.Daniel Wood (757) 878-3509 and the site designer.

(1) All work for construction or relocation of the sanitary sewer shall be performed by ODUS to a point 5 feet from the proposed building including abandonment and filling of existing sanitary sewers and manholes with concrete, providing new sanitary sewers, two way cleanouts and connection to existing manhole. Contractor shall make final connection to work by ODUS and provide required flushing and testing of the system to the point of that connection.

(2) The Contractor shall determine the sewerage contribution for the facility and shall provide information to ODUS. The Contractor shall prepare the design of the building sewer system and shall coordinate with ODUS connection to the sanitary system being installed by ODUS.

(3) Costs or fees assessed by ODUS for the design and construction of or connection to the sanitary sewer system shall be paid to ODUS by the Government from construction funds for this project.

6.4.7.4 NATURAL GAS
(a) The natural gas utility service at Fort Eustis has not been privatized. Natural gas is currently provided to Fort Eustis by Virginia Natural Gas (VNG). VNG point of contact for this project is Heath Deaver at 757-455-5361.

(b) The DB Contractor shall coordinate the anticipated natural gas demand with Fort Eustis DPW and with VNG.

(c) Fort Eustis DPW in coordination with VNG is responsible for the design and construction of the natural gas system from the connection with the main to the gas meter.

(d) The DB Contractor is responsible for the design and construction of the natural gas distribution from the meter to each point of use within the building. All natural gas systems shall be designed constructed in accordance with UFC and Local, State, and Federal standards as listed in Paragraph 4. Local and State standards will dictate unless the Federal standards are more stringent.

6.4.7.5 CATV SERVICE
A complete CATV system shall be provided to the Company HQ and Soldier and Family Assist Center (SFAC) facilities. Cox Communications owns and operates the exterior CATV system on Fort Eustis. See Chapter 6.9.5 for additional information.

6.4.7. Cut and Fill

See Grading Plans (Appendix J) for the anticipated earthwork cuts and fills to bring the site to final grade. Every attempt shall be made to reuse the on-site suitable soils as defined in the Geotechnical Engineering Report and to balance earthwork cuts and fills to minimize the amount of additional fill that would be required. Any off-site borrow soils required to bring the site to final grade or to backfill below grade structure walls, earth retaining structures, or utility trenches shall be approved by the government before use.

6.4.7.1 Soils Preparation and Compaction.

The near surface soils at the project site primarily consist of soft to stiff clay and silt with varying amounts of sand as indicated in the Preliminary Geotechnical Engineering Report in Appendix A. The clay and silt pavement subgrade soils are susceptible to strength loss and deterioration from excess moisture and manipulation by construction equipment. Areas with high construction traffic will likely need subgrade repair. The Contractor shall expect construction activities to be curtailed during and after wet periods. Natural subgrade soils may require drying by aerating and discing to be able to compact and to develop a suitable subgrade for areas to receive compacted-controlled fill, pavement sections and slab on grades. Over excavating softened subgrade soils and replacing those with suitable granular fill can be considered if unfavorable weather conditions prevent the proper drying and compaction. However, this shall be performed at no additional cost to the Government. Any over-excavation due to the action/inaction of the Contractor, or done to expedite the Contractors construction time, will be at no additional cost to the Government. Construction shall occur in the drier summer and fall months if at all possible to lessen delays and change orders associated with construction on these fine-grained soils. Surface soils that are to be turfed shall be aerated by discing and augmented with additional organics and soil amendments to facilitate increased infiltration of storm water.

Fill/backfill placed within and a minimum of 5-feet beyond building footprints or to a distance at least equal to the height of the maximum fill depth shall be properly placed and compacted. Controlled structural fill shall consist of clean natural well-graded sandy material containing less than 15 percent by weight fine grained (passing No.200 sieve) material. Materials classified as CH and MH are unsatisfactory for utility backfill or for any fill beneath building areas. Materials classified as OH, OL, and peat are unsatisfactory in-situ and as fill of any kind. Fill or backfill material shall be placed in maximum 8-inch loose thickness lifts.

Soil compaction shall be achieved by equipment well-suited to the type and condition of materials being compacted and as approved by the D/B Contractor's professional Geotechnical Engineer. Material shall be moistened or aerated as necessary, but in no case to more than plus or minus 3 percent from the optimum moisture content of the soil as determined by moisture density test using modified effort [Modified Proctor] (ASTM D 1557). Compact subgrade materials and each layer of fill beneath structures and pavement subbase to not less than 90 and 95 percent of the maximum dry unit weight as determined by ASTM D1557 for cohesive and cohesionless soils, respectively. General grading materials shall be compacted to not less than 85 and 90 percent of the maximum dry unit weight as determined by ASTM D-1557 for cohesive and cohesionless soils, respectively.

The following minimum testing requirements for subgrade, fill, backfill, and aggregate base materials shall be incorporated into the specifications:

a. All exposed subgrade, whether in cut or fill should be proof-rolled with a fully loaded tri-axle dump truck or a minimum ten-ton smooth drum vibratory roller prior to receiving structural fill or foundation.

b. A minimum of one modified proctor (ASTM D 1557) and one soil classification test (ASTM D 422) shall be performed for each different on-site or borrow soil material proposed for fill, backfill, and base course.

c. One Atterberg Limits test (ASTM D4318) and one gradation analysis (ASTM D422) shall be performed for every ten field density test.

d. For cohesionless materials, a minimum of one sand cone field density test (ASTM D 1556) is required for every ten nuclear gage field density (ASTM D 6938) test. Results by ASTM D 1556 shall govern, and results by ASTM D 6938 shall be adjusted (calibrated) accordingly.

e. Field density tests (ASTM D 1556 or ASTM D6938) shall be performed on compacted subgrade and on each layer of fill/backfill/base at minimum frequencies of:

i. one test per column footing and per 50 feet of foundation wall

ii. one test per 50 feet utility trench

iii. one test per 2000 square feet of paved area and building area, and per 4000 square feet for all other areas.

These requirements shall be verified or betterments recommended by the consulting professional Geotechnical Engineer in the report wherever engineering, soils, or climatic factors indicate the necessity. These requirements shall also be verified to be consistent with the selected foundation system. Any modification to the stated compaction requirements shall be supported by engineering analysis and shall require the approval of the Contracting Officer. The final approved requirements shall be specified and/or shown in the final contract submission documents.

The licensed project design geotechnical engineer shall oversee and direct proof rolling operations (for subgrade suitability); fill placement and compaction operations, including associated soil properties, compaction, and field density testing, and footing inspections on a full time basis. A Corps of Engineers validated geotechnical testing firm shall inspect, test, and document earthwork construction. Documentation of the inspection and testing shall be submitted including but not limited to all test results, including retests of failed density tests. The testing laboratory shall submit an information copy of all test reports directly to thr Contracting Officer. All documentation shall be signed by the geotechnical engineer and submitted to the Government for review.

6.4.3.2 Capillary Water Barrier

A capillary water barrier is required for all interior slabs on grade. As a minimum, the capillary water barrier shall be 6 mil polyethlylene with all joints and seams taped to provide a continuous barrier and underlain by a minimum 6-in of well-draining and structurally adequate granular material consisting of VDOT size No 57 or approved equivalent.

6.4.8. Borrow Material

Fort Eustis does not have any areas that can be considered as viable source of borrow material for this project. All suitable borrow (if needed) material for this project must be procured by the Contractor at his cost from off-post commercial sources.

6.4.9. Haul Routes and Staging Areas

Entry gates to be used and haul routes throughout Fort Eustis will be identified at the pre-construction meeting. The contractor's staging area will utize the existing parking lot that is south of Bldg 577 and north of Bldg 370. See the Site Plan found in Appendix J. The Contractor will be allowed to use Fort Eustis road system for transporting construction materials and debris to and from the project sites. Care shall be taken to minimize "tracking"of mudfrom the project sites with regular cleaning of equpment and street cleaning. The route for hauling of such material and debris shall be coordinated with Fort Eustis DPW prior to start of construction.

6.4.10. Clearing and Grubbing:

The Offeror and his or her professional geotechnical engineer consultant are responsible for determining the depth of stripping and/or over-excavation necessary to provide a suitable subgrade. Topsoil and forest litter thickness in the borings located within the project site ranged from 4- to 18-inches. Other near surface materials encountered that are unsuitable for subgrade include approximately 1- to 2.5-feet thick uncontrolled fill materials. Grubbing and clearing of unsuitable materials may result in surface soil disturbances up to 36-inches, especially with regard to the removal of root balls from large sized trees and uncontrolled fill materials. The Offeror should realize that certain areas of the site may need to be backfilled with controlled structural fill following stripping/grubbing operations and the removal of unsuitable organic materials. The Offeror shall engage his or her geotechnical engineers in determining the extent of the removal and replacement of unsuitable materials and include an allowance for such occurrence in the proposal. **(Am#2)** Any additional removal and replacement of unsuitable materials in excess of that identified in the proposal by the Offeror and in the Offeror's final geotechnical report shall be performed at no cost to the Government. **(/Am#2)**

6.4.11. Landscaping:

The Contractor shall provide a landscape architect whose task is to develop a site landscaping plan and an enhanced landscaping plan for the areas shown on the Site Plan in Appendix J. An approved planting list can be found in Appendix I of this RFP. All plant materials shall comply with the American Nursery Standards. In addition, selection of plantings and locations shall be in accordance with AT/FP requirements. The landscape plan shall include at a minimum the locations of plantings, caliper, plant list and quantities, coordinating the type of trees when the installation is adjacent to light poles, as well as method(s) of weed control.

6.4.12. Turf:

The Contractor shall be responsible for establishment of turf over disturbed areas of the project limits. Turf ~~**shall be in accordance with the grasses indicated in the Appendix I and**~~ **(Am#1)** shall be approved by Fort Eustis Environmental Office.

1. Seed mix **MUST** be approved by Forestry Manager to meet seasonal needs.

~~**2. Refer to Appendix I for information regarding turf.**~~ **(Am#1)**

6.5. ARCHITECTURE

6.5.1. General: To the maximum extent possible within the contract cost limitation, the buildings shall conform to the look and feel of the architectural style and shall use the same colors as adjacent facilities as expressed herein . The Government will evaluate the extent to which the proposal is compatible with the architectural theme expressed in the RFP during the contract or task order competition. The first priority in order of importance is that

the design provides comparable building mass, size, height, and configuration compared to the architectural theme expressed herein. The second priority is that design is providing compatible exterior skin appearance based upon façade, architectural character (period or style), exterior detailing, matching nearby and installation material/color pallets, as described herein.

6.5.2. **Design**

6.5.2.1. Appendix F is provided "For Information Only", to establish the desired site and architectural themes for the area. Appendix F identifies the desired project look and feel based on Fort Eustis**'s** Installation Architectural Theme from existing and proposed adjacent building forms; i.e. building exterior skin, roof lines, delineation of entrances, proportions of fenestration in relation to elevations, shade and shadow effects, materials, textures, exterior color schemes, and organizational layout.

6.5.2.2. The design should address Fort Eustis's identified preferences. Implement these preferences considering the following:

(a) Achievable within the Construction Contract Cost Limitation (CCL)

(b) Meets Milestones within Maximum Performance Duration.

(c) Achieves Full Scope indentified in this Solicitation

(d) Best Life-Cycle Cost Design

(e) Meets the Specified Sustainable Design and LEED requirements

(f) Complies with Energy Conservation Requirements Specified in this RFP.

6.5.2.3. Priority #1. Visual Compatibility: Facility Massing (Size, Height, Spacing, Architectural Theme, etc.) Exterior Aesthetic Considerations: The buildings massing, exterior functional aesthetics, and character shall create a comprehensive and harmonious blend of design features that are sympathetic to the style and context of the Installation. The Installation's intent for this area is:

6.5.2.3.1. GENERAL OVERVIEW

The project site is bounded by residential structures and adjacent to the installation medical center. The residential architecture is a combination of older styles from the late fifties to early sixties and more recently constructed buildings. The exterior of the older buildings is comprised of brick veneer and vertical T-1-11 plywood siding with low pitch asphalt shingle roofs. The newer residential structures are of a more contemporary style, reflecting the colonial style of the region. The exterior of these buildings is comprised of horizontal lap siding and high pitch asphalt shingle roofs with dormers.

The medical center complex is comprised of older and newer buildings. The older structures employ brick veneer with stucco bands and painted brown flashing. The newer buildings of the complex are brick veneer with panted green metal standing seam roofing. Also adjacent to the site is the USA MEDDAC ADMIN BUILDING whose exterior is also comprised of brick veneer and green painted metal seam roofing.

The COF building is in nature a commercial occupancy. With the proposed location being opposite the medical center, it may not have to be as responsive to the residential occupancies as much as to the medical center, but is going to be visible to those residential adjacencies. As a part of a larger complex situated between the medical center and base housing, the design of this building will have to be coordinated with the design of the barracks building.

The SFAC building, while in nature is a commercial occupancy, is to be located directly opposite to the adjacent residential occupancy. The design for this building needs to be responsive to that occupancy and present an appearance that is conducive and consistent with a small office building (doctors office?) that would be constructed in or on the edge of a residential neighborhood. As a part of a larger complex situated between the medical center and base housing, the design of this building will have to be coordinated with the design of the barracks building.

6.5.2.3.2. GREEN ROOF

For the SFAC building, the contractor shall design and provide an “extensive” type green/garden roof assembly which will be lightweight and support hardy plantings. The roof shall be low maintenance with no irrigation requirement, the medium/retention layer shall be sufficient to sustain the plantings between periods of rainfall, and shall be designed to mitigate heat island effect and reduce overall stormwater runoff. In order to maintain watertightness, the green roof assembly shall incorporate a fluid-applied, rubberized asphalt roof utilizing at least 25% recycled materials, appropriate insulation as identified elsewhere in this RFP, green roof components, plant and vegetative growing medium. Roof slope shall be low to moderate with a pitch between 2:12 and 4:12. Growing depth of plantings shall be shallow at 3” minimum and 4” maximum depth. Plantings shall be drought, wind, and frost resistant and shall be self-generating sedums. Entire green/garden roof assembly shall be designed and constructed by a single-source provider and ensure a minimum 25-year warranty.

6.5.2.4. Priority #2. Architectural Compatibility: Exterior Design Elements (Materials, Style, Construction Details, etc.) Roofs, Exterior Skin, and Windows & Door Fenestrations should promote a visually appealing compatibility with the desired character while not sacrificing the integrity and technical competency of building systems.

6.5.2.5. See Appendix F for exterior colors that apply to Architectural character at Fort Eustis. The manufacturers and materials referenced are intended to establish color only, and are not intended to limit manufacturers and material selections.

6.5.2.6. Additional architectural requirements:

(a) Install fall protection anchor points on all roofs with a slope greater than 2:12

(a) Fenestrations - At a minimum, entrance doors shall be aluminum storefront. Service doors shall be painted hollow metals. Exterior doors and windows shall have Low-e insulated glass. Windows, except at vestibules, shall have operable blinds. Where possible, especially in storage buildings, operable windows shall be used.

(b) Roofs - All roof systems are required to provide with manufacture’s standard warranty. Where sloped roofs are provided, roof slope shall be a minimum 4:12. Sloped roofs shall have snow /ice guards, exposed gutters and downspouts. Splash-blocks shall be provided at each downspout, or rain leaders shall be tied into a sub-surface stormwater collection system. Insulated roof systems shall not be ventilated; non-insulated roofs creating attics shall be ventilated with storm-proof ridge vents matching the roof construction. All roof penetrations shall match the roof construction and be discretely located. Varying roofing options/materials are covered further elsewhere within this Paragraph.

(c) Fort Eustis Fire Department requires the Knox Box (provided by the Contractor) be located at the front entry. The Contractor shall contact the Fire Department through the Contracting Officer to obtain order information and forms for the Knox Box.

6.5.3. Programmable Electronic Key Card Access Systems:

Install Programmable electronic key card access systems in facilities per Army Installation Design Standards Paragraph 3.5.11, "Locks and Locking Devices." The Installation has established the following single source manufacturer/system for this equipment: Best BASIS V hardware and BASIS G software.

6.5.4. INTERIOR DESIGN

(a) Public spaces of each building will have design interest; color scheme will be neutral with the appropriate selection and placement of color, texture and patterns. Accent color or layering of colors will be considered for the walls and flooring to highlight and accentuate architectural features. Flooring will be designed with minimal patterning.

(b) Office type spaces will be welcoming, comfortable and designed with future flexibility in mind. Access to exterior light and views for the greatest number of occupants is an objective.

Interior building signage requirements:

[Not Supplied - PS_Architecture : INTERIOR_SIGNAGE]

6.6. STRUCTURAL DESIGN

6.6.1 General

Consider mission effectiveness, the most economical system in the locality, life-cycle economics, and space adaptability in choosing the structural systems. Space adaptability includes future reorganization or reallocation of space.

Analyze, design, and detail the Warrior in Transition Army Soldier Family Assistance Center (SFAC) and Headquarters (COF). Design structural elements to preclude damage to finishes, partitions, and other frangible, nonstructural elements; to prevent impaired operability of moveable components; and to prevent cladding leakage and roof ponding. Limit deflections of structural members to the allowable of the applicable material standard, e.g. ACI, AISC, Brick Industry Association (BIA).

Consider climate conditions, high humidity, industrial atmosphere, saltwater exposure, or other adverse conditions when selecting the type of cement and admixtures used in concrete, the concrete cover on reinforcing steel, the coatings on structural members, expansion joints, the level of corrosion protection, and the structural systems. All concrete shall be a minimum of 3,000 psi and shall be steel reinforced. Place floor mounted mechanical and electrical equipment on a 4” minimum concrete pad.

In addition to gravity, seismic, and lateral loads, design ancillary building items, e.g. doors, window jambs and connections, overhead architectural features, equipment bracing, for the requirements of UFC 4-010-01, DOD Minimum Antiterrorism Standards for Buildings. Ensure and document that the design of glazed items includes, but is not limited to, the following items under the design loads prescribed in UFC 4-010-01:

(a) Supporting members of glazed elements, e.g. window jamb, sill, header

(b) Connections of glazed element to supporting members, e.g. window to header

(c) Connections of supporting members to each other, e.g. header to jamb

(d) Connections of supporting members to structural system, e.g. jamb to foundation.

6.6.2 Applicable Standards, Codes, and Criteria

The structural design shall fully comply with the following listed criteria in addition to the provisions provided in Section 01 10 00 paragraph 4.0 Applicable Criteria. Use the latest edition of the International Building Code (IBC) for design guidance, and coordinate design with UFC 4-010-01. For buildings three stories and taller, design for progressive collapse in accordance with UFC 4-023-03, Design of Buildings to Resist Progressive Collapse.

6.6.3 Project Specific Design Loads:

6.6.3.1. Building Occupancy Category II

6.6.3.2. Ground Snow: 15 psf

6.6.3.3. Wind Speed: 97 mph, Exposure C, Importance Factor 1

6.6.3.4. Frost Penetration: 9 inches

6.6.3.5. Seismic Design Data: Importance Factor 1

The mapped maximum considered earthquake (MCE) spectral response accelerations for site class B are:

S_s (at short periods) = 13% g

S1 (at 1-second period) = 5% g

The acceleration values identified are for the general location of the facility. Verify and use site specific criteria based on the final site location of the facility. Adjust site class per IBC to match specific site information in geotechnical report.

6.6.3.6. Antiterrorism/Force Protection loads and minimum requirements are per UFC 4-010-01. For design of structural components subjected to dynamic loads, the U.S. Army Corps of Engineers Protective Design Center (PDC) developed SBEDS, Single-Degree-of-Freedom Blast Effects Design Spreadsheets (SBEDS). SBEDS is available at the software tab of the PDC website, HYPERLINK "https://pdc.usace.army.mil/"https://pdc.usace.army.mil/.

6.6.4 Foundation

The foundation is site specific and must be designed upon known geotechnical considerations by an engineer knowledgeable of the local conditions, e.g. highly expansive soils, groundwater levels. Coordinate the need for a vapor barrier with the architectural floor finishes and requirements of the geotechnical report. All slab-on-grade to receive a coating (e.g. epoxy) or to receive an overlaying finish (e.g. carpet or tile), shall be underlain by a vapor barrier system with a minimum 10-mil polyethylene membrane.

6.6.5 Site Features – Retaining Walls/Bridges/etc.

Design site features, e.g. retaining walls, culverts, bridges, in accordance with the appropriate American Association of State Highway and Transportation Officials (AASHTO) criteria including AASHTO LRFD Bridge Design Specifications, AASHTO Standard Specifications for Highway Bridges, and AASHTO Guide Specifications for Design of Pedestrian Bridges. Consider operation and maintenance requirements, e.g. painting, mowing, inspecting, routine maintenance. Design site features to drain properly in order to meet loading assumptions.

6.7. THERMAL PERFORMANCE

No additional requirements.

6.8. PLUMBING

No additional requirements.

6.9. SITE ELECTRICAL AND TELECOMMUNICATIONS SYSTEMS

6.9.1 ELECTRICAL DISTRIBUTION

(a) All exterior electrical distribution system design work shall be coordinated with Dominion Virginia Power (DVP). The point of contact at DVP for coordination purposes is Mr. Steve Buell (757) 434-6195 or email at steve.buell@dom.com. The point of contact at Fort Eustis DPW for power company coordination purposes is Mr. Daniel Wood (757) 878-2489 ext 228.

(b) DVP owns and operates the 13.2kv electrical distribution system (aerial and underground) on Fort Eustis. Electrical distribution system, transformer and secondary capacity to support the new services at the Company HQ and Soldier and Family Assist Center (SFAC) facilities will be determined by DVP, based on electrical load information provided by the Contractor. The Contractor will complete a DVP load letter for all electrical service requests. The load letter can be found on DVP's web site at HYPERLINK "www.dom.com"www.dom.com (type Load Letter in search box).

(c) DVP will be responsible for the design and construction of the exterior electrical distribution system, transformer and secondary service work up to 5 feet within the each facility as per the requirements of the DVP Information and Requirements for Electrical Service "Blue Book". The DVP point of connection (service delivery point) at each facility shall be specified in the "Blue Book" and includes interior mounted CT cabinet, meterbase, electrical switchboard or panelboard within each facility (5' rule applies), etc. Specification for all termination/metering compartments for switchboard / switchgear equipment must have written approval by DVP prior to material procurement. Contractor shall provide service entrance duct stub-out to the five foot line of each facility. Contractor shall coordinate size and location of duct stub-out with DVP POC. Contractor shall provide an empty conduit from the metering section to the exterior mounted meter base for each facility to allow for DVP exterior metering. Contractor shall coordinate location and requirements with DVP. Please reference DVP's Information and Requirements for Electrical Service for other restrictions and requirements for electric service connections.

(d) If the service equipment connection point is greater than 5 feet within the building, then contractor shall follow the DVP Blue Book requirements on the exceptions to the Five Foot Rule.

(e) The DVP electrical distribution system shall include all primary and secondary duct banks and conductors, manholes, primary switchgear, transformers, current transformer (CT) cabinets and utility connection boxes.

(f) CT cabinets shall be provided by DVP and will be installed by the Contractor as per the requirements of the DVP Blue Book. Contractor shall be responsible for coordinating the service location with DVP, installing the DVP provided CT cabinet (if used), and providing an empty conduit(s) from the building service entrance to the CT cabinet and meter base.

(g) The DVP electrical service requirements (Blue Book) can be obtained at:

HYPERLINK "http://www.dom.com/dominion-virginia-power/customer-service/for-businesses/pdf/bluebook.pdf"http://www.dom.com/dominion-virginia-power/customer-service/for-businesses/pdf/bluebook.pdf

(h) The Government will engage DVP to perform this work and pay all associated costs; however, the Contractor shall carefully adapt scheduling and performing the work under this contract to fully coordinate and accommodate work by DVP.

(i) The electrical design shall be in accordance with DVP's safety and construction standards and any applicable codes and standards listed in Chapter 4 of the RFP.

6.9.2 EXTERIOR LIGHTING

All exterior site and parking area lighting shall be fed directly from the building electrical system, with all related wiring provided by the Contractor. The construction of all exterior roadway street lighting (if required) is the responsibility of DVP. The Contractor shall coordinate the exterior roadway lighting with DVP. The Contractor shall provide DVP the design for the location of street lighting poles, and DVP will install and circuit the street lighting. The point of contact at DVP for Fort Eustis roadway lighting is Mr. Steve Buell (757) 434-6195.

6.9.3 ELECTRICAL DEMOLITION

The completed site plan shall include power, communications and CATV demolition. Demolition of the existing systems (if required) shall be coordinated with the following points of contact to the nearest location as required by the applicable utility POC:

Dominion Virginia Power (DVP): Mr. Steve Buell (757) 434-6195 or email at steve.buell@dom.com

Network Enterprise Center (NEC) Mr. Glenn Fisher, (757) 878-3246

Cox Communications: Kelley Bristow (757) 369-6408 or email at Kelly.bristow@cox.com

6.9.4 TELECOMMUNICATIONS SYSTEM (OUTSIDE PLANT)

(a) The communications infrastructure system at Fort Eustis has not been privatized and is managed by the Fort Eustis Network Enterprise Center (NEC). NEC point of contact for this project is Mr. Glenn Fisher (757) 878-3246.

(b) The DB Contractor will contact and coordinate all communications service connections with NEC.

(c) All communications systems, outside plant (OSP), voice system, and data network shall be designed and constructed in accordance with the USAISEC Technical Guide for Installation, Information, Infrastructure, Architecture (I3A), TR No. AMSEL-IE-TI-06001-7 United States Army Information Systems Engineering Command Worldwide Outside Plant Design and Performance Requirements or as directed by the NEC requirements.

(d) The DB Contractor shall coordinate communication infrastructure design and construction requirements with the NEC and USAISEC Site Engineer through the Corps of Engineers, Resident Engineer or other COE POC as designated. Construction drawings and specifications shall comply with UFC-3-580-01 and be coordinated with USAISEC, Fort Detrick Engineering. (For a copy of the I3A Guide, contact USAISEC-FDED, email: DetrickISECI3Aguide@conus.army.mil.)

(e) The DB Contractor is responsible for the design and construction of the communications systems within the building and from the building to the connection point with the installation infrastructure. The DB Contractor shall engineer, furnish, install, secure, and test (EFIS&T) the telecommunications and information technology infrastructure and make operational.

(f) All design work shall be performed by a Registered Communications Distribution Designer (RCDD) with a minimum of 5 years experience in the application of related telecommunications systems of outside plant and interior systems. Provide evidence to certify designer's qualifications.

(g) Contractor shall establish applicable Work Area Protection (WAP).

(h) Provide new 6'x12'x7'manhole near existing handhole 65, Southeast of Sternberg/25th Street. Exact location to be determined by 733rd Communications Branch.

(i) Open cut Heiner Street from manhole 175 to Southeast corner of Heiner/Sternberg.

(j) Provide 4-way, 4-inch Schedule 40 conduit from manhole 175 to new manhole location near existing handhole 65. Conduit is to be concrete encased. One 4-inch conduit to have 4 way innerduct. Pull line, (mule tape), and trace (#14 grd) to be provided.

(k) Provide 400-24 AWG copper cable from manhole 29 at Washington and Jefferson through existing conduit to manhole 47 at Jefferson and 28th Street. Duct selection to be determined by the 733rd Communications Branch. Approximate distance is 375 feet.

(l) Provide 400-24 AWG copper cable from manhole 47 through existing conduit to manhole 48 at Jefferson and 26th street. Duct selection to be determined by the 733rd Communications Branch. Approximate distance is 293 feet.

(m) Provide 400-24 AWG copper cable from manhole 48 through existing conduit to manhole 172 at Jefferson and Heiner Street. Duct selection to be determined by the 733rd Communications Branch. Approximate distance is 430 feet.

(n) Provide 400-24 AWG copper cable from manhole 172 through existing conduit to manhole 174 located on Heiner Street across from building 574/575. Duct selection to be determined by the 733rd Communications Branch. Approximate distance is 554 feet.

(o) Provide 400-24 AWG copper cable from manhole 174 through existing conduit to manhole 175 located on Heiner Street and Sternburg Avenue. Duct selection to be determined by the 733rd Communications Branch. Approximate distance is 213 feet.

(p) Provide 400-24 AWG copper cable from manhole 175 through newly installed conduit to new manhole Southeast of Sternburg/25th Street. Duct selection to be determined by the 733rd Communications Branch. Approximate distance is 285 feet.

(q) Provide 48 strand FOC from manhole 174 to manhole 175. Pull line, (mule tape), and trace (#14 grd) to be installed. FOC to be installed in remaining open 4 way innerduct.

(r) Provide 48 strand FOC from manhole 175 to new manhole Southeast of Sternburg/25th Street. Pull line, (mule tape), and trace (#14 grd) to be installed. FOC to be installed in one of the 4 way innerducts.

(s) From newly installed manhole, provide one 4 inch schedule 40 PVC conduit to the SFAC building access conduit at the 5 foot line. Pull line, (mule tape), and trace (#14 grd) to be installed. FOC to be installed in one of the 4 way innerducts.

(t) From newly installed manhole, provide one 4 inch schedule 40 PVC conduit to the Company Headquarters building access conduit at the 5 foot line. Pull line, (mule tape), and trace (#14 grd) to be installed. FOC to be installed in one of the 4 way innerducts.

(u) From newly installed manhole, provide 150-24AWG copper cable and 12 FOC into conduit for the Company Headquarters Building. Leave 30 feet of copper cable and FOC inside the building and manhole for splicing.

(v) From newly installed manhole, provide 50-24AWG copper cable and 12 FOC into conduit for the SFAC Building. Leave 30 feet of copper cable and FOC inside the building and manhole for splicing.

(w) 733rd Communications Branch will be responsible for all terminations of OSP cable

(x) Contractor shall have good clean up operations throughout the course of the project

(y) Contractor shall abide by all applicable OSHA rules, Post requirements and Standard Safety Procedures

(z) DOIM POC – Bob Beil 878-1133/Paul Rogers 878-1298

(aa) See Site Map and applicable OSP Cable Construction Standards in Appendix GG.

6.9.5 EXTERIOR CABLE TELEVISION SYSTEM (CATV)

A complete CATV system shall be provided to the Company HQ and Soldier and Family Assist Center (SFAC) facilities. Cox Communications owns and operates the exterior CATV system on Fort Eustis. All exterior CATV work shall be coordinated with the Fort Eustis DPW Mr. Daniel Wood (757) 878-2489 ext 228 and Cox Communications. The POC for COX Communications is Kelley Bristow (757) 369-6408 or email at kelly.bristow@cox.com. Contractor shall provide a 4 inch empty conduit stub-out 5 feet from each building exterior. Contractor shall coordinate with Cox Communications on the exact location of the stub-out.

6.10. FACILITY ELECTRICAL AND TELECOMMUNICATIONS SYSTEMS

6.10.1 LOADS

The loads for all facilities will be determined by the Contractor. The electrical service will be sized by DVP based upon Contractor provided Load Letter for the Company HQ and Soldier and Family Assist Center (SFAC) facilities. The primary service is described in 6.9.

6.10.2 POWER DISTRIBUTION

The D/B contractor shall coordinate with DVP, follow DVP requirements, follow Appendix BB requirements and provide service entrance duct stubbed out to the five foot line of each facility. The D/B Contractor shall design and provide the facility service entrance disconnect within the main electrical distribution panel located within (but not more than five feet within) of each building. DVP will be responsible for providing the secondary service entrance conductors to the service entrance disconnect for each facility.

6.10.3 ELECTRICAL SECONDARY SERVICE VOLTAGE (480/277V or 208/120V)

The Contractor shall coordinate the electrical secondary service voltage for the Company HQ and Soldier and Family Assist Center (SFAC) facilities based upon the calculated load and availability of service from DVP.

6.10.4 SURGE PROTECTION

The Contractor shall provide a SPD (Surge Protection Device) at the electrical service entrance for the Company HQ and Soldier and Family Assist Center (SFAC) facilities.

6.10.5 TAMPER RESISTANT OUTLETS

In addition to requirements stated in Paragraph 3.7.1.4.7, the contractor shall provide tamper resistant outlets in the Childrens Activity Room and other child-occupied areas of the SFAC facility.

No additional requirements.

6.11. HEATING, VENTILATING, AND AIR CONDITIONING

Connect and integrate building level DDC control systems into current base wide UMCS at Ft Eustis. The building level DDC control shall be fully integrated with the base wide Ft. Eustis UMCS system located in building 6220 in accordance with UL 916. The current base side UMCS system shall fully control and monitor the new DDC control system for the complete building. All communications between the current base side UMCS and the new building level DDC networks shall be via the ANSI/EIA 709.1B protocol over the Fort Eustis IP newtork. The controls contractor shall submit final as-built drawings in hard copy on CD-ROM in AutoCAD format delivered to the government for use and record. Use Appendix DD as a guide for development of control design drawings and basis for determination of level of effort during the design of the control system by the designer of record during design after award. Appendix EE shall be edited for project. Note that there are system CAD templetes available for systems listed within Appendix EE which are available for the designers use for editing upon request.

Integrate the control system to the installation's existing UMCS. The existing UMCS is [Not Supplied - PS_HVAC : UMCS_DESCRIPTION]

6.12. ENERGY CONSERVATION

6.12.1. General

Edit specification provided under Appendix AA for Air Barrier for development of construction documents based on materials selected by designer of record.

Appendix CC shall be used as guidance for generation of testing procedures and reports for testing of air barriers and reporting of results. The contractor shall engage the air barrier contractor during the design process for development of the project construction document and testing requirements. Appendix BB Commissioning shall be edited to cover all commissioning of energy related systems to include at minimum divisions 22, 23, and 26.

6.12.2. Inclusion of Renewable Energy Features. The following renewable energy features have been determined lifecycle cost effective, are included in the project budget and shall be provided:

There are no renewable energy feature requirements.

6.13. FIRE PROTECTION

Design of fire protection system, including location of fire alarm control and annunciation panels shall be coordinated with the Fire Chief of Fort Eustis. The Contractor shall contact Patricia Lee of the Fire Department at (757) 878-4281 x321 for specific requirements.

(a) All fire protection and life safety features for the facilities will be in accordance with UFC 3-600-01.

(b) Provide automatic fire suppression protection throughout.

(c) Provide a mass notification system complying with UFC 4-021-01. The Fort Eustis Fire Department requirement for the system is to have a fully addressable panel with a Monaco BTXM 4 transmitter that transmits to the Fire Department Communications Center in Building 648.

(d) Fire Alarm and Detection System: Required fire alarm and detection systems shall be the addressable type. All initiation devices shall have unique addresses. Provide a annunciator panel at the main building entrance.

(e) Preliminary Fire Flow Test Data is provided in Appendix D.

(f) Each fire department connection shall be a 2-1/2" Siamese connection.

(g) Provide a minimum of 36" maintenance clearance to backflow preventer and system riser.

(h) The Contractor shall provide the following infrastructure and equipment to support Government Furnished Government Automatic External Defibrillators. The Contractor shall design and place AED cabinets throughout the facility so that the AED user does not travel more than 300 feet to reach the device. At a minimum, one AED cabinet shall be located on each level of the building. POC is EMS, Mike Holland, (757) 878-4281 x328..

1) A 17 ½" H x 17 ½" W x 7 ¼" deep recessed AED Cabinet.

2) Each AED cabinet shall be furnished with a tamper switch to send a supervisory signal to the fire department through the fire alarm panel alerting them when the cabinet door is opened.

3) An 8 ½" x 11" AED PLUS wall sign.

4) Necessary electrical and fire alarm connectivity.

6.14. SUSTAINABLE DESIGN

6.14.1. LEED Rating Tool Version. This project shall be executed using LEED-NC Version 3.

6.14.2. The minimum requirement for this project is to achieve LEED Silver level. Each non-exempt facility (building plus sitework) must achieve this level. In addition to any facilities indicated as exempt in paragraph 3, the following facilities are exempt from the minimum LEED achievement requirement: None.

6.14.3. Credit Validation: LEED registration, compiling of documentation at LEED OnLine and use of the LEED Letter Templates is required. Registration and payment of registration fees will be by the Government. Administration/team management of the online project will be by the Government. Validation of credits will be accomplished by the Government. LEED certification of the project by the Contractor is not required. The Government may choose to seek LEED certification of the project, in which case the Government will pay certification fees and coordinate with the GBCI and the Contractor will furnish audit data as requested at no additional cost.

6.14.4. Commissioning: See Appendix M for Owner's Project Requirements document(s).

6.14.5. LEED Credits Coordination. The following information is provided relative to Sustainable Sites and other credits.

SS Credit 1 Site Selection:

Project site IS NOT considered prime farmland.

Delineation of 100-year flood elevation is shown on site drawings provided in this CONTRACT.

Delineation of threatened or endangered species habitat is shown on site drawings provided in this CONTRACT.

Delineation of water, wetlands and areas of special concern is shown on site drawings provided in this CONTRACT.

Project site WAS NOT previously used as public parkland.

SS Credit 2 Development Density & Community Connectivity.

Project site DOES NOT meets the criteria for this credit.

SS Credit 3 Brownfield Redevelopment.

Project site DOES NOT meets the criteria for this credit.

SS Credit 4.1 Public Transportation Access.

Project site DOES NOT meets the criteria for this credit.

EA Credit 6 Green Power.

35% of the project's electricity WILL NOT will be provided through an Installation renewable energy contract. Do not purchase Renewable Energy Credits (REC's) to earn this credit.

MR Credit 2 Construction Waste Management.

The Installation does not have an on-post recycling facility available for Contractor's use.

Regional Priority Credits (Version 3 only)

The project zip code is 23604.

6.14.6. LEED Credit Preferences, Guidance and Resources. See Appendix L LEED Project Credit Guidance for supplemental information relating to individual credits.

6.14.7. Not Used

6.14.8. Additional Information

There are no renewable energy requirements.

6.15. ENVIRONMENTAL

6.15 ENVIRONMENTAL

All work is to be performed in a manner that prevents pollution, protects the environment, and conserves natural and cultural resources and in compliance with all requirements noted in the Environmental Information included in Appendix E.

6.15.1 The Contractor shall coordinate with Fort Eustis DPW-to define the limits of construction with the environmental constraints surrounding each site. The following examples of constraints should be considered if known:

(a) Any archaeological site that is adjacent to or within the project limits.

(b) Wetlands and the 100' RPA Buffer that exists adjacent to or within the project limits.

6.15.2 No land disturbance work shall begin without approval of the Fort Eustis.

6.16. PERMITS

The Contractor shall obtain all needed licenses and permits.

(a) Air permitting is required for this project unless formal written confirmation from USAG-Fort Eustis's DPW-Air Quality Program is received by USACE RFP Preparer or Contractor that states air permitting will not be required for the project.

(b) Proper Storm Water permits must be obtained from the State of Virginia. Contractor shall provide copy of Forms DCR01 and DCR199-146 and any required plans and specifications to DPW for review at least 30 days prior to submission to VA DCR. Contractor shall submit this registration and any required plans and specifications to VA DCR at least 30 days prior to construction start.

(c) For specific requirements refer to Paragraph 4 Applicable Criteria; Appendix E Environmental Information and Appendix BB Sustainable Management of Waste.

(d) All military construction, renovation and demolition projects shall include contract performance requirements for a 50% minimum diversion of construction and demolition (C&D) waste by weight, from landfill disposal.

(e) Non-Army agencies require an Army Radiation Permits (ARP) to use, store, or possess ionizing radiation sources on an Army Installation (32 DFR 655, para 2-4a). Non Army applicants will apply by letter with supporting documentation to the Garrison Commander through the Installation Safety Office. The letter shall be submitted such that the Garrison Commander receives the application at least 30 days before the requested start date of the permit (AR 385-10, Chap. 7.)

6.17. DEMOLITION

(a) Demolition and removal of existing materials shall be performed as necessary to properly construct the project,

appropriate requirements shall be detailed in Offeror's plans and specifications after award. Demolition shall include, but

not be limited to, trees and vegetation, pavements, curbs, and utilities. Demolition materials shall be disposed off

Government property. Utility piping shall not be abandoned within the project limits, but shall not be removed back to

the connection point at the main or manhole. Removal of pavements shall be complete where required including

surface and basecourse layers. Recycling of pavements, concrete curb and gutters, and base materials to meet

recycling requirement and LEED credits is encouraged. Trees to be removed shall have stumps and roots grubbed and

removed completely. Open voids shall be backfilled and filled with topsoill to match proposed grades. Materials

disposed off Government property shall be recycled whenever possible. The DB Contractor shall obtain demolition and

disposal permits from appropriate agencies. Obtain approval of the disposal site from the Contracting Oficer and the

Fort Eustis DPW Environmental Division. Succesful Offeror shall comply with 50% minimum diversion of C & D waste;

by weight, from landfill.

(b) Existing utilities abandoned in place. Existing underground utility lines do not fall under the new facilities may be

abandoned in place after being cut, capped, and filled with flowable fill, or lean concrete. This work shall be performed

by the privatized utility contractor in accordance with the DB Contractor's site and demolition plan.

6.18. ADDITIONAL FACILITIES

None

6.18 OTHER PROJECT REQUIREMENTS

6.18.1 PROJECT WORK REQUIREMENTS AND RESTRICTIONS

The normal work hours for construction shall be from 0730 to 1600, Monday through Friday of each week. Any

request to change these hours shall be made in writing to the Contracting Officer at least two calendar days

prior to the desired day on which the change is to go into effect. The changed hours shall not go into effect

until written permission has been received from the Contracting Officer.

6.18.1.2 GATE TIMES

Main Gate, 24 hours a day, seven days a week. Fort Eustis Gate passes are obtained by submitting full name,

full social security number, sex, race and date of birth on a "company letterhead stationary" along with a

general statement explaining what the person/s will be doing on Fort Eustis and for how long, to the MP

station at Building 648 or fax to 878-5481. This information can be given to the COE office who in turn forwards

to the MPs. The information is run through vehicle registration at Building 2 where the passes will be .

picked up.

6.18.1.3. CELLULAR PHONE USE

Cellular phone use is prohibited within the construction site, except by superintendents and job foreman.

Cellular phone use while driving and/or operating construction equipment is prohibited.

6.18.1.4 ANTITERRORISM AND FORCE PROTECTION

Electronic Intrusion Detection System (IDS): Any IDS installed will be compatible with the current Fort Eustis base-wide system, to include the current base-wide operating platform and remote monitoring work stations and will meet all Fort Eustis and US Army security requirements. The IDS shall include, but not limited to, passive infrared detection, triple balanced biased magnetic switches, central on-site IDS controller which monitors, interrogates, supervises, annunciates, identifies unauthorized intrusion, electronically notifies the operating platform by use of "dry copper telephone lines" (no cellular communication) in order for the base security response to events. Contractor will coordinate all IDS issues with the user and the Physical Security Office, Ft Eustis.

6.18.2 PROJECT SCHEDULE

Information contained within this paragraph shall supplement Section 01 32 01.00 10, providing requirements specific to Norfolk District USACE.

6.18.2.1 GENERAL REQUIREMENTS

Pursuant to the Contract Clause, SCHEDULE FOR CONSTRUCTION CONTRACTS, a Project Schedule as described below shall be prepared. The NAS Project Schedule shall be a composite schedule including the design and construction activities. The scheduling of construction design and construction shall be the responsibility of the Contractor. Contractor management personnel shall actively participate in its development. Subcontractors and suppliers Designers, Subcontractors and suppliers working on the project shall also contribute in developing and maintaining an accurate Project Schedule. The approved Project Schedule shall be used

To measure the progress of the work, to aid in evaluating time extensions, and to provide the basis of all progress payments. The Government will use the NAS Project Schedule to evaluate the contractor's progress for timely completion, plan for Quality Assurance verification of the work and evaluate the effects of a proposed modification on the contract duration (critical path activities)

6.18.2.2 QUALIFICATIONS- CONTRACTOR SCHEDULING REPRESENTATIVE

The Contractor shall designate, a scheduling representative, the individual tasked with the responsibility for preparation-updating-revision of the NAS schedule who shall be responsible for the preparation and submittal of the entire NAS project schedule including all items specified below and revisions to the schedule or supplemental completion schedules, as applicable or directed by the Contracting Officer. The scheduling representative shall be approved by the Contracting Officer based on a resume indicating as a minimum, formal training from software vendor or 5 years experience in working with NAS schedules.

6.18.2.3 PROJECT SCHEDULE

The contractor shall prepare the NAS schedule using a computer software system. The system utilized by the Contractor shall be capable of satisfying all requirements of this specification and ER 1-1-11. Manual methods used to produce any required information shall require prior approval by the Contracting Officer. The Contracting Officer intends to use PRIMAVERA P3. Should the contractor utilize software that is different than that utilized by the Contracting Officer, based on the software utilized by the contractor for the preparation of the NAS schedule, the

Contractor shall provide a copy of the software and a license to the Administrative Contracting Officer at the Government field office. The Contractor shall submit a copy of the user's manual outlining the selected CPM

computer program's mathematical analysis capabilities, details, functions and operation. The Contractor shall provide to the Government a complete input listing for the selected software.

a) The Critical Path Method (CPM) of network calculation shall be used to generate the Project Schedule. The Contractor shall provide the Project Schedule in the Precedence Diagram Method (PDM).

b) The Project Schedule shall include an appropriate level of detail. Failure to develop or update the Project Schedule or provide data to the Contracting Officer at the appropriate level of detail, as specified by the Contracting Officer, shall result in the disapproval of the schedule. The Contracting Officer will use, but is not limited to, the following conditions to determine the appropriate level of detail to be used in the Project Schedule:

1 Cost and Resource Loading

a. Cost Loading Activities: Costs for incremental design preparation will be assigned to the respective design phase submittal milestone(s). Equipment costs will be assigned to their respective Procurement Activities (i.e., the delivery milestone activity). Costs for installation of the material/equipment (labor, construction equipment, and temporary materials) will be assigned to their respective Construction Activities. The value of inspection/testing activities will not be less than 10 percent of the total costs for Procurement and Construction Activities. Evenly disperse overhead and profit to each activity over the duration of the project. The total of all cost loaded activities; including costs for material and equipment delivered for installation on the project, and labor and construction equipment loaded construction activities, shall total to 100 percent of the value of the contract.

b. Quantities and Units of Measure: Each cost loaded activity will have a detailed breakdown of the contract price, giving quantities for each of the various kinds of work, unit prices, etc.

c. Labor Resource Loading: As part of the Baseline Schedule development each construction activity shall have an estimate of the number of workers per day by trade, hours per day by trade and total expected hours used by trade during the execution of the activity. If no workers are required for an activity, then the activity shall be identified as using zero workers per day. Actual labor resource expended on an activity will be recorded in the monthly updated schedules and will coincide with entries made in the Daily Reports.

d. Equipment Resource loading: As part of the Baseline Schedule development each construction activity shall have an estimate of the equipment used per day, number of units per day and total expected hours for each piece of equipment used during the duration of the activity. Include a description of the major items of construction equipment planned for each construction activity on the project. The description shall include the year, make, model, and capacity. If no equipment is required for an activity, then the activity shall be identified as using zero equipment per day. Actual equipment resource expended on an activity will be recorded in the monthly updated schedules and will coincide with entries made in the Daily Reports.

2 Activity Durations - Contractor submissions shall follow the direction of the Contracting Officer regarding reasonable activity durations. Reasonable durations are those that allow the progress of activities to be accurately determined between payment periods (usually less than 2 percent of all non-procurement activities' Original Durations are greater than 20 days). Durations shall be in work days.

3 Design and Permit Activities - Design and permitting activities, including necessary conferences and follow-up actions and design package submission dates, shall be integrated into the schedule.

4 Procurement Activities - Tasks related to the procurement of long lead materials or equipment shall be included as separate activities in the project schedule. Long lead materials and equipment are those materials that have a procurement cycle of over 90 days. Examples of procurement process activities include, but are not limited to: submittals, approvals, procurement, fabrication, and delivery.

5 Critical Activities - The following activities shall be listed as separate line activities on the Contractor's project schedule:

a. Submission and approval of mechanical/electrical layout drawings.

b. Submission and approval of O & M manuals.

c. Submission and approval of as-built drawings.

d. Submission and approval of 1354 data and installed equipment lists.

e. Submission and approval of testing and air balance (TAB).

f. Submission of TAB specialist design review report.

g. Submission and approval of fire protection specialist.

h. Submission and approval of testing and balancing of HVAC plus commissioning plans and data.

i. Air and water balance dates.

j. HVAC commissioning dates.

k. Controls testing plan.

l. Controls testing.

m. Performance Verification testing.

n. Other systems testing, if required.

o. Pre-final inspection.

p. Correction of punch list from pre-final inspection.

q. Final inspection.

6 Government Activities - Government and other agency activities that could impact progress shall be included in the schedule. These activities include, but are not limited to: Government approvals, Government review and verification that design submittals are in accordance with the RFP, inspections, utility tie-in, Government Furnished Equipment (GFE) and Notice to Proceed (NTP) for phasing requirements, environmental permit approvals by State regulators, inspections, Government approval of shop drawings activities should be shown with the duration at least the minimum allowed by the contract. The contractor's failure to provide reasonable durations in its schedule for Government activities does not establish or change the Government's review or approval path periods and the durations established for Government's activities are subject to approval by the Contracting Officer.

a. Work activities to be included on the critical path

- CQC (all) mechanical systems test (indicate the specific system)
- CQC (all) electrical system tests (indicate the specific system)
- Government QA (all) mechanical system acceptance/operational test (indicate specific system)
- Government QA (all) electrical system acceptance /operational test (indicate specific system)
- CQC completion inspection of the entire project
- Contractor works off CQC punch list
- Pre-final inspection performed when the facility is completed such that it can be used for it intended function (as determined by the Contracting Officer)
- Contractor works off pre-final punch list

- Final/acceptance inspection of the entire project

- Contractor works off final punch list.

- Contractor shall allow 30 calendar days total duration prior to current contract completion date for the above stated activities. (See Specification Section 01 45 04.00 50 CONTRACTOR QUALITY CONTROL).

b. Contracts with multiple buildings/facilities - The contractor shall prepare a separate detailed NAS schedule for each building/facility indicating its critical path for specified interim completion dates or critical milestone date. The master NAS schedule shall indicate the interface/lag/link between buildings/facilities to maximize/level the labor and other resources. The master schedule critical path must be indicated through the various buildings/facilities and total duration equal to the contract duration.

7 Responsibility - All activities shall be identified in the project schedule by the party responsible to perform the work. Responsibility includes, but is not limited to, the subcontracting firm, contractor work force, or government agency performing a given task. Activities shall not belong to more than one responsible party. The responsible party for each activity shall be identified by the Responsibility Code.

8 Work Areas - All activities shall be identified in the project schedule by the work area in which the activity occurs. Activities shall not be allowed to cover more than one work area. The work area of each activity shall be identified by the Work Area Code.

9 Modification or Claim Number - Any activity that is added or changed by contract modification or used to justify claimed time shall be identified by a mod or claim code that changed the activity. Activities shall not belong to more than one modification or claim item. The modification or claim number of each activity shall be identified by the Mod or Claim Number. Whenever possible, changes shall be added to the schedule by adding new activities. Existing activities shall not normally be changed to reflect modifications.

10 Bid Item - All activities shall be identified in the project schedule by the Bid Item to which the activity belongs. An activity shall not contain work in more than one bid item. The bid item for each appropriate activity shall be identified by the Bid Item Code.

11 Phase of Work - All activities shall be identified in the project schedule by the phases of work in which the activity occurs. Activities shall not contain work in more than one phase of work. The project phase of each activity shall be by the unique Phase of Work Code.

12 Category of Work - All Activities shall be identified in the project schedule according to the category of work which best describes the activity. Category of work refers, but is not limited, to the procurement chain of activities including such items as submittals designs, design package submissions design reviews, review conferences, permits, submittals, approvals, procurement, fabrication, delivery, installation, start-up, and testing. The category of work for each activity shall be identified by the Category of Work Code.

13 Feature of Work - All activities shall be identified in the project schedule according to the feature of work to which the activity belongs. Feature of work refers, but is not limited to, a work breakdown structure for the project. The feature of work for each activity shall be identified by the Feature of Work Code.

c) Scheduled Project Completion - The schedule duration shall extend from NTP to the official contract completion date as awarded (unless approved by Contracting Officer-for early completion).

1 Project Start Date - The schedule shall start no earlier than the date on which the NTP was acknowledged. The Contractor shall include as the first activity in the project schedule an activity called "Start Project". The "Start Project" activity shall have an "ES" constraint date equal to the date that the NTP was acknowledged, and a zero day duration.

2 Constraint of Last Activity - Completion of the last activity in the schedule shall be constrained by the contract completion date. Calculation on project updates shall be such that if the early finish of the last activity falls after the contract completion date, then the float calculation shall reflect a negative float on the critical path. The Contractor shall include as the last activity in the project schedule an activity called "End Project". The "End Project" activity shall have an "LF" constraint date equal to the completion date for the project, and a zero day duration.

3 Early Project Completion - In the event the project schedule shows completion of the project prior to the contract completion date, the Contractor shall identify those activities that have been accelerated and/or those activities that are scheduled in parallel to support the Contractor's "early" completion. Contractor shall specifically address each of the activities noted in the narrative report at every project schedule update period to assist the Contracting Officer in evaluating the Contractor's ability to actually complete prior to the contract period. The Contractor shall include an activity named "contingency" with no cost and a duration equal to the number of calendar days from the date all the contract work is planned to be completed, to the official contract completion date as awarded.

d) Interim Completion Dates

Contractually specified interim completion dates shall also be constrained to show negative float if the early finish date of the last activity in that phase falls after the interim completion date.

1 Design phase - The contractor shall include the following design phase activities in the composite design and construction NAS Project schedule.

a. Pre-work conference within 5 days after NTP

b. Design Charrette (Preliminary Design) within 7 days after NTP

c. Submittal of preliminary design (60%)

d. Design review conference of Preliminary design Submittal of Final design (95%)

e. Design review conference of Final design

f. Submittal of Corrected Final design (100%)

g. Design review conference of Corrected Final design

h. Design Complete--- {The contracting officer shall advise the contractor in writing when the final design documents are approved for construction}

i. The duration of each of these activities must be the duration as included in the contract award.

2 Design Network Analysis Schedule

Submit the Design Network Analysis Schedule defining the planned operations during the design phase(s) of the contract. The general (summarized) approach for the construction phase(s) of the project shall also be indicated. When the project is being Fast-Tracked, the Design Network Analysis Schedule shall include all fast-tracked design phases, including the required or proposed design submittals within each phase that will occur during the duration of the project. In accordance with paragraph entitled "Monthly Network Analysis Updates" the design network may be used for requesting progress payments for a period not to exceed the design phase(s) of the contract. Submittal and acceptance of the Design Network Analysis Schedule is condition precedent to the processing of the Contractor's pay requests on this schedule. The activities and relationships of the design schedule shall coincide and mesh with the activities of the Baseline NAS project Schedule. As part of this submittal, provide the Project Name format (and Project Group Name if used) that will be used by the Contractor to identify initial schedule submittals, updates, fragments, changes, etc.

3 Start Phase - The Contractor shall include as the first activity for a project phase an activity called "Start Phase X" where "X" refers to the phase of work. The "Start Phase X" activity shall have an "ES" constraint date equal to the date on which the NTP was acknowledged, and a zero day duration.

4 End Phase - The Contractor shall include as the last activity in a project phase an activity called "End Phase X" where "X" refers to the phase of work. The "End Phase X" activity shall have an "LF" constraint date equal to the completion date for the project, and a zero day duration.

5 Phase X - The Contractor shall include a hammock type activity for each project phase called "Phase X" where "X" refers to the phase of work. The "Phase X" activity shall be logically tied to the earliest and latest activities in the phase.

e) Default Progress Data Disallowed

Actual Start and Finish dates shall not be automatically updated by default mechanisms that may be included in CPM scheduling software systems. Actual Start and Finish dates on the CPM schedule shall match those dates provided from Contractor Quality Control Reports. Failure of the Contractor to document the Actual Start and Finish dates on the Daily Quality Control report for every in-progress or completed activity, and failure to ensure that the data contained on the Daily Quality Control reports is the sole basis for schedule updating shall result in the disapproval of the Contractor's schedule and the inability of the Contracting Officer to evaluate Contractor progress for payment purposes. Updating of the percent complete and the remaining duration of any activity shall be independent functions. Program features which calculate one of these parameters from the other shall be disabled.

f) Out-of-Sequence Progress

Activities that have posted progress without all preceding logic being satisfied (Out-of-Sequence Progress) will be allowed only on a case-by-case approval of the Contracting Officer. The Contractor shall propose logic corrections to eliminate all out of sequence progress or justify not changing the sequencing for approval prior to submitting an updated project schedule.

g) Negative Lags

Lag durations contained in the project schedule shall not have a negative value.

6.18.2.4 PROJECT SCHEDULE SUBMISSIONS

The Contractor shall provide the submissions as described below. The data for each submission is as follows: The contractor shall provide a bar chart schedule for the first 30 calendar days of the contract at the Pre-construction conference.

a) Preliminary NAS Project Schedule Submission

The Preliminary NAS Project Schedule, defining the Contractor's planned operations for the first {90} calendar days shall be submitted for approval within 21 days after NTP. The approved preliminary schedule shall be used for payment purposes not to exceed {90} calendar days after NTP. The preliminary schedule shall be detailed for the first {90} days and depict the remainder of the project in summary format. The preliminary schedule shall be submitted on data disk or CD (2 copies).

Two hard copy of diagrams in color.

Three hard copies of all sorts / report ----earning curve----manpower plot

b) Initial NAS Project Schedule Submission

The Initial NAS Project Schedule shall be submitted for approval within 60 calendar days after NTP is acknowledged. The schedule shall include detailed activities for the entire project with a reasonable sequence of activities, and shall be at a reasonable level of detail as approved by the Contracting Officer.

The Initial schedule shall be submitted on data disk or CD (2 copies).

Two hard copy of diagrams in color.

Three hard copies of all sorts / report ----earning curve----manpower plot

c) Monthly Network Analysis Updates (Entire NAS Project Schedule)

The Contractor shall submit monthly schedule updates to the Contracting Officer for approval. Monthly updates shall continue until the contract is accepted by the Contracting Officer. These submissions shall enable the Contracting Officer to evaluate the Contractor's monthly progress.

The contractor's invoice may be deemed as an improper invoice, if it fails to provide monthly updates acceptable to Contracting Officer, this may delay progress payment and may result in an interim unsatisfactory performance rating. The contractor shall include its requests to revise/adjust the NAS schedule for approval, prior to implementing the revisions into the official schedule.

d) Review and Evaluation

After the Government's review(s) of the Design Network Analysis Schedule and Initial Network Analysis Schedule, the Contractor shall meet with the Contracting Officer to discuss the review and evaluation of the NAS submittal. Revisions necessary as a result of this review shall be resubmitted for acceptance within 10 calendar days after the meeting.

1 Acceptance - Review comments made by the Government on the Contractor's schedule(s) will not relieve the Contractor from compliance with requirements of the Contract Documents. The Contractor is responsible for scheduling, sequencing, and prosecuting the Work to comply with the requirements of the Contract Documents. Government acceptance extends only to the activities of the Contractor's schedule that the Government has been assigned responsibility for and agrees it is responsible. The Government will also review for contract imposed schedule constraints and conformance, and cost loading of the CPM activities. Comments offered on other parts of the schedule, which the Contractor is assigned responsibility, are offered as a courtesy and are not conditions of Government acceptance; but are for the general conformance with established industry schedule concepts.

a. When the Design Network Analysis Schedule is submitted and accepted by the Contracting Officer it will be considered the "Baseline Network Analysis Schedule for Design". The Design Network Analysis Schedule shall be updated at least monthly or submitted as part of the design submittals, whichever occurs first. When the Initial NAS Project Schedule is submitted and accepted by the Contracting Officer, it will then be considered the "Baseline Network Analysis Schedule". The Baseline Network Analysis Schedule will then be used by the Contractor for planning, organizing, and directing the work; reporting progress; and requesting payment for work accomplished. The schedule will be updated monthly by the Contractor and submitted monthly with the progress pay request to reflect the current status of the work. Submittal and acceptance of the Baseline Network Analysis Schedule for Design and Baseline Network Analysis Schedule and accurate updated schedules accompanying the pay requests are both conditions precedent to processing pay requests. Only bonds will be paid prior to acceptance of the Baseline Schedule(s).

b. Submittal of the Network, and subsequent schedule updates, will be understood to be the Contractor's representation that the submitted schedule meets all of the requirements of the Contract Documents, accurately reflects the work accomplished, and that Work will be executed in the sequence indicated on the submitted schedule.

2 Baseline Network Analysis Schedule - Once review comments are resolved and the Contracting Officer has accepted the Design Network Analysis Schedule and Construction Network Analysis Schedule, the Contractor shall within 5 calendar days furnish:

a. Two copies of the network diagrams.

b. Two copies of the Cash Flow S-Curve indicating the cash flow based upon both the projected early and late finish dates.

c. Two sets of data disks containing the project schedule shall be provided for the initial submission and every periodic project update. Data shall be submitted on electronic media that is acceptable to the Contracting Officer. A permanent exterior label shall be affixed to each disk submitted. The label shall indicate the type of schedule (Design NAS, Construction NAS, Baseline, Update, Recovery, Change, etc.), full contract number, Project Name used to identify project in scheduling software, contract name & location, data status date, diskette number with total number of diskettes in set, software name and version used to run the schedule, and the name and telephone number of person responsible for the schedule. For major revisions, updates or changes to the network diagrams, once accepted by the Contracting Officer, the Contractor shall submit these same diagrams and reports.

e) Standard Activity Coding Dictionary

The Contractor shall use the activity coding structure defined in the Standard Data Exchange Format (SDEF) in ER 1-1-11, Appendix A. This exact structure is mandatory, even if some fields are not used.

6.18.2.5 SUBMISSION REQUIREMENTS

The following items shall be submitted by the Contractor for the preliminary submission, initial submission, and every periodic project schedule update throughout the life of the project:

a) Data Disks

Two data disks containing the project schedule shall be provided. Data on the disks shall adhere to the SDEF format specified in ER 1-1-11, Appendix A.

1 File Medium - The electronic files will be supplied on compact disc, read-only memory (CD-ROM) unless otherwise approved by the Contracting Officer.

2 Disk Label - A permanent exterior label shall be affixed to each disk submitted. The label shall indicate the type of schedule (Preliminary, Initial, Update, or Change), full contract number, project name, project location, data date, name and telephone number or person responsible for the schedule, and the MS-DOS version used to format the disk.

3 File Name - Each file submitted shall have a name related to either the schedule data date, project name, or contract number. The Contractor shall develop a naming convention that will ensure that the names of the files submitted are unique. The Contractor shall submit the file naming convention to the Contracting Officer for approval.

b) Narrative Report

A Narrative Report shall be provided with the preliminary, initial, and each monthly update of the project schedule. This report shall include a description of activities along the most critical paths, a description of current and anticipated problem areas or delaying factors and their impact, and an explanation of corrective actions taken or required to be taken. The narrative report is expected to relay to the Government, the Contractor's thorough analysis of the schedule output and its plans to compensate for any problems, either current or potential, which are revealed through that analysis. If the contractor believes that any Government action or inaction has, or potentially, will impact its progress, it will include the specific notice of the fact in this report. This information should include the activity number of the impacted work, nature and duration of the impact. The narrative report shall address all modifications and weather activities that were input for the progress and their impact on the contract completion and total float.

c) Approved Changes Verification

Only project schedule changes that have been previously approved by the Contracting Officer shall be included in the schedule submission. The Narrative Report shall specifically reference, on an activity by activity basis, all changes made since the previous period and relate each change to documented, approved schedule changes.

d) Schedule Reports

The format for each activity for the schedule reports listed below shall be printed for those activities in progress or completed. The report shall contain:

Activity Numbers

Activity Description

Original Duration

Remaining Duration

Early Start Date

Early Finish Date

Late Start Date

Late Finish Date

Total Float

Actual Start

Actual Finish Dates

1. Milestone Report - The established monthly and special milestones shall be included in this report. The milestones must be established for each significant project features such as: Clearing-grading-demolition, foundation, slab-on-grade, structure-frame, exterior walls-windows, roof-building dry-in, interior walls-mech/elect R/I, above ceiling mech/elect R/I, ceiling, interior wall finish--doors, painting-coverings, floor finish, installation of mech/elect and other equipment-fixtures-casework, plumbing, HVAC system, finish interior mech/elect, testing-commissioning mech/elect systems, onsite utilities, paving-landscaping, prefinal-final inspections-final cleanup and/or other features (as applicable for the project).

The milestones for a building must approximate the following

Milestone work activity % of total duration

NTP 0%

STRUCTURE COMPLETE 36%

ROOF COMPLETE 40%

BUILDING DRY-IN 44%

INTERIOR WALLS COMPLETE 53%

PLUMBING COMPLETE 78%

FLOORING COMPLETE 80%

HVAC DUCTWORK 88%

FINISH MECH/ELECT SYSTEMS COMPLETE 91%

QC TESTING COMPLETE 92%

QA ACCEPTANCE TESTING COMPLETE 93%

CQC INSPECTION OF ENTIRE CONTRACT 95%

PREFINAL INSPECTION 97%

FINAL INSPECTION 99%

CCD 100%

Late Start /Late Finish Report

Late Start -Actual Start/Late Finish-Actual Finish-----total float-duration sort ----------sorted by LS in chronological order from data date to contract completion date.

2 Activity Report - A list of all activities sorted according to activity number.

3 Logic Report - A list of Preceding and Succeeding activities for every activity in ascending order by activity number. Preceding and succeeding activities shall include all information listed above in paragraph Schedule Reports. A blank line shall be left between each activity grouping.

4 Total Float Report - A list of all incomplete activities sorted in ascending order of total float. Activities which have the same amount of total float shall be listed in ascending order of Early Start Dates. Completed activities shall not be shown on this report.

5 Earnings Report - A compilation of the Contractor's Total Earnings on the project from the NTP until the most recent Monthly Progress Meeting. This report shall reflect the Earnings of specific activities based on the agreements made in the field and approved between the Contractor and Contracting Officer at the most recent Monthly Progress Meeting. Provided that the Contractor has provided a complete schedule update, this report shall serve as the basis of determining Contractor Payment. Activities shall be grouped by bid item and sorted by activity numbers. This report shall: sum all activities in a bid item and provide a bid item percent; and complete and sum all bid items to provide a total project percent complete. The printed report shall contain, for each activity: the Activity Number, Activity Description, Original Budgeted Amount, Total Quantity, Quantity to Date, Percent Complete (based on cost), and Earnings to Date.

e) Network Diagram

One hard copy of the network diagram shall be required on the preliminary schedule, initial schedule submission, and updated on each monthly schedule submissions. Monthly updates must indicate actual progress as of the data date. The network diagram shall depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished.

Network diagrams shall show the order and interdependence of project activities and the sequence in which the work is to be accomplished, as planned by the Contractor. The network diagramming procedure which will be used will show how the start of a given activity is dependent on the completion of preceding activities, and how its completion restricts the start of following activities.

Activity Duration: The activity duration shall be indicated in "work" days, and revise the assigned calendar.

The contractor may request to change the work days from 5 days/week to 6 or 7 days/week should this action become necessary to regain the schedule due to problems unrelated to the Government actions.

Contractor submissions shall include reasonable activity durations as determined by the contractor and subcontractors. The durations are to be determined by the contractor using the planned crew size/composition.

The network diagram shall be required on the initial schedule submission and on monthly schedule update submissions. The network diagram shall depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished. The Contracting Officer will use, but is not limited to, the following conditions to review compliance with this paragraph:

1 Continuous Flow - Diagrams shall show a continuous flow from left to right with no arrows from right to left. The activity number, description, duration, and estimated earned value shall be shown on the diagram.

2 Project Milestone Dates - Dates shall be shown on the diagram for start of project, any contract required interim completion dates, and contract completion dates.

3 Critical Path - The critical path shall be clearly shown.

4 Banding - Activities shall be grouped to assist in the understanding of the activity sequence. Typically, this flow will group activities by category of work, work area and/or responsibility.

5 Earning (S-Curves) - Earnings (cash flow) curves (as required for submissions) shall show scheduled ES/EF and LS/LF curves The monthly updates must indicate the actual progress plotted as of the data date. The cash flow curves are affected by the assigned cost and duration of the activities. The LS/LF cash flow curve is expected approximate 40% earning (without stored material) @ 50% of the contract duration and 70% earning @ 70% of contract duration. Earnings curves showing projected early and late earnings and earnings to date.

6.18.2.6 PERIODIC PROGRESS MEETINGS

a) There will be two progress meetings for the review and updating of the project scheduling.

A progress update meeting will be held at the onsite between USACE and the authorized contractor representatives, on the agreed cut-off date established at the pre-construction conference. During this meeting the Contractor shall indicate its requested percentage completed on each activity on which there was a revised percentage of completion. The Contracting Officer must approve actual progress percentages for each Progress meetings to discuss payment shall include a monthly onsite meeting or other regular intervals mutually agreed to at the pre-construction conference. During this meeting the Contractor shall describe, on an activity-by-activity basis, all proposed revisions and adjustments to the project schedule required to reflect the current status of the project. The Contracting Officer will approve activity progress, proposed revisions, and adjustments as appropriate.

b) The updated progress data will be evaluated at the second progress meeting.

A progress evaluation meeting shall be held with the contractor, after the updating of the current progress period work activities percentage is complete including modifications and adverse weather activities, to evaluate progress and the NAS schedule.

Adjustments to the NAS schedule. Update information must include the Actual Start Dates, Actual Finish Dates, Remaining Durations, and Cost to Date. The Contractor must address all the activities on an activity-by-activity basis during the second progress meeting.

The monthly updated NAS schedule is submitted to the Contracting Officer, for approval, with the contractor's request for progress payment. The evaluation will include a review of actual durations compared to scheduled durations for critical and non-critical activities, progress on critical activities and near critical activities, trends, and current/potential problem areas, cash flow progress, and projected workflow of activities.

The contractor's narrative report shall be available for review at least three days prior to the second progress meeting.

c) Meeting Attendance

The Contractor's Project Manager and Scheduler shall attend the regular progress meeting.

d) Update Submission Following Progress Meeting

A complete update of the project schedule containing all approved progress, revisions, and adjustments, based on the regular progress meeting, shall be submitted not later than 4 working days after the monthly progress meeting.

e) Progress Meeting Contents

Update information, including Actual Start Dates, Actual Finish Dates, Remaining Durations, and Cost-to-Date shall be subject to the approval of the Contracting Officer. As a minimum, the Contractor shall address the following items on an activity by activity basis during each progress meeting.

1 Start and Finish Dates - The Actual Start and Actual Finish dates for each activity currently in-progress or completed.

2 Time Completion - The estimated Remaining Duration for each activity in-progress. Time-based progress calculations shall be based on Remaining Duration for each activity.

3 Cost Completion - The earnings for each activity started. Payment will be based on earnings for each in-progress or completed activity. Payment for individual activities will not be made for work that contains quality defects. A portion of the overall project amount may be retained based on delays of activities.

4 Logic Changes - All logic changes pertaining to NTP on change orders, change orders to be incorporated into the schedule, contractor proposed changes in work sequence, corrections to schedule logic for out-of-sequence progress, lag durations, and other changes that have been made pursuant to contract provisions shall be specifically identified and discussed.

5 Other Changes - Other changes required due to delays in completion of any activity or group of activities include:

a. Delays beyond the Contractor's control, such as strikes and unusual weather.

b. Delays encountered due to submittals, Government Activities, deliveries or work stoppages which make re-planning the work necessary.

c. Changes required to correct a schedule which does not represent the actual or planned prosecution and progress of the work.

6.18.2.7 REQUESTS FOR TIME EXTENSIONS

In the event the Contractor requests a time extension of the contract completion date, or any interim milestone date, the Contractor shall furnish the following for a determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the contract: justification, project schedule data, and supporting evidence as the Contracting Officer may deem necessary. Submission of proof of delay shall be based on a subnet/fragnet of work activities, revised activity logic, duration, and costs (updated to the specific date that the delay occurred) is required for any time extension approvals. The project schedule shall clearly display that the Contractor has used, in full, all the float time available for the work involved with this request. Actual delays that are found to be caused by the Contractor's own actions, which result in the extension of the schedule, shall not be a cause for a time extension to the contract completion date.

a) Justification of Delay

The project schedule shall clearly display that the Contractor has used, in full, all the float time available for the work involved with this request. The Contracting Officer's determination as to the number of allowable days of contract extension shall be based upon the project schedule updates in effect for the time period in question, and other factual information. Actual delays that are found to be caused by the Contractor's own actions, which result in the extension of the schedule, will not be a cause for a time extension to the contract completion date.

b) Submission Requirements for Time Extension Requests

The Contractor shall submit a comprehensive time analysis and justification for each "Request for Proposal" for a change in the contract, based upon the most recent approved schedule update at the time of the RFP issued. Such a time analysis and justification shall be in accordance with the requirements of other appropriate Contract Clauses and shall include, as a minimum:

1. A subnet/fragnet of activities indicating all new change activities and the affect on existing schedule activities.

2. A brief explanation of the causes of the change.

3. An analysis of the overall impact the subnet/fragnet has when applied to the current-updated approved NAS schedule.

4. Activities impacted in each justification for change shall be identified by a unique activity code contained in the required data file.

5. Modifications to the contract

6. Unpriced, unilateral and bilateral (without agreement on time) modifications

Upon receipt of the signed SF 30, for un-priced and unilateral modifications (or bilateral modifications with agreement on costs without an agreement on time, the Contractor shall submit proposed schedule revisions (in the form of a proposed subnet/fragnet) to the Contracting Officer for approval, within 14 days of the SF 30 being issued. The proposed (subnet/fragnet) revisions to the schedule will be approved by the Contracting Officer prior to application of those changes within the project schedule.

Should the contractor fail or refuse to submit the provisions, the Contracting Officer may furnish the Contractor suggested (subnet/fragnet) revisions to the project schedule.

Upon receipt, the Contractor shall include these subnet/fragnet revisions in the project schedule.

If the Contractor has any objections to the revisions furnished by the Contracting Officer, the Contractor shall advise the Contracting Officer within 14 days of receipt of the revisions.

Regardless of the objections, the Contractor shall continue to update the schedule with the Contracting Officer's revisions until a mutual agreement on the revisions is reached.

If the Contractor fails to submit alternative revisions within 2 weeks of receipt of the Contracting officer's proposed revisions, the contractor will be deemed to have concurred with the Contracting Officer's proposed revisions. The proposed revisions will be the basis for an "equitable adjustment" for performance of the work.

Bilateral modifications shall be entered into the NAS schedule, utilizing the subnet/fragnet as agreed during negotiations, immediately after receipt of signed SF 30. Entries to the schedule must be approved by Contracting Officer.

All modifications subnets/fragnets shall be applied to the NAS schedule immediately in the sequence in which they were finalized (received signed SF 30). The modification with time extension shall result in new work activities entered adjacent to the critical path work activity affected by the modification.

Weather time extensions must be included monthly upon receipt of the written results of the monthly weather evaluation from the Contracting Officer.

c) Contractor falls behind the approved project schedule

If the Contractor falls behind its approved schedule, (behind the LS/LF cash flow curve or more than 10 work days of negative float) or performs the work in such a manner that the network diagram and mathematical analysis no longer indicate reasonable logic and duration for completion of the work by the current contract completion date, as determined by the Contracting Officer, the Contractor shall promptly provide a supplemental NAS recovery or completion schedule for completion by the current completion date, by reducing the remaining durations, revising logic, or adjusting resources onsite (in addition to the original approved NAS schedule) as approved by the Contracting Officer. The supplemental schedule shall be resource loaded with crew size and productivity for each remaining activity, and indicating overtime, weekend work, double shifts needed to regain the schedule, in accordance with FAR 52.236-15, without additional cost to the Government. The supplement schedule shall not replace the original approved schedule as the official contract schedule. The original approved schedule shall be updated monthly (in addition to the supplemental schedule) and monitored by the contractor and the Contracting Officer to determine the effect of the supplemental schedule progress has on the contract progress to regain its rate of progress for timely completion as specified.

The Contractor shall not artificially improve its progress by revising the schedule logic restraints or shortening future work activity durations. The contractor may improve its progress by performing sequential work activities concurrently or by performing activities more quickly than planned, but such improvements shall be indicated on a supplement schedule and shall not be recorded on the official until they have actually been achieved by the contractor. The additional resources required to improve the progress must be evident on the work site.

Failure of the contractor to perform work and maintain progress in accordance with the supplemental recovery or completion schedule may result in an interim and final unsatisfactory performance rating and/or may result in corrective action by the contracting officer in accordance with FAR 52.236-15.

The Contractor shall submit a justification for each request for a change in the contract completion date of less than 2 weeks based upon the most recent schedule update at the time of the NTP or constructive direction issued for the change. Such a request shall be in accordance with the requirements of other appropriate Contract Clauses and shall include, as a minimum:

1. A list of affected activities, with their associated project schedule activity number.

2. A brief explanation of the causes of the change.

3. An analysis of the overall impact of the changes proposed.

4. A sub-network of the affected area.

Activities impacted in each justification for change shall be identified by a unique activity code contained in the required data file.

d) Additional Submission Requirements

For any requested time extension of over 2 weeks, the Contracting Officer may request an interim update with revised activities for a specific change request. The Contractor shall provide this disk within 4 days of the Contracting Officer's request.

6.18.2.8 DIRECTED CHANGES

If the NTP is issued for changes prior to settlement of price and/or time, the Contractor shall submit proposed schedule revisions to the Contracting Officer within 2 weeks of the NTP being issued. The proposed revisions to the schedule will be approved by the Contracting Officer prior to inclusion of those changes within the project schedule. If the Contractor fails to submit the proposed revisions, the Contracting Officer may furnish the Contractor with suggested revisions to the project schedule. The Contractor shall include these revisions in the project schedule until revisions are submitted and final changes and impacts have been negotiated. If the Contractor has any objections to the revisions furnished by the Contracting Officer, the Contractor shall advise the Contracting Officer within 2 weeks of receipt of the revisions. Regardless of the objections, the Contractor shall continue to update the schedule with the Contracting Officer's revisions until a mutual agreement in the revisions is reached. If the Contractor fails to submit alternative revisions within 2 weeks of receipt of the Contracting Officer's proposed revisions, the Contractor will be deemed to have concurred with the Contracting Officer's proposed revisions. The proposed revisions will then be the basis for an equitable adjustment for performance of the work.

6.18.2.9 OWNERSHIP OF FLOAT

Float available in the schedule, at any time, shall not be considered for the exclusive use of either the Government or the Contractor.

6.18.3 SUPPLEMENAL SUBMITTAL PROCEDURES

The following are submittals and submittal procedures to supplement those described in Section 01.33.00.

6.18.3.1 SUBMITTAL DESCRIPTIONS (SD)

SD-01 Preconstruction Submittals

- Activity Hazard Analysis (AHA)
- Design Network Analysis Schedule
- Crane Critical Lift Plan

6.18.3.2 SUBMITTALS

Government approval is required for submittals with a “G” designation; submittals not having a “G” designation are for information only. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SC-01 preconstruction Submittals

Submittal register; G

6.18.3.3 GOVERNMENT REVIEW SCHEDULING

Submittals covering component items forming a system or items that are interrelated shall be scheduled to be coordinated and submitted concurrently. Certifications to be submitted with the pertinent drawings shall be so scheduled. Adequate time (a minimum of 30 calendar days exclusive of mailing time) shall be allowed and shown on the register for review and approval. No delay damages or time extensions will be allowed for time lost in late submittals.

a) Pre-Construction Submittal Scheduling

Pre-Construction submittals shall be scheduled and shown on the submittal register to allow a minimum of 30 calendar days (exclusive of mailing time) for review and approval. No delay damages or time extensions will be allowed for time lost in late submittals.

b) Design Submittal Scheduling

Design submittals shall be submitted in accordance with the requirements of Section 01 33.16 “Design After Award”.

6.18.3.4 SUBMITTAL PROCEDURES (Refer to Paragraph 1.11)

Submittals shall be made as follows:

a) Procedures

1. The Contractor shall be responsible for the scheduling and control of all submittals. The Contractor is responsible for confirming that the submittal register includes all submittals required by the contract documents.

2. In addition to those items listed on ENG Form 4288, the Contractor will furnish submittals for any deviation from the plans or specifications. The scheduled need dates must be recorded on the document for each item for control purposes and critical items must be tied to the Contractor's approved schedule where applicable.

3. The Contractor will submit to the Contracting Officer for approval a minimum of five copies of all G/RE (Resident/Area Office Review), G/ED (Engineering Division Review) or G/AE (Architect-Engineer Review) level submittals. Three copies of all FIO level submittals will be provided. The number of copies of submittals specified in this portion of the contract shall be complied with in lieu of four copies as specified by FAR 52.236-21.

4. For those contracts requiring Network Analysis System (NAS), the Contractor will schedule on the NAS critical items of equipment submittals and procurement activities which will, or have the potential to, significantly impact project completion. The inclusion or exclusion of critical items shall be subject to the approval of the Contracting Officer. Where ENG Form 4025 must be submitted prior to approval of the Construction Progress Schedule, the Contractor shall submit an initial annotated ENG Form 4288 upon which dates for submittal, approval and delivery of procurement items shall be included for the first 60 days of the work. Upon approval of the Construction Progress Schedule, or no later than 60 days after Notice to Proceed, the Contractor shall submit final annotated copies of ENG Form 4288. Dates shall be coordinated with the approved Construction Progress Schedule to logically interface with the sequence of construction. Critical item numbers will be shown on the listing if NAS is required.

5. Furnishing the schedule shall not be interpreted as relieving the Contractor of his obligation to comply with all the specification requirements for the items on the schedule. Contractor's Quality Control representative shall review the listing at least every 30 days and take appropriate action to maintain an effective system. The Contractor

shall furnish a list each 30 days of all submittals on which either Government's or Contractor's action is past due. He shall also furnish revised due dates in those cases when the original submittal schedule is no longer realistic. This monthly list of delayed items shall also be annotated by the Contractor to show what corrective action he is taking with regard to slippages in submittal schedule which are attributable to actions by him, his subcontractors, or suppliers.

6. The Contractor shall provide a complete updated submittal register indicating the current status of all submittals when requested by the Contracting Officer in order to assure himself the schedule is being maintained.

7. The Contractor shall certify that each submittal is correct and in strict conformance with the contract drawings and specifications. All submittals not subject to the approval of the Contracting Officer will be submitted for information purposes only.

8. No Corps of Engineers action will be required prior to incorporating these items into the work, but the submittal shall be furnished to the Area/Resident Engineer not less than 2 weeks prior to procurement of Contractor certified material, equipment, etc.

9. These Contractor approved submittals will be used to verify that material received and used in the job is the same as that described and approved and will be used as record copies. All samples of materials submitted as required by these specifications shall be properly identified and labeled for ready identification, and upon being certified by the Contractor and reviewed by the Contracting Officer, shall be stored at the site of the work for job site use until all work has been completed and accepted by the Contracting Officer. Delegation of this approval authority to Contractor Quality Control does not relieve the Contractor from the obligation to conform to any contract requirement and will not prevent the Contracting Officer from requiring removal and replacement of construction not in contract conformance; nor does it relieve the Contractor from the requirement to furnish "samples" for testing by the Government Laboratory or check testing by the Government in those instances where the technical specifications so prescribe.

10. Contractor certified drawings will be subject to quality assurance review by the Government at any time during the duration of the contract. No adjustment for time or money will be allowed for corrections required as a result of noncompliance with plans and specifications.

11. Submittals Requiring Government Approval (G/ED Level, G/RE Level or G/AE level). Where the review authority is designated to the Government, the Contractor is required to sign the certification on ENG Form 4025 in the box beside the remarks block in Section I. The Government will code the items in block h and sign the approval action block in Section II as the approving authority.

12. Operating and Maintenance Instructions. Six complete sets of instructions containing the manufacturer's operating and maintenance instructions for each piece of equipment shall be furnished. Each set shall be permanently bound and shall have a hard cover. One complete set shall be furnished at the time test procedures are submitted. Remaining sets shall be furnished before the contract is completed. The following identification shall be inscribed on the covers: The words "OPERATING AND MAINTENANCE INSTRUCTIONS," name and location of the facility, name of the Contractor, and contract number. Fly sheets shall be placed before instructions covering each subject. Instruction sheets shall be approximately 8-1/2 by 11 inches, with large sheets of drawings folded in. Instructions shall include but are not limited to:

a. System layout showing piping, valves and controls;

b. Approved wiring and control diagrams;

c. A control sequence describing startup, operation and shutdown;

d. Operating and maintenance instructions for each piece of equipment, including lubrication instructions and troubleshooting guide; and

e. Manufacturer's bulletins, cuts and descriptive data; parts lists and recommended parts.

13. The Government will further discuss and detail the required submittal procedures at the Pre-Construction Conference.

14. If the Government performs a conformance review of other Designer of Record approved submittals, the submittals will be so identified and returned, as described above.

15. For design-build construction the Government will retain 2 copies of information only submittals.

6.18.4 SAFETY AND OCCUPATIONAL HEALTH REQUIREMENTS

6.18.4.1 GENERAL

a) REFERENCES

Refer to APPLICABLE CRITERIA in Paragraph 4.

b) SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Government acceptance is required for submittals with a "G, A" designation.

SD-01 Preconstruction Submittals

Accident Prevention Plan (APP); G, A

Activity Hazard Analysis (AHA); G, A

Crane Critical Lift Plan; G, A

Proof of qualification for Crane Operators; G, A

SD-06 Test Reports

Reports

Submit reports as their incidence occurs, in accordance with the requirements of the paragraph entitled, "Reports."

Accident Reports

Monthly Exposure Reports

Crane Reports

Regulatory Citations and Violations

SD-07 Certificates

Confined Space Entry Permit

Hot work permit

Certificate of Compliance (Crane)

Submit one copy of each permit/certificate attached to each Daily Quality Control Report.

c) DEFINITIONS

1. High Visibility Accident. Any mishap which may generate publicity and/or high visibility.

2. Medical Treatment. Treatment administered by a physician or by registered professional personnel under the standing orders of a physician. Medical treatment does not include first aid treatment even through provided by a physician or registered personnel.

3. Recordable Injuries or Illnesses. Any work-related injury or illness that results in:

a. Death, regardless of the time between the injury and death, or the length of the illness;

b. Days away from work (any time lost after day of injury/illness onset);

c. Restricted work;

d. Transfer to another job;

e. Medical treatment beyond first aid;

f. Loss of consciousness; or

g. A significant injury or illness diagnosed by a physician or other licensed health care professional, even if it did not result in (1) through (6) above.

4. "USACE" property and equipment specified in USACE EM 385-1-1 should be interpreted as Government property and equipment.

6.18.4.2 REGULATORY REQUIREMENTS

In addition to the detailed requirements included in the provisions of this contract, work performed shall comply with USACE EM 385-1-1, and the following federal, state, and local, laws, ordinances, criteria, rules and regulations. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting work. Where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements shall apply.

6.18.4.3 SITE QUALIFICATIONS, DUTIES AND MEETINGS

a) Personnel Qualifications

1. Site Safety and Health Officer (SSHO): Site Safety and Health Officer (SSHO) shall be provided at the work site at all times to perform safety and occupational health management, surveillance, inspections, and safety enforcement for the Contractor. The Contractor Quality Control (QC) person cannot be the SSHO on this project, even though the QC has safety inspection responsibilities as part of the QC duties. The SSHO shall meet the following requirements:

Level 3:

A minimum of 5 years safety work on similar projects.

30-hour OSHA construction safety class or equivalent within the last 5 years.

An average of at least 24 hours of formal safety training each year for the past 5 years.

Competent person training as needed.

2. Crane Operators: Crane operators shall meet the requirements in USACE EM 385-1-1, Section 16 and Appendix G. In addition, for mobile cranes with Original Equipment Manufacturer (OEM) rated capacitates of 50,000 pounds or greater, crane operators shall be designated as qualified by a source that qualifies crane operators (i.e., union, a government agency, or and organization that tests and qualifies crane operators). Proof of current qualification shall be provided.

b) Personnel Duties

1. Site Safety and Health Officer (SSHO)/Superintendent

a. Conduct daily safety and health inspections and maintain a written log which includes area/operation inspected, date of inspection, identified hazards, recommended corrective actions, estimated and actual dates of corrections. Safety inspection logs shall be attached to the Contractors' daily quality control report.

b. Conduct mishap investigations and complete required reports. Maintain the OSHA Form 300 and Daily Production reports for prime and sub-contractors.

c. Maintain applicable safety reference material on the job site.

d. Attend the pre-construction conference, pre-work meetings including preparatory inspection meeting, and periodic in-progress meetings.

e. Implement and enforce accepted APPS and AHAs.

f. Maintain a safety and health deficiency tracking system that monitors outstanding deficiencies until resolution. A list of unresolved safety and health deficiencies shall be posted on the safety bulletin board.

g. Ensure sub-contractor compliance with safety and health requirements.

2. Failure to perform the above duties will result in dismissal of the superintendent and/or SSHO, and a project work stoppage. The project work stoppage will remain in effect pending approval of a suitable replacement.

c) Meetings

Preconstruction Conference

1. Contractor representatives who have a responsibility or significant role in accident prevention on the project shall attend the preconstruction conference. This includes the project superintendent, site safety and health officer, quality control supervisor, or any other assigned safety and health professionals who participated in the development of the APP (including the Activity Hazard Analyses (AHAs) and special plans, program and procedures associated with it).

2. The Contractor shall discuss the details of the submitted APP to include incorporated plans, programs, procedures and a listing of anticipated AHAs that will be developed and implemented during the performance of the contract. This list of proposed AHAs will be reviewed at the conference and an agreement will be reached between the Contractor and the Contracting Officer's representative as to which phases will require an analysis. In addition, a schedule for the preparation, submittal, review, and acceptance of AHAs shall be established to preclude project delays.

3. Deficiencies in the submitted APP will be brought to the attention of the Contractor at the preconstruction conference, and the Contractor shall revise the plan to correct deficiencies and re-submit it for acceptance. Work shall not begin until there is an accepted APP.

4. The functions of a Preconstruction conference may take place at the Post-Award Kickoff meeting for Design Build Contracts.

1. ACCIDENT PREVENTION PLAN (APP)

a. The Contractor shall use a qualified person to prepare the written site-specific APP. Prepare the APP in accordance with the format and requirements of USACE EM 385-1-1 and as supplemented herein. Cover all paragraph and subparagraph elements in USACE EM 385-1-1, Appendix A, "Minimum Basic Outline for Accident Prevention Plan". Specific requirements for some of the APP elements are described below. The APP shall be job-specific and shall address any unusual or unique aspects of the project or activity for which it is written. The APP shall interface with the Contractor's overall safety and health program. Any portions of the Contractor's overall safety and health program referenced in the APP shall be included in the applicable APP element and made site-

specific. The Government considers the Prime Contractor to be the "controlling authority" for all work site safety and health of the subcontractors. Contractors are responsible for informing their subcontractors of the safety provisions under the terms of the contract and the penalties for noncompliance, coordinating the work to prevent one craft from interfering with or creating hazardous working conditions for other crafts, and inspecting subcontractor operations to ensure that accident prevention responsibilities are being carried out. The APP shall be signed by the person and firm (senior person) preparing the APP, the Contractor, the on-site superintendent, the designated site safety and health officer and any designated CSP and/or CIH.

b. Submit the APP to the Contracting Officer 15calendar days prior to the date of the preconstruction conference for acceptance. Work cannot proceed without an accepted APP.

c. Once accepted by the Contracting Officer, the APP and attachments will be enforced as part of the contract. Disregarding the provisions of this contract or the accepted APP will be cause for stopping of work, at the discretion of the Contracting Officer, until the matter has been rectified.

d. Once work begins, changes to the accepted APP shall be made with the knowledge and concurrence of the Contracting Officer, project superintendent, SSHO and quality control manager. Should any hazard become evident, stop work in the area, secure the area, and develop a plan to remove the hazard. Notify the Contracting Officer within 24 hours of discovery. Eliminate/remove the hazard. In the interim, all necessary action shall be taken to restore and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public (as defined by ANSI/ASSE A10.34,) and the environment.

e. Copies of the accepted plan will be maintained at the resident engineer's office and at the job site.

f. The APP shall be continuously reviewed and amended, as necessary, throughout the life of the contract. Unusual or high-hazard activities not identified in the original APP shall be incorporated in the plan as they are discovered.

6.18.4.4 ACTIVITY HAZARD ANALYSIS (AHA)

a) The Activity Hazard Analysis (AHA) format shall be in accordance with USACE EM 385-1-1. Submit the AHA for review at least 15 calendar days prior to the start of each phase. Format subsequent AHAs as amendments to the APP. The analysis should be used during daily inspections to ensure the implementation and effectiveness of the activity's safety and health controls.

b) The AHA list will be reviewed periodically (at least monthly) at the Contractor supervisory safety meeting and updated as necessary when procedures, scheduling, or hazards change.

c) The activity hazard analyses shall be developed using the project schedule as the basis for the activities performed. Any activities listed on the project schedule will require an AHA. The AHAs will be developed by the contractor, supplier or subcontractor and provided to the prime contractor for submittal to the Contracting Officer.

6.18.4.5 DISPLAY OF SAFETY INFORMATION

Within 1 calendar days after commencement of work, erect a safety bulletin board at the job site. The safety bulletin board shall include information and be maintained as required by EM 385-1-1, section 01.A.06.

6.18.4.6 SITE SAFETY REFERENCE MATERIAL

Maintain safety-related references applicable to the project, including those listed in the article "References." Maintain applicable equipment manufacturer's manuals.

6.18.4.7 EMERGENCY MEDICAL TREATMENT

Contractors will arrange for their own emergency medical treatment. Government has no responsibility to provide emergency medical treatment.

6.18.4.8 REPORTS

a) Accident Reports - For recordable injuries and illnesses, and property damage accidents resulting in at least $2,000 in damages, the Prime Contractor shall conduct an accident investigation to establish the root cause(s) of the accident, complete the USACE Accident Report Form 3394 and provide the report to the Contracting Officer within 5 calendar day(s) of the accident. The Contracting Officer will provide copies of any required or special forms.

b) Accident Notification - Notify the Contracting Officer as soon as practical, but not later than four hours, after any accident meeting the definition of Recordable Injuries or Illnesses or High Visibility Accidents, property damage equal to or greater than $2,000, or any weight handling equipment accident Information shall include contractor name; contract title; type of contract; name of activity, installation or location where accident occurred; date and time of accident; names of personnel injured; extent of property damage, if any; extent of injury, if known, and brief description of accident (to include type of construction equipment used, PPE used, etc.). Preserve the conditions and evidence on the accident site until the Government investigation team arrives on-site and Government investigation is conducted.

c) Monthly Exposure Reports - Monthly exposure reporting to the Contracting Officer is required to be attached to the monthly billing request. This report is a compilation of employee-hours worked each month for all site workers, both prime and subcontractor. The Contracting Officer will provide copies of any special forms.

d) Crane Reports - Submit crane inspection reports required in accordance with USACE EM 385-1-1, Appendix H and as specified herein with Daily Reports of Inspections.

e) Certificate of Compliance - The Contractor shall provide a Certificate of Compliance for each crane entering an activity under this contract (see Contracting Officer for a blank certificate). Certificate shall state that the crane and rigging gear meet applicable OSHA regulations (with the Contractor citing which OSHA regulations are applicable, e.g., cranes used in construction, demolition, or maintenance shall comply with 29 CFR 1926 and USACE EM 385-1-1 section 16 and Appendix H. Certify on the Certificate of Compliance that the crane operator(s) is qualified and trained in the operation of the crane to be used. The Contractor shall also certify that all of its crane operators working on the DOD activity have been trained in the proper use of all safety devices (e.g., anti-two block devices). These certifications shall be posted on the crane.

6.18.4.9 HOT WORK

a) Prior to performing "Hot Work" (welding, cutting, etc.) or operating other flame-producing/spark producing devices, a written permit shall be requested from the Fire Division. CONTRACTORS ARE REQUIRED TO MEET ALL CRITERIA BEFORE A PERMIT IS ISSUED. The Contractor will provide at least two (2) twenty (20) pound 4A:20 BC rated extinguishers for normal "Hot Work". All extinguishers shall be current inspection tagged, approved safety pin and tamper resistant seal. It is also mandatory to have a designated FIRE WATCH for any "Hot Work" done at this activity. The Fire Watch shall be trained in accordance with NFPA 51B and remain on-site for a minimum of 30 minutes after completion of the task or as specified on the hot work permit.

b) When starting work in the facility, Contractors shall require their personnel to familiarize themselves with the location of the nearest fire alarm boxes and place in memory the emergency Fire Division phone number. ANY FIRE, NO MATTER HOW SMALL, SHALL BE REPORTED TO THE RESPONSIBLE FIRE DIVISION IMMEDIATELY.

6.18.4.10 CONSTRUCTION AND/OR OTHER WORK

a) Hazardous Material Exclusions - Notwithstanding any other hazardous material used in this contract, radioactive materials or instruments capable of producing ionizing/non-ionizing radiation (with the exception of radioactive material and devices used in accordance with USACE EM 385-1-1 such as nuclear density meters for compaction testing and laboratory equipment with radioactive sources) as well as materials which contain asbestos, mercury or polychlorinated biphenyls, di-isocynates, lead-based paint are prohibited. The Contracting Officer, upon written request by the Contractor, may consider exceptions to the use of any of the above excluded materials.

b) Unforeseen Hazardous Material - If material, not indicated, that may be hazardous to human health upon disturbance during construction operations is encountered, stop that portion of work and notify the Contracting Officer immediately. Within 14 calendar days the Government will determine if the material is hazardous. If material

is not hazardous or poses no danger, the Government will direct the Contractor to proceed without change. If material is hazardous and handling of the material is necessary to accomplish the work, the Government will issue a modification pursuant to "FAR 52.243-4, Changes" and "FAR 52.236-2, Differing Site Conditions."

6.18.4.1 PRE-OUTAGE COORDINATION MEETING

Contractors are required to apply for utility outages at least 15 days in advance. As a minimum, the request should include the location of the outage, utilities being affected, duration of outage and any necessary sketches. Special requirements for electrical outage requests are contained elsewhere in this specification section. Once approved, and prior to beginning work on the utility system requiring shut down, the Contractor shall attend a pre-outage coordination meeting with the Contracting Officer and the Public Utilities representative to review the scope of work and the lock-out/tag-out procedures for worker protection. No work will be performed on energized electrical circuits unless proof is provided that no other means exist.

6.18.4.2 FALL HAZARD PROTECTION AND PREVENTION PROGRAM

The Contractor shall establish a fall protection and prevention program, for the protection of all employees exposed to fall hazards. The program shall include company policy; identify responsibilities, education and training requirements, fall hazard identification, prevention and control measures, inspection, storage, care and maintenance of fall protection equipment and rescue and evacuation procedures.

1. Training - The Contractor shall institute a fall protection training program. As part of the Fall Hazard Protection and Prevention Program, the Contractor shall provide training for each employee who might be exposed to fall hazards. A competent person for fall protection shall provide the training. Training requirements shall be in accordance with USACE EM 385-1-1, section 21.A.16.

2. Fall Protection Equipment and Systems - The Contractor shall enforce use of the fall protection equipment and systems designated for each specific work activity in the Fall Protection and Prevention Plan and/or AHA at all times when an employee is exposed to a fall hazard. Employees shall be protected from fall hazards as specified in EM 385-1-1, section 21. In addition to the required fall protection systems, safety skiff, personal floatation devices, life rings etc., are required when working above or next to water in accordance with USACE EM 385-1-1, paragraphs 05.H. and 05.I. Personal fall arrest systems are required when working from an articulating or extendible boom, swing stages, or suspended platform. In addition, personal fall arrest systems are required when operating other equipment such as scissor lifts if the work platform is capable of being positioned outside the wheelbase. The need for tying-off in such equipment is to prevent ejection of the employee from the equipment during raising, lowering, or travel. Fall protection must comply with 29 CFR 1926.500, Subpart M, USACE EM 385-1-1 and ANSI A10.32.

Personal Fall Arrest Equipment - Personal fall arrest equipment, systems, subsystems, and components shall meet ANSI Z359.1. Only a full-body harness with a shock-absorbing lanyard or self-retracting lanyard is an acceptable personal fall arrest body support device. Body belts may only be used as a positioning device system (for uses such as steel reinforcing assembly and in addition to an approved fall arrest system). Harnesses shall have a fall arrest attachment affixed to the body support (usually a Dorsal D-ring) and specifically designated for attachment to the rest of the system. Only locking snap hooks and carabiners shall be used. Webbing, straps, and ropes shall be made of synthetic fiber. The maximum free fall distance when using fall arrest equipment shall not exceed 1.8 m (6 feet). The total fall distance and any swinging of the worker (pendulum-like motion) that can occur during a fall shall always be taken into consideration when attaching a person to a fall arrest system.

3. Fall Protection for Roofing Work - Fall protection controls shall be implemented based on the type of roof being constructed and work being performed. The roof area to be accessed shall be evaluated for its structural integrity including weight-bearing capabilities for the projected loading.

a. Low Sloped Roofs:

(1) For work within 6 feet of an edge, on low-slope roofs, personnel shall be protected from falling by use of personal fall arrest systems, guardrails, or safety nets.

(2) For work greater than 6 feet from an edge, warning lines shall be erected and installed in accordance with 29 CFR 1926.500 and USACE EM 385-1-1.

b. Steep-Sloped Roofs: Work on steep-sloped roofs requires a personal fall arrest system, guardrails with toe-boards, or safety nets. This requirement also includes residential or housing type construction.

4. Existing Anchorage - Existing anchorages, to be used for attachment of personal fall arrest equipment, shall be certified (or re-certified) by a qualified person for fall protection in accordance with ANSI Z359.1. Exiting horizontal lifeline anchorages shall be certified (or re-certified) by a registered professional engineer with experience in designing horizontal lifeline systems.

5. Horizontal Lifelines - Horizontal lifelines shall be designed, installed, certified and used under the supervision of a qualified person for fall protection as part of a complete fall arrest system which maintains a safety factor of 2 (29 CFR 1926.500).

6. Guardrails and Safety Nets - Guardrails and safety nets shall be designed, installed and used in accordance with EM 385-1-1 and 29 CFR 1926 Subpart M.

7. Rescue and Evacuation Procedures - When personal fall arrest systems are used, the contractor must ensure that the mishap victim can self-rescue or can be rescued promptly should a fall occur. A Rescue and Evacuation Plan shall be prepared by the contractor and include a detailed discussion of the following: methods of rescue; methods of self-rescue; equipment used; training requirement; specialized training for the rescuers; procedures for requesting rescue and medical assistance; and transportation routes to a medical facility. The Rescue and Evacuation Plan shall be included in the Activity Hazard Analysis (AHA) for the phase of work, in the Fall Protection and Prevention (FP&P) Plan, and the Accident Prevention Plan (APP).

6.18.4.3 EQUIPMENT

a) Material Handling Equipment -

1. Material handling equipment such as forklifts shall not be modified with work platform attachments for supporting employees unless specifically delineated in the manufacturer's printed operating instructions.

2. The use of hooks on equipment for lifting of material must be in accordance with manufacturer's printed instructions.

3. Operators of forklifts or power industrial trucks shall be licensed in accordance with OSHA.

b) Weight Handling Equipment

1. Cranes and derricks shall be equipped as specified in EM 385-1-1, section 16.

2. The Contractor shall comply with the crane manufacturer's specifications and limitations for erection and operation of cranes and hoists used in support of the work. Erection shall be performed under the supervision of a designated person (as defined in ASME B30.5). All testing shall be performed in accordance with the manufacturer's recommended procedures.

3. The Contractor shall comply with ASME B30.5 for mobile and locomotive cranes, ASME B30.22 for articulating boom cranes, ASME B30.3 for construction tower cranes, and ASME B30.8 for floating cranes and floating derricks.

4. Under no circumstance shall a Contractor make a lift at or above 90% of the cranes rated capacity in any configuration.

5. When operating in the vicinity of overhead transmission lines, operators and riggers shall be alert to this special hazard and shall follow the requirements of USACE EM 385-1-1 section 11 and ASME B30.5 or ASME B30.22 as applicable.

6. Crane suspended personnel work platforms (baskets) shall not be used unless the Contractor proves that using any other access to the work location would provide a greater hazard to the workers or is impossible. Personnel shall not be lifted with a line hoist or friction crane.

7. Portable fire extinguishers shall be inspected, maintained, and recharged as specified in NFPA 10, Standard for Portable Fire Extinguishers.

8. All employees shall be kept clear of loads about to be lifted and of suspended loads.

9. The Contractor shall use cribbing when performing lifts on outriggers.

10. The crane hook/block must be positioned directly over the load. Side loading of the crane is prohibited.

11. A physical barricade must be positioned to prevent personnel from entering the counterweight swing (tail swing) area of the crane.

12. Certification records which include the date of inspection, signature of the person performing the inspection, and the serial number or other identifier of the crane that was inspected shall always be available for review by Contracting Officer personnel.

13. Written reports listing the load test procedures used along with any repairs or alterations performed on the crane shall be available for review by Contracting Officer personnel.

14. Certify that all crane operators have been trained in proper use of all safety devices (e.g. anti-two block devices).

6.18.4.4 EXCAVATIONS

The competent person shall perform soil classification in accordance with 29 CFR 1926.

a) Utility Locations - Prior to digging, the appropriate digging permit must be obtained. All underground utilities in the work area must be positively identified by a private utility locating service in addition to any station locating service and coordinated with the station utility department. Any markings made during the utility investigation must be maintained throughout the contract.

b) Utility Location Verification - The Contractor must physically verify underground utility locations by hand digging using wood or fiberglass handled tools when any adjacent construction work is expected to come within three feet of the underground system. Digging within 2 feet of a known utility must not be performed by means of mechanical equipment; hand digging shall be used. If construction is parallel to an existing utility the utility shall be exposed by hand digging every 100 feet if parallel within 5 feet of the excavation.

c) Shoring Systems - Trench and shoring systems must be identified in the accepted safety plan and AHA. Manufacture tabulated data and specifications or registered engineer tabulated data for shoring or benching systems shall be readily available on-site for review. Job-made shoring or shielding shall have the registered professional engineer stamp, specifications, and tabulated data. Extreme care must be used when excavating near direct burial electric underground cables.

d) Trenching Machinery - Trenching machines with digging chain drives shall be operated only when the spotters/laborers are in plain view of the operator. Operator and spotters/laborers shall be provided training on the hazards of the digging chain drives with emphasis on the distance that needs to be maintained when the digging chain is operating. Documentation of the training shall be kept on file at the project site.

6.18.4.5 UTILITIES WITHIN CONCRETE SLABS ELECTRICAL

Utilities located within concrete slabs or pier structures, bridges, and the like, are extremely difficult to identify due to the reinforcing steel used in the construction of these structures. Whenever contract work involves concrete chipping, saw cutting, or core drilling, the existing utility location must be coordinated with station utility departments in addition to a private locating service. Outages to isolate utility systems shall be used in circumstances where utilities are unable to be positively identified. The use of historical drawings does not alleviate the contractor from meeting this requirement.

6.18.4.6 ELECTRICAL

a) Conduct of Electrical Work - Underground electrical spaces must be certified safe for entry before entering to conduct work. Cables that will be cut must be positively identified and de-energized prior to performing each cut. Positive cable identification must be made prior to submitting any outage request for electrical systems. Arrangements are to be coordinated with the Contracting Officer and Station Utilities for identification. The Contracting Officer will not accept an outage request until the Contractor satisfactorily documents that the circuits have been clearly identified. Perform all high voltage cable cutting remotely using hydraulic cutting tool. When racking in or live switching of circuit breakers, no additional person other than the switch operator will be allowed in the space during the actual operation. Plan so that work near energized parts is minimized to the fullest extent possible. Use of electrical outages clear of any energized electrical sources is the preferred method. When working in energized substations, only qualified electrical workers shall be permitted to enter. When work requires Contractor to work near energized circuits as defined by the NFPA 70, high voltage personnel must use personal protective equipment that includes, as a minimum, electrical hard hat, safety shoes, insulating gloves with leather protective sleeves, fire retarding shirts, coveralls, face shields, and safety glasses. In addition, provide electrical arc flash protection for personnel as required by NFPA 70E. Insulating blankets, hearing protection, and switching suits may also be required, depending on the specific job and as delineated in the Contractor's AHA.

b) Portable Extension Cords - Portable extension cords shall be sized in accordance with manufacturer ratings for the tool to be powered and protected from damage. All damaged extension cords shall be immediately removed from service. Portable extension cords shall meet the requirements of NFPA 70.

6.18.4.7 WORK IN CONFINED SPACES

The Contractor shall comply with the requirements in Section 06.I of USACE EM 385-1-1, OSHA 29 CFR 1910.146 and OSHA 29 CFR 1926.21(b)(6). Any potential for a hazard in the confined space requires a permit system to be used.

6.18.5 TEMPORARY CONSTRUCTION FACILITIES

6.18.5.1 GENERAL

The following are Temporary Construction Facilities to supplement those described in Section 01.50 02.

Refer to APPLICABLE CRITERIA in Paragraph 4.

6.18.5.2 IDENTIFICATION OF EMPLOYEES

The Contractor shall be responsible for furnishing to each employee, and for requiring each employee engaged on the work to display, identification as approved and directed by the Contracting Officer. Prescribed identification shall immediately be delivered to the Contracting Officer for cancellation upon release of any employee. When required, the Contractor shall obtain and provide fingerprints of persons employed on the project. Contractor and subcontractor personnel shall wear identifying markings on hard hats clearly identifying the company for whom the employee works.

6.18.5.3 AVAILABILITY AN USE OF UTILITY SERVICES

a) Payment for Utility Services

The Government will make all reasonably required utilities available to the Contractor from existing outlets and supplies, as specified in the contract. Unless otherwise provided in the contract, the amount of each utility service consumed shall be charged to or paid for by the Contractor at prevailing rates charged to the Government or, where the utility is produced by the Government, at reasonable rates determined by the Contracting Officer. The Contractor shall carefully conserve any utilities furnished without charge.

b) Meters and Temporary Connections

The Contractor is responsible for obtaining all meters and temporary connections for temporary facilities or temporary use. Utilities on Ft. Eustis, including electric, water; sewer, telephone, and cable are operated by privatized utility companies. The Contractor shall be required to contact the local telephone provider and local cable provider directly and coordinate and pay for all services required.

c) Sanitation

The Contractor shall provide and maintain within the construction area minimum field-type sanitary facilities approved by the Contracting Officer. Government toilet facilities will not be available to Contractor's personnel.

d) Telephone

The Contractor shall make arrangements and pay all costs for telephone facilities desired.

6.18.5.4 BULLETIN BOARD, PROJECT SIGN, AND PROJECT SAFETY SIGN

a) Bulletin Board

Immediately upon beginning of work, the Contractor shall provide a weatherproof glass-covered bulletin board not less than 36 by 48 inches in size for displaying the Equal Employment Opportunity poster, a copy of the wage decision contained in the contract, Wage Rate Information poster, and other information approved by the Contracting Officer. The bulletin board shall be located at the project site in a conspicuous place easily accessible to all employees, as approved by the Contracting Officer. Legible copies of the aforementioned data shall be displayed until work is completed. Upon completion of work the bulletin board shall be removed by and remain the property of the Contractor.

b) Project and Safety Signs

The requirements for the signs, their content, and location shall be provided at a location designated by the Contracting Officer. The signs shall be erected within 15 days after receipt of the Notice to Proceed. The data required by the safety sign shall be corrected daily, with light colored metallic or non-metallic numerals. Upon completion of the project, the signs shall be removed and disposed of by the Contractor.

1. Project Identification Signs as shown on Figure 1, Appendix FF, shall be in accordance with standards as follows:

2. Safety Sign - The safety sign shall conform to the requirements as indicated on Figure 2, Appendix FF. The data required by the sign shall be corrected daily, with light colored metallic or non-metallic numerals. Numerals, including mounting hardware, shall be subject to the approval of the CO.

3. Sign Erection - The project sign shall be erected (see Sign Erection Details found in Appendix FF) to conform to the requirements as indicated on Figure 1 as previously noted.

6.18.5.5 PROTECTION AND MAINTENANCE OF TRAFFIC

a) During construction the Contractor shall provide access and temporary relocated roads as necessary to maintain traffic. The Contractor shall maintain and protect traffic on all affected roads during the construction period except as otherwise specifically directed by the Contracting Officer. Measures for the protection and diversion of traffic, including the provision of watchmen and flagmen, erection of barricades, placing of lights around and in front of equipment and the work, and the erection and maintenance of adequate warning, danger, and direction signs, shall be as required by the State and local authorities having jurisdiction. The traveling public shall be protected from damage to person and property. The Contractor's traffic on roads selected for hauling material to and the site shall interfere as little as possible with public traffic. The Contractor shall investigate the adequacy of existing roads and the allowable load limit on these roads. The Contractor shall be responsible for the repair of any damage to roads caused by construction operations.

b) Barricades: The Contractor shall erect and maintain temporary barricades to limit public access to hazardous areas. Such barricades shall be required whenever safe public access to paved areas such as roads, parking areas or sidewalks is prevented by construction activities or as otherwise necessary to ensure the safety of both pedestrian and vehicular traffic. Barricades shall be securely placed, clearly visible with adequate illumination to provide sufficient visual warning of the hazard during both day and night.

6.18.5.6 CONTRACTOR’S TEMPORARY FACILITIES

a) Administrative Field Offices

The Contractor shall provide and maintain administrative field office facilities within the construction area at the designated site. Government office and warehouse facilities will not be available to the Contractor's personnel.

b) Project Area

The Contractor shall construct a temporary 6 foot high chain link fence around trailers and materials. The fence shall include plastic strip inserts, colored brown so that visibility through the fence is obstructed. Fence posts may be driven, in lieu of concrete bases, where soil conditions permit. Trailers, materials, or equipment shall not be placed or stored outside the fenced area unless such trailers, materials, or equipment are assigned a separate and distinct storage area by the Contracting Officer away from the vicinity of the construction site but within the military boundaries. Trailers, equipment, or materials shall not be open to public view with the exception of those items which are in support of ongoing work on any given day. Materials shall not be stockpiled outside the fence in preparation for the next day's work. Mobile equipment, such as tractors, wheeled lifting equipment, cranes, trucks, and like equipment, shall be parked within the fenced area at the end of each work day.

c) Supplemental Storage Area

Upon Contractor's request, the Contracting Officer will designate another or supplemental area for the Contractor's use and storage of trailers, equipment, and materials. This area may not be in close proximity of the construction site but shall be within the military boundaries. Fencing of materials or equipment will not be required at this site; however, the Contractor shall be responsible for cleanliness and orderliness of the area used and for the security of any material or equipment stored in this area. Utilities will not be provided to this area by the Government.

d) Appearance of Trailers

Trailers utilized by the Contractor for administrative or material storage purposes shall present a clean and neat exterior appearance and shall be in a state of good repair. clean and neat exterior appearance and shall be in a state of good repair. Trailers which, in the opinion of the Contracting Officer, require exterior painting or maintenance will not be allowed on the military property.

e) Maintenance of Project Area

Fencing shall be kept in a state of good repair and proper alignment. Should the Contractor elect to traverse, with construction equipment or other vehicles, grassed or unpaved areas which are not established roadways, such areas shall be covered with a layer of gravel as necessary to prevent rutting and the tracking of mud onto paved or established roadways; gravel gradation shall be at the Contractor's discretion. Grass located within the boundaries of the construction site shall be mowed for the duration of the project. Grass and vegetation along fences, buildings, under trailers, and in areas not accessible to mowers shall be edged or trimmed neatly.

f) Security Provisions

Adequate outside security lighting shall be provided at the Contractor's temporary facilities. The Contractor shall be responsible for the security of its own equipment; in addition, the Contractor shall notify the appropriate law enforcement agency requesting periodic security checks of the temporary project field office.

6.18.5.7 GOVERNMENT FIELD OFFICE

The Contractor shall provide the Government Resident Engineer with an office, located on the site as directed by the Contracting Officer. The trailer shall be like new in appearance with at least one operable window in each exterior wall and an entrance landing and steps per 29 OER 1910 (OSHA Standards). Minimum square footage shall be 1440 SF. Space shall include heat, electric power, lighting, plumbing, air conditioning, and high speed broad band internet service from a local cable provider. Office space shall be provided with minimum of 7 desks with chairs, 7 three section and 3 five section bookshelves, a telephone/data jack at each desk plus one additional jack for a printer an one additional telephone jack from the fax machine, 4-4 drawer file cabinets or equal, plan table with plan and rack, mini-blinds in all windows, kitchen (with wet sink, 18 cf refrigerator, and microwave oven), bottled water services with a dispenser that dispenses cold and hot water, toilet and lavatory in a separate room, including sewer and hot and cold water connections. One faucet at lavatory to include hot water, janitorial service

shall be provided twice a week. A minimum 192 SF conference room shall also be provided which shall include a conference room table and 8 conference room chairs. Provide a storage room minimum of 48 SF. Contractor shall also provide and maintain a graveled parking area suitably sized for 7 full size vehicles. At completion of the project, the office shall remain the property of the Contractor and shall be removed from the site. Utilities shall be connected and disconnected in accordance with local codes and to the satisfaction of the Contracting Officer. The Contractor is responsible for payment of all utility usage, to include electric, water, sewer, telephone, and internet service. This project has multiple project sites, but only one Field Office Trailer is required and will be located at the direction of the Contracting Officer.

6.18.5.8 PLANT COMMUNICATION

Whenever the Contractor has the individual elements of its plant so located that operation by normal voice between these elements is not satisfactory, the Contractor shall install a satisfactory means of communication, such as telephone or other suitable devices. The devices shall be made available for use by Government personnel.

6.18.5.9 TEMPORARY PROJECT SAFETY FENCING

As soon as practicable, but not later than 15 days after the date established for commencement of work, the Contractor shall furnish and erect temporary project safety fencing at the work site. The safety fencing shall be a high visibility orange colored, high density polyethylene grid or approved equal, a minimum of 42 inches high, supported and tightly secured to steel posts located on maximum 10 foot centers, constructed at the approved location. The safety fencing shall be maintained by the Contractor during the life of the contract and, upon completion and acceptance of the work, shall become the property of the Contractor and shall be removed from the work site.

6.18.5.10 CLEANUP

Construction debris, waste materials, packaging material and the like shall be removed from the work site daily. Any dirt or mud which is tracked onto paved or surfaced roadways shall be cleaned away. Materials resulting from demolition activities which are salvageable shall be stored within the fenced area described above or at the supplemental storage area. Stored material not in trailers, whether new or salvaged, shall be neatly stacked when stored.

6.18.5.11 RESTORATION OF STORAGE AREA

Upon completion of the project and after removal of trailers, materials, and equipment from within the fenced area, the fence shall be removed and will become the property of the Contractor. Areas used by the Contractor for the storage of equipment or material, or other use, shall be restored to the original or better condition. Gravel used to traverse grassed areas shall be removed and the area restored to its original condition, including top soil and seeding as necessary.

6.18.6 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

6.18.6.1 GOVERNMENT POLICY

Government policy is to apply sound environmental principles in the design, construction and use of facilities. As part of the implementation of that policy the Contractor shall: (1) practice efficient waste management when sizing, cutting, and installing products and materials and (2) use all reasonable means to divert construction and demolition waste from landfills and incinerators and to facilitate their recycling or reuse.

6.18.6.2 MANAGEMENT

The Contractor shall take a pro-active, responsible role in the management of construction and demolition waste and require all subcontractors, vendors, and suppliers to participate in the effort. Construction and demolition waste includes products of demolition or removal, excess or unusable construction materials, packaging materials for construction products, and other materials generated during the construction process but not incorporated into the work. In the management of waste consideration shall be given to the availability of viable markets, the condition of the material, the ability to provide the material in suitable condition and in a quantity acceptable to available markets, and time constraints imposed by internal project completion mandates. The Contractor shall be

responsible for implementation of any special programs involving rebates or similar incentives related to recycling of waste. Revenues or other savings obtained for salvage, or recycling shall accrue to the Contractor. Firms and facilities used for recycling, reuse, and disposal shall be appropriately permitted for the intended use to the extent required by federal, state, and local regulations.

6.18.6.3 CONSTRUCTION AND DEMOLITION (C&D) WASTE MANAGEMENT PLAN

A waste management plan shall be submitted within 15 days after notice to proceed and prior to initiating any site preparation work. At a minimum, the plan shall include the contractor's plan(s) for a minimum fifty percent (50%) diversion rate or justification for less than a fifty percent (50%) rate due to time and/or cost constraints as identified below. The plan shall include the following:

a. Name of individuals on the Contractor's staff responsible for waste prevention and management.

b. Actions that will be taken to reduce solid waste generation.

c. Description of the specific approaches to be used in recycling/reuse of the various materials generated, including the areas and equipment to be used for processing, sorting, and temporary storage of wastes.

d. Characterization, including estimated types and quantities, of the waste to be generated.

e. Name of landfill and/or incinerator to be used and the estimated costs for use, assuming that there would be no salvage or recycling on the project.

f. Identification of local and regional reuse programs, including non-profit organizations such as schools, local housing agencies, and organizations that accept used materials such as materials exchange networks and Habitat for Humanity.

g. List of specific waste materials that will be salvaged for resale, salvaged and reused, or recycled. Recycling facilities that will be used shall be identified.

h. Identification of materials that cannot be recycled/reused with an explanation or justification.

i. Anticipated net cost savings determined by subtracting Contractor program management costs and the cost of disposal from the revenue generated by sale of the materials and the incineration and/or landfill cost avoidance.

The contractor shall notify the Contracting Officer if diversion activities will cause the project duration time to be exceeded. Along with the notification, the contractor shall provide the highest diversion rate that can be obtained based on the project schedule. If it is determined by the Government that the project is mission-critical, the diversion rate may be amended.

If the cost of achieving the fifty percent (50%) minimum diversion rate is significantly greater than the cost of conventional demolition methods and the risk can be attributed directly to meeting the minimum diversion rate, the contractor shall immediately notify the Contracting Officer for a determination on whether a lower diversion rate is acceptable. If the Contracting Officer determines that a lower diversion rate is acceptable, the rate may be amended to the highest obtainable rate that can be met as agreed upon by all parties.

6.18.6.4 RECORDS

Records shall be maintained to document the quantity of waste generated; the quantity of waste diverted through sale, reuse, or recycling; and the quantity of waste disposed by landfill or incineration. In addition to the reporting criteria contain herein, the Contractor shall refer to Appendix E ENVIRONMENTAL INFORMATION for specific reporting requirements. The records shall be made available to the Contracting Officer during construction, and a copy of the records shall be delivered to the Contracting Officer upon completion of the construction. Throughout the duration of the contract, contractor shall maintain and make available to the Contracting Officer, records, to include all weight tickets, documenting the quantity of waste generated, the quantity of waste diverted from a landfill or incineration and the quantity of waste disposed by landfill or incineration. Upon contract completion, the

contractor shall submit a copy of all records with a statement certifying that at least fifty percent (50%) of C&D waste has been diverted from landfill disposal to the Installation.

6.18.6.5 COLLECTION

The necessary containers, bins and storage areas to facilitate effective waste management shall be provided and shall be clearly and appropriately identified. Recyclable materials shall be handled to prevent contamination of materials from incompatible products and materials and separated by one of the following methods:

a) Source Separated Method.

Waste products and materials that are recyclable shall be separated from trash and sorted into appropriately marked separate containers and then transported to the respective recycling facility for further processing.

b) Co-Mingled Method.

Waste products and recyclable materials shall be placed into a single container and then transported to a recycling facility where the recyclable materials are sorted and processed.

c) Other Methods.

Other methods proposed by the Contractor may be used when approved by the Contracting Officer.

6.18.6.6 DISPOSAL

Except as otherwise specified in other sections of the specifications, disposal shall be in accordance with the following:

a) Reuse.

First consideration shall be given to salvage for reuse since little or no re-processing is necessary for this method, and less pollution is created when items are reused in their original form. Sale or donation of waste suitable for reuse shall be considered. Salvaged materials, other than those specified in other sections to be salvaged and reinstalled, shall not be used in this project.

b) Recycle.

Waste materials not suitable for reuse, but having value as being recyclable, shall be made available for recycling whenever economically feasible.

c) Waste.

Materials with no practical use or economic benefit shall be disposed at a landfill or incinerator.

6.18.7 STRUCTURAL INTERIOR DESIGN (SID) REQUIREMENTS

6.18.7.5 GENERAL INFORMATION

Structural Interior Design includes all building related elements and components generally part of the building itself, such as wall finishes, ceilings finishes, floor coverings, marker/bulletin boards, blinds, signage and built in casework. The SID should be developed in conjunction with the furniture footprint. Structural interior design shall be in accordance with UFC 3-120-10.

6.18.7.6 STRUCURAL INTERIOR DESIGN (SID) REQUIREMENTS FOR THE INTERIM AND FINAL DESIGN SUBMITTALS

a) FORMAT AND SCHEDULE

1. Prepare and submit for approval an interior and exterior building finishes scheme for an interim design submittal. The DOR shall meet with and discuss the finish schemes with the appropriate Government officials prior to preparation of the schemes to be presented. Present original sets of the schemes to reviewers at an interim design conference.

2. At the conclusion of the interim phase, after resolutions to the comments have been agreed upon between DOR and Government reviewers, the DB Contractor may proceed to final design with the interior finishes scheme presented.

3. The SID information and samples are to be submitted in 8 ½" x 11" format using three ring binders with pockets on the inside of the cover. When there are numerous pages with thick samples, use more than one binder. Large D-ring binders are preferred to O-ring binders. Use page protectors that are strong enough to keep pages from tearing out. Anchor large or heavy samples with mechanical fasteners, Velcro, or double-faced foam tape rather than rubber cement or glue. Fold out items must have a maximum spread of 25 ½". Provide cover and spine inserts sheets identifying the document as "Structural Interior Design" package and include the project title and location, project number, Contractor/A/E name and phone number(s), submittal stage and date.

4. The design submittal requirements will include, but are not limited to:

a. Narrative of the Structural Interior Design Objectives - The SID shall include a narrative that discusses the building related finishes. Include topics that relate to base standards, life safety, sustainable design issues, aesthetics, durability and maintainability, discuss the development and features as they relate to the occupants requirements and the building design.

b. Interior Color Boards - Each item on the color boards shall be identified and keyed to the contract documents to provide a clear indication of how and where each item will be used. To the maximum extent possible, finish samples shall be arranged by room type in order to illustrate room color coordination. All samples shall be labeled on the color boards with the manufacturer's name, patterns and colors name and number. Samples shall also be keyed or coded to match key code system used on contract drawings.

c. Material and finish samples shall indicate true pattern, color and texture. Photographs or colored photocopies of materials or fabrics to show large overall patterns are required in conjunction with actual samples to show the actual colors. Finish samples must be large enough to show a complete pattern or design where practical.

d. Interior Color boards shall include but not be limited to original color samples of the following:

i. All walls finishes, ceiling finishes, including information regarding tile patterns.

ii. All flooring finishes, including information regarding tile patterns.

iii. All signage, wall base, toilet partitions, operable/folding partitions and trim

iv. All millwork materials and finishes (cabinets, counter tops, etc.)

v. All window treatments (sills, blinds, etc.)

e. Exterior Color Boards - Prepare exterior finishes color boards in similar format as the interior finishes color boards, for presentation to the reviewers during an interim design conference. The exterior finishes boards shall include original color samples of all exterior finishes including but not limited to the following:

i. All Roof Finishes

ii. All Brick and cast stone Samples

iii. All Exterior Insulation and Finish Samples

iv. All Glass Color Samples

v. All Exterior Metals Finishes

vi. All Window & Door Frame Finishes

vii. All Specialty Item Finishes, including trim

viii. Identify each item on the exterior finishes color boards and key to the building elevations to provide a clear indication of how and where each item will be used.

f. Color board samples shall reflect all actual finish textures, patterns and colors required as specified. Patterned samples shall be of sufficient size to adequately show pattern and its repeat if a repeat occurs.

b) STRUCTURAL INTERIOR DESIGN DOCUMENTS

1. General - Structural interior design related drawings must indicate the placement of extents of SID material, finishes and colors and must be sufficiently detailed to define all interior work. The following is a list of minimum requirements:

2. Finish Color Schedule - Provide finish color schedule(s) in the contract documents. Provide a finish code, material type, manufacturer, series, and color designations.

3. Interior Finish Plans - Indicate wall and floor patterns and color placement, material transitions and extents of interior finishes.

4. Furniture Footprint Plans - Provide furniture footprint plans showing the outline of all freestanding and systems furniture for coordination of all other disciplines.

5. Interior Signage - Include interior signage plans or schedules showing location and quantities of all interior signage. Key each interior sign to a quantitative list indicating size, quantity of each type and signage text.

6. Interior Elevations, Sections and Details - Interior Elevations, Sections and Details: Indicate material, color and finish placement.

6.18.8 FURNITURE, FIXTURES & EQUIPMENT (FF&E) REQUIREMENTS

6.18.8.1 GENERAL INFOMATION

a) FF&E is the selection, layout, specification and documentation of furniture includes but is not limited to workstations, seating, tables, storage and shelving, filing, trash receptacles, clocks, framed artwork, artificial plants, and other accessories. Contract documentation is required to facilitate pricing, procurement and installation. The FF&E package is based on the furniture footprint developed in the SID portion of the interior design. The FF&E package shall be developed concurrently with the building design to ensure that there is coordination between the furniture design, the electrical, IT and other building requirements.

b) The DOR shall interview Government personnel to determine FF&E requirements for furniture and furnishings. Determine FF&E items and quantities by, but not limited to: (1) the number of personnel to occupy the building, (2) job functions and related furniture/office equipment to support the job function, (3) room functions, (4) rank and grade.

c) Lastly, for all designs provided regardless of facility type, the DOR shall make every effort to implement all aspects of sustainability to the greatest extent possible for all the selections made in the FF&E package. This includes but is not limited to the selection of products that consider: Material Chemistry and Safety of Inputs (What chemicals are used in the construction of the selections?); Recyclability (Do the selections contain recycled content?); Disassembly (Can the selections be disassembled at the end of their useful life to recycle their materials?).

d) The DOR is encouraged to make selections to the greatest extent possible of products that possess

McDonough Braungart Design Chemistry (HYPERLINK "http://www.mbdc.com" MBDC) certification or other

“third-party” certified Cradle to Cradle program, Forest Stewardship Council (FSC) certification,

GREENGAURD certification or similar “third-party” certified products consisting

of low-emitting materials.

6.18.8.2 FF&E REQUIREMENTS FOR THE INTERIM AND FINAL DESIGN SUBMITTALS

a) FORMAT AND SCHEDULE

1. Prepare and submit for approval a comprehensive FF&E scheme for an interim design submittal. The DOR shall meet with and discuss the FF&E scheme with the appropriate Government representatives prior to preparation of the scheme to be presented to discuss the intent of the overall design with regard to all the aspects of the FF&E design listed in paragraph 2.1.1 Narrative of Interior Design Objectives below. Then, present original sets of the scheme to reviewers at an interim design conference in conjunction with the interim architectural design or three months prior to the submittal of the final FF&E package (whichever comes first).

2. At the conclusion of the interim phase, after resolutions to the comments have been agreed upon between DOR and Government reviewers, the DB Contractor may proceed to final design with the FF&E scheme presented.

3. A complete and final FF&E package must be submitted to the Government in conjunction with the 100% architectural design submittal or ten months prior to the contract completion date (whichever comes first) to ensure adequate time for furniture acquisition.

4. The FF&E information and samples are to be submitted in 8 ½” x 11” format using three ring binders with pockets on the inside of the cover. When there are numerous pages with thick samples, use more than one binder. Large D-ring binders are preferred to O-ring binders. Use page protectors that are strong enough to keep pages from tearing out. Anchor large or heavy samples with mechanical fasteners, Velcro, or double-faced foam tape rather than rubber cement or glue. Fold out items must have a maximum spread of 25 ½”. Provide cover and spine inserts sheets identifying the document as “Furniture, Fixtures & Equipment” package and include the project title and location, project number, Contractor/A/E name and phone number(s), submittal stage and date.

5. The design submittal requirements will include, but are not limited to:

a. Narrative of Interior Design Objectives - Provide a narrative description of the furnishings design speaking to the selection of furnishings, finishes and colors. The narrative shall also include a discussion of the market research that resulted in the selection of a preferred vendor(s) items, including the sources that were considered and rejected, and why. Enumerate the design decisions made to fully coordinate the SID and the FF&E. Furthermore the narrative should include but not be limited to discussions on function, safety and ergonomics, durability, aesthetics, and all aspects of sustainability. Lastly, the narrative shall also include the written product description (item o. on the Furnishings Order Form) for each item to be procured in the FF&E package.

b. FF&E Procurement Listing - Provide a comprehensive listing of all the FF&E items with designation of whether each item will be procured as part of furnishings, equipment or the construction contract. The FF&E package shall be divided into sections based on this listing.

c. Point of Contacts - Provide a comprehensive list of Point of Contacts (POCs) needed to implement the FF&E project. This would include appropriate project team members, using activity contacts, interior design representatives, contractors and installers involved in the project. For each contact the name, company, job function, address, phone, fax and email.

d. Item Code Legend - Provide a consolidated list of all FF&E items in the design package with the item code and a short description of each item.

e. Item Installation List - The Item Code Legend may be expanded to be used as an Item installation List. Indicate quantity per room, model number, manufacturer and which vendor is responsible for installing each furnishings item.

f. Manufacturers Source List - Provide the Contractor's address, the ordering address, and the payment address including contact names, phone numbers, fax and email address. Also provide GSA contract information including contract number, FSC group, part, section, expiration date, maximum order limit, pricing terms, shipping terms, etc.

g. Furnishings Order Forms - One Furnishings Order Form will be prepared for each item selected in the design. The goal is to provide this information on one page, however, if necessary, a second page may be used for additional detailed requirements. Each form shall identify all information required to procure each individual item. In addition to the project name and location, project number, and submittal phase, the order form must include:

i. Furniture item illustration and code

ii. Furniture item name

iii. Job name, location, and date

iv. General Services Administration (GSA) FSC Group, part, and section

v. GSA Contract Number, Special Item Number (SIN), and contract expiration date

vi. Maximum Order Limitation

vii. GSA Contractor name (Include ordering and payment address, telephone number & fax number, e-mail or website)

viii. Manufacturer's name (Include address, telephone number & fax number) or indicate if same as GSA Contractor

ix. Dealership/Installer name (include address, telephone number, fax number and point of contact name)

x. Product name

xi. Product model number or National Stock Number (NSN)

xii. Finish name and number (code to finish samples)

xiii. Fabric name and number, minimum Wyzenbeek Abrasion Test double rubs (code to fabric samples)

xiv. Dimensions

xv. Written Product Description: include a non-proprietary paragraph listing the salient features of the item to include but not limited to:

- required features and characteristics
- ergonomic requirements
- functional requirements
- testing requirements

- furniture style
- construction materials
- minimum warranty

(Example: Include the following statement on each of the furniture order sheet to reflect the following statement - "These guest chairs are coordinated to match the task seating at each workstation. The size of the guest chair is critical because of the limited space where they are to be placed. If this company is not selected, coordinate the newly proposed finishes with furniture item numbers #001, 002, 003.")

xvi. Item location by room number

xvii. Quantity per room

xviii. Total quantity

xix. Special instructions for procurement ordering and/or installation (if applicable)

xx. In addition to the preferred selected item, list two additional manufacturers' products that meet the requirements of the written product description. Information provided for each of the two additional manufacturer's products selected shall include manufacturer name address and telephone number, product series, product name and any other pertinent information necessary for their procurement.

h. Color Boards - Color boards shall be provided for all finishes and fabrics for all FF&E items. Finishes to be included but not limited to paint, laminate, wood finish, fabric, etc.

i. Itemized Furniture Cost Estimate - Provide an itemized cost estimate of furnishings keyed to the plans and specifications of products included in the package. This cost estimate should be based on GSA price schedules. The cost estimate must include separate line items for general contingency, installation, electrical hook-up for systems furniture or other furniture requiring hardwiring by a licensed electrician, freight charges and any other related costs. Installation and freight quotes from vendors should be use in lieu of a percentage allowance when available.

b) INTERIOR DESIGN DOCUMENTS

1. Overall Furniture and Area Plans - Provide floor Plans showing locations and quantities of all freestanding, and workstation furniture proposed for each floor of the building. Key each room to a large scale Furniture Placement Plan showing the furniture configuration, of all furniture. Provide enlarged area plans with a key plan identifying the area in which the building is located. All the items on the drawings should be keyed by furniture item code.

2. Workstation Plans - Provide plans showing each typical workstation configuration in plan view, elevations or isometric view. Drawings shall illustrate panels and all major components for each typical workstation configuration. Workstations shall be identified using the same numbering system as shown on the project drawings. Components shall be keyed to a legend on each sheet which identifies and describes the components along with dimensions. To facilitate review the plan, elevations and isometric of each typical workstation shall appear together on a drawing sheet.

3. Panel Plans - Provide plans showing panel locations and critical dimensions from finished face of walls, columns, panels including clearances and aisle widths. Assemblies shall be keyed to a legend which shall include width, height, configuration and composition of frames, covers finishes, and fabrics, (if different selections exist within a project), power or non-powered connectors and wall mount hardware.

4. Electrical and Telecommunication Plans - Provide plans showing power provisions including type and locations of feeder components, activated outlets and other electrical components. Include on the plans locations and quantities of outlets for workstations. Clearly identify different outlets, i.e. electrical, LAN and telecommunication receptacles indicating each type proposed. Show wiring configuration, (circuiting, switching, internal and external connections) and provide as applicable.

5. Artwork Placement Plans - Provide an Artwork Placement Plan to show location of artwork, assign an artwork item code to each piece of artwork. As an alternative, artwork can be located on the Furniture Plans. Provide a schedule that identifies each piece by room name and number. Provide installation instructions; include mounting height.

6. Window Drapery Plans - Provide Interior Window Drapery Plans. Key each drapery treatment to a schedule showing color, pattern, material, drapery size and type, draw direction, location and quantities.

c) ELECTRONIC DOCUMENTS (Not Required for Interim Submittal)

1. Upon completion of the corrected final submittal, provide five compact disks with electronic versions of all FF&E documents. Provide all drawings files in the latest release of AutoCAD. Provide all files needed to view complete drawings. These drawing files shall not be bound.

2. Provide all text documents in Microsoft Word and/or Excel.

6.18.9 FORT EUSTIS REQUIREMENTS FOR CAD DRAWINGS

6.18.9.1 Use National Cad Standard, A/E/C CADD Standard Release 3.0 dated September 2006.

9.18.9.2. CD requirements:

(a) Label CD using a label maker. See 8. CD Label Requirements. The top portion of the label shows the layout and the information required. The bottom portion is an example of a cd label.

(b) CD of all as-built drawings is required.

(c) Cost estimates are to be on a separate CD from CD with drawings.

(d) The CD that contains drawings shall have the following subdirectories and files:

cad - dwg files of every drawing.

pdf - pdf files of every drawing.

cal - cal files of every drawing.

cal files are required only for Corps of Engineers projects.

basis of design – files related to basis of design.

6.18.9.3. Title Blocks:

(a) Fort Eustis will supply title block drawings for DPW Design Projects. Insert title block drawings as a block. DPW title block drawings have attributes. Do not explode the title block drawings.

(b) Corps of Engineers will supply title block drawings for their Design Projects.

6.18.9.4. Drawing Index Sheet:

An index sheet is required for each set of drawings. Include the following on the index sheet for each drawing that makes up the set.

1. three digit sequential number starting with 001

2. sheet number

3. sheet name

6.18.9.5. Electronic CAD files names:

(a) See the National Cad Standard, A/E/C CADD Standard Release 3.0 dated September 2006 starting on page 6 for file name requirements.

(b) A 20 character project code field shall be used as part of the electronic file name for ready-to-plot files and all other files that make up a set of drawings.

(c) Ready-to-plot files – these drawings are listed on the index sheet.

(d) Ready-to-plot electronic file names shall start with a three digit sequential number starting with 001, followed by an underscore, followed by the last four digits of the Fort Eustis drawing number, followed by an underscore, followed by a 10 digit project number, followed by an X or X's to complete the 20 character project code.

(e) All other files - can be defined as reference and block files.

(f) All other electronic file names shall start with XXX, followed by an underscore, followed by the last four digits of the Fort Eustis drawing number, followed by an underscore, followed by a 10 digit project number, followed by an X or X's to complete the 20 character project code.

(g) The drawing number and project number shall be assigned to each set of drawings by Fort Eustis.

(h) The drawing number assigned to the project by Fort Eustis shall be on every drawing, the drawing number is the same for each sheet.

(i) Use the same ready-to-plot .dwg file names for the pdf & cal files.

6.18.9.6. Misc. Requirements:

(a) If a revision occurs to a drawing after a cd is submitted, a cd with all current drawings for the project shall be resubmitted to replace the old cd.

(b) use the insertion point of 0,0 for all reference files.

6.18.9.7. CD Label Requirements:

The following are examples of CD Labels:

End of Section 01 10 00.0003

SECTION 01 33 00.0003
SUBMITTAL PROCEDURES
(DESIGN-BUILD TASK ORDERS)

1.0 GENERAL

1.13. GOVERNMENT APPROVED OR CONCURRED WITH SUBMITTALS

1.14. INFORMATION ONLY SUBMITTALS

1.0 GENERAL

1.1.1. This section contains requirements specifically applicable to this task order. The requirements of Base ID/IQ contract Section 01 33 30 apply to this task order, except as otherwise specified herein.

1.13. GOVERNMENT APPROVED OR CONCURRED WITH SUBMITTALS

Upon completion of review of submittals requiring Government approval or concurrence, the Government will stamp and date the submittals as approved or concurred. The Government will retain one (1) copies of the submittal and return zero(0) copy(ies) of the submittal.

1.14. INFORMATION ONLY SUBMITTALS

Normally submittals for information only will not be returned. Approval of the Contracting Officer is not required on information only submittals. The Government reserves the right to require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications; will not prevent the Contracting Officer from requiring removal and replacement of nonconforming material incorporated in the work; and does not relieve the Contractor of the requirement to furnish samples for testing by the Government laboratory or for check testing by the Government in those instances where the technical specifications so prescribe. The Government will retain zero(0) copies of information only submittals.

End of Section 01 33 00.0003

SECTION 01 33 16
DESIGN AFTER AWARD

1.0 GENERAL INFORMATION

1.1. INTRODUCTION

1.2. DESIGNER OF RECORD

2.0 PRODUCTS (Not Applicable)

3.0 EXECUTION

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3.7.5. Preparation of DD Form 1354 (Transfer of Real Property)

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3.9. SUBMITTAL DISTRIBUTION, MEDIA AND QUANTITIES

3.9.1. Submittal Distribution and Quantities

3.9.2. Web based Design Submittals

3.9.3. Mailing of Design Submittals

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ATTACHMENT A STRUCTURAL INTERIOR DESIGN (SID) REQUIREMENTS

ATTACHMENT B FURNITURE, FIXTURES AND EQUIPMENT REQUIREMENTS

ATTACHMENT C TRACKING COMMENTS IN DRCHECKS

ATTACHMENT D SAMPLE FIRE PROTECTION AND LIFE SAFETY CODE REVIEW

ATTACHMENT E LEED SUBMITTALS

ATTACHMENT F BUILDING INFORMATION MODELING REQUIREMENTS

ATTACHMENT G DESIGN SUBMITTAL DIRECTORY AND SUBDIRECTORY FILE ARRANGEMENT

1.0 GENERAL INFORMATION

1.1. INTRODUCTION

1.1.1. The information contained in this section applies to the design required after award. After award, the Contractor will develop the accepted proposal into the completed design, as described herein.

1.1.2. The Contractor may elect to fast track the design and construction that is, proceed with construction of parts of the sitework and facilities prior to completion of the overall design. To facilitate fast tracking, the Contractor may elect to divide the design into no more than ten (10) design packages per major facility type and no more than three (3) design packages for site and associated work. Designate how it will package the design, consistent with its overall plan for permitting (where applicable) and construction of the project. See Sections 01 33 00 SUBMITTAL PROCEDURES and 01 32 01.00 10 PROJECT SCHEDULE for requirements for identifying and scheduling the design packaging plan in the submittal register and project schedule. See also Sections 01 10 00 STATEMENT OF WORK and 01 57 20.00 10 ENVIRONMENTAL PROTECTION for any specified permit requirements. If early procurement of long-lead item construction materials or installed equipment, prior to completion of the associated design package, is necessary to facilitate the project schedule, also identify those long-lead items and how it will assure design integrity of the associated design package to meet the contract requirements (The Contract consists of the Solicitation requirements and the accepted proposal). Once the Government is satisfied that the long-lead items meet the contract requirements, the Contracting Officer will allow the Contractor to procure the items at its own risk.

1.1.3. The Contractor may proceed with the construction work included in a separate design package after the Government has reviewed the final (100%) design submission for that package, review comments have been addressed and resolved to the Government's satisfaction and the Contracting Officer (or the Administrative Contracting Officer) has agreed that the design package may be released for construction.

1.1.4. INTEGRATED DESIGN. To the maximum extent permitted for this project, use a collaborative, integrated design process for all stages of project delivery with comprehensive performance goals for siting, energy, water, materials and indoor environmental quality and ensures incorporation of these goals. Consider all stages of the building lifecycle, including deconstruction.

1.2. DESIGNER OF RECORD

Identify, for approval, the Designer of Record (“DOR”) that will be responsible for each area of design. One DOR may be responsible for more than one area. Listed, Professional Registered, DOR(s) shall account for all areas of design disciplines shall be accounted for by a listed. The DOR’s shall stamp, sign, and date each design drawing and other design deliverables under their responsible discipline at each design submittal stage (see contract clause Registration of Designers). If the deliverables are not ready for release for construction, identify them as "preliminary" or "not for release for construction" or by using some other appropriate designation. The DOR(s) shall also be responsible for maintaining the integrity of the design and for compliance with the contract requirements through construction and documentation of the as-built condition by coordination, review and approval of extensions of design, material, equipment and other construction submittals, review and approval or disapproval of requested deviations to the accepted design or to the contract, coordination with the Government of the above activities, and by performing other typical professional designer responsibilities.

2.0 PRODUCTS (Not Applicable)

3.0 EXECUTION

3.1. PRE-WORK ACTIVITIES & CONFERENCES

3.1.1. Design Quality Control Plan

Submit for Government acceptance, a Design Quality Control Plan in accordance with Section 01 45 04.00 10 CONTRACTOR QUALITY CONTROL before design may proceed.

3.1.2. Post Award Conference

3.1.2.1. The government will conduct a post award contract administration conference at the project site, as soon as possible after contract award. This will be coordinated with issuance of the contract notice to proceed (NTP). The Contractor and major sub-contractor representatives shall participate. All designers need not attend this first meeting. Government representatives will include COE project delivery team members, facility users, facility command representatives, and installation representatives. The Government will provide an agenda, meeting goals, meeting place, and meeting time to participants prior to the meeting.

3.1.2.2. The post award conference shall include determination and introduction of contact persons, their authorities, contract administration requirements, discussion of expected project progress processes, and coordination of subsequent meetings for quality control (see Section 01 45 04.00 10 CONTRACTOR QUALITY CONTROL), Partnering (see below and SCR: Partnering), and the initial design conference (see below).

3.1.2.3. The government will introduce COE project delivery team members, facility users, facility command representatives, and installation representatives. The DB Contractor shall introduce major subcontractors, and other needed staff. Expectations and duties of each person shall be defined for all participants. A meeting roster shall be developed and distributed by the government with complete contact information including name, office, project role, phone, mailing and physical address, and email address.

3.1.3. Partnering & Project Progress Processes

3.1.3.1. The initial Partnering conference may be scheduled and conducted at any time with or following the post award conference. The Government proposes to form a partnership with the DB Contractor to develop a cohesive building team. This partnership will involve the COE project delivery team members, facility users, facility command representatives, installation representatives, Designers of Record, major subcontractors, contractor quality control staff, and contractor construction management staff. This partnership will strive to develop a cooperative management team drawing on the strengths of each team member in an effort to achieve a quality project within budget and on schedule. This partnership will be bilateral in membership and participation will be totally voluntary. All costs, excluding labor and travel expenses, shall be shared equally between the Government and the Contractor. The Contractor and Government shall be responsible for their own labor and travel costs. Normally, partnering meetings will be held at or in the vicinity of the project installation.

3.1.3.2. As part of the partnering process, the Government and Contractor shall develop, establish, and agree to comprehensive design development processes including conduct of conferences, expectations of design development at conferences, fast-tracking, design acceptance, Structural Interior Design (SID)/ Furniture, Fixtures & Equipment (FF&E) design approval, project closeout, etc. The government will explain contract requirements and the DB Contractor shall review their proposed project schedule and suggest ways to streamline processes.

3.1.4. Initial Design Conference

The initial design conference may be scheduled and conducted at the project installation any time after the post award conference, although it is recommended that the partnering process be initiated with or before the initial design conference. Any design work conducted after award and prior to this conference should be limited to site and is discouraged for other items. All Designers of Record shall participate in the conference. The purpose of the meeting is to introduce everyone and to make sure any needs the contractor has are assigned and due dates established as well as who will get the information. See also Attachment F, BUILDING INFORMATION MODELING REQUIREMENTS for discussion concerning the BIM Implementation Plan demonstration at this meeting. The DB Contractor shall conduct the initial design conference.

3.1.5. Pre-Construction Conference

Before starting construction activities, the Contractor and Government will jointly conduct a pre-construction administrative conference to discuss any outstanding requirements and to review local installation requirements for start of construction. It is possible there will be multiple Pre-Construction Conferences based on the content of the design packages selected by the Contractor. The Government will provide minutes of this meeting to all participants.

3.2. STAGES OF DESIGN SUBMITTALS AND OVER THE SHOULDER PROGRESS REVIEWS

The stages of design submittals described below define Government expectations with respect to process and content. The Contractor shall determine how to best plan and execute the design and review process for this project, within the parameters listed below. As a minimum, the Government expects to see at least one interim design submittal, at least one final design submittal before construction of a design package may proceed and at least one Design Complete submittal that documents the accepted design. The Contractor may sub-divide the design into separate packages for each stage of design and may proceed with construction of a package after the Government accepts the final design for that package. See discussion on waivers to submission of one or more intermediate design packages where the parties partner during the design process. See also Attachment F, BUILDING INFORMATION MODELING REQUIREMENTS for discussion concerning BIM and the various stages of design submittals and over-the-shoulder progress reviews**.**

3.2.1. Site/Utilities

To facilitate fast-track design-construction activities the contractor may submit a final (100%) site and utility design as the first design submittal or it may elect to submit interim and final site and utility design submittals as explained below. Following review, resolution, and incorporation of all Government comments, and submittal of a satisfactory set of site/utility design documents, after completing all other pre-construction requirements in this contract and after the pre-construction meeting, the Government will allow the Contractor to proceed with site development activities, including demolition where applicable, within the parameters set forth in the accepted design submittal. For the first site and utility design submission, whether an interim or final, the submittal review, comment, and resolution times from this specification apply, except that the Contractor shall allow the Government a 14 calendar day review period, exclusive of mailing time. No on-site construction activities shall begin prior to written Government clearance to proceed.

3.2.2. Interim Design Submittals

The Contractor may submit either a single interim design for review, representing a complete package with all design disciplines, or split the interim design into smaller, individual design packages as it deems necessary for fast-track construction purposes. As required in Section 01 32 01.00 10 PROJECT SCHEDULE, the Contractor shall schedule its design and construction packaging plan to meet the contract completion period. This submission is the Government's primary opportunity to review the design for conformance to the solicitation and to the accepted contract proposal and to the Building Codes at a point where required revisions may be still made, while minimizing lost design effort to keep the design on track with the contract requirements. The requirements for the interim design review submittals and review conferences are described hereinafter. This is not necessarily a hold point for the design process; the Contractor may designate the interim design submittal(s) as a snapshot and proceed with design development at its own risk. See below for a waiver, where the parties establish an effective over-the-shoulder progress review procedure through the partnering process that would eliminate the need for or expedite a formal intermediate design review on one or more individual design packages.

3.2.3. Over-the-Shoulder Progress Reviews

To facilitate a streamlined design-build process, the Government and the Contractor may agree to one-on-one reviewer or small group reviews, electronically, on-line (if available within the Contractor's standard design practices) or at the Contractor's design offices or other agreed location, when practicable to the parties. The Government and Contractor will coordinate such reviews to minimize or eliminate disruptions to the design process. Any data required for these reviews shall normally be provided in electronic format, rather than in hard copy. If the Government and Contractor establish and implement an effective, mutually agreeable partnering procedure for regular (e.g., weekly) over-the shoulder review procedures that allow the Government reviewers the opportunity to keep fully informed of the progress, contents, design intent, design documentation, etc. of the design package, the Government will agree to waive or to expedite the formal intermediate design review period for that package. The Contractor shall still be required to submit the required intermediate design documentation, however the parties may agree to how that material will be provided, in lieu of a formal consolidated submission of the package. It should be noted that Government funding is extremely limited for non-local travel by design reviewers, so the maximum use of virtual teaming methods must be used. Some possible examples include electronic file sharing, interactive software with on-line or telephonic conferencing, televideo conferencing, etc. The Government must still perform its Code and Contract conformance reviews, so the Contractor is encouraged to partner with the reviewers to find ways to facilitate this process and to facilitate meeting or bettering the design-build schedule. The Contractor shall maintain a fully functional configuration management system as described herein to track design revisions, regardless of whether or not there is a need for a formal intermediate design review. The formal intermediate

review procedures shall form the contractual basis for the official schedule, in the event that the partnering process determines that the formal intermediate review process to be best suited for efficient project execution. However, the Government pledges to support and promote the partnering process to work with the Contractor to find ways to better the design schedule.

3.2.4. Final Design Submissions

This submittal is required for each design package prior to Government acceptance of that design package for construction. The requirements for the final design submittal review conferences and the Government's acceptance for start of construction are described herein after.

3.2.5. Design Complete Submittals

After the final design submission and review conference for a design package, revise the design package to incorporate the comments generated and resolved in the final review conferences, perform and document a back-check review and submit the final, design complete documents, which shall represent released for construction documents. The requirements for the design complete submittals are described hereinafter.

3.2.6. Holiday Periods for Government Review or Actions

Do not schedule meetings, Government reviews or responses during the last two weeks of December or other designated Government Holidays (including Friday after Thanksgiving). Exclude such dates and periods from any durations specified herein for Government actions.

3.2.7. Late Submittals and Reviews

If the Contractor cannot meet its scheduled submittal date for a design package, it must revise the proposed submittal date and notify the government in writing, at least one (1) week prior to the submittal, in order to accommodate the Government reviewers' other scheduled activities. If a design submittal is over one (1) day late in accordance with the latest revised design schedule, or if notification of a proposed design schedule change is less than seven (7) days from the anticipated design submission receipt date, the Government review period may be extended up to seven (7) days due to reviewers' schedule conflicts. If the Government is late in meeting its review commitment and the delay increases the Contractor's cost or delays completion of the project, the Suspension of Work and Defaults clauses provide the respective remedy or relief for the delay.

3.3. DESIGN CONFIGURATION MANAGEMENT

3.3.1. Procedures

Develop and maintain effective, acceptable design configuration management (DCM) procedures to control and track all revisions to the design documents after the Interim Design Submission through submission of the As-Built documents. During the design process, this will facilitate and help streamline the design and review schedule. After the final design is accepted, this process provides control of and documents revisions to the accepted design (See Special Contract Requirement: Deviating From the Accepted Design). The system shall include appropriate authorities and concurrences to authorize revisions, including documentation as to why the revision must be made. The DCM data shall be available to the Government reviewers at all times. The Contractor may use its own internal system with interactive Government concurrences, where necessary or may use the Government's "DrChecks Design Review and Checking System" (see below and Attachment C).

3.3.2. Tracking Design Review Comments

Although the Contractor may use its own internal system for overall design configuration management, the Government and the Contractor shall use the DrChecks Design Review and Checking System to initiate, respond to, resolve and track Government design compliance review comments. This system may be useful for other data which needs to be interactive or otherwise available for shared use and retrieval. See Attachment C for details on how to establish an account and set-up the DrChecks system for use on the project.

3.3.3. Design and Code Checklists

Develop and complete various discipline-specific checklists to be used during the design and quality control of each submittal. Submit these completed checklists with each design submittal, as applicable, as part of the project documentation. See Section 01 45 04.00 10 Contractor Quality Control, Attachment D for a Sample Fire Protection and Life Safety Code review checklist and Attachment E for LEED SUBMITTALS.

3.4. INTERIM DESIGN REVIEWS AND CONFERENCES

3.4.1. General

At least one interim design submittal, review and review conference is required for each design package (except that, per paragraph 3.2.1, the Contractor may skip the interim design submission and proceed directly to final design on the sitework and utilities package). The DB Contractor may include additional interim design conferences or over-the-shoulder reviews, as needed, to assure continued government concurrence with the design work. Include the interim submittal review periods and conferences in the project schedule and indicate what part of the design work is at what percentage of completion. The required interim design conferences shall be held when interim design requirements are reached as described below. See also Paragraph: **Over-the-Shoulder Progress Reviews** for a waiver to the formal interim design review.

3.4.2. Procedures

After receipt of an Interim Design submission, allow the Government fourteen (14) calendar days after receipt of the submission to review and comment on the interim design submittal. For smaller design packages, especially those that involve only one or a few separate design disciplines, the parties may agree on a shorter review period or alternative review methods (e.g., over-the–shoulder or electronic file sharing), through the partnering process. For each interim design review submittal, the COR will furnish, to the Contractor, a single consolidated, validated listing of all comments from the various design sections and from other concerned agencies involved in the review process using the DrChecks Design Review and Checking System. The review will be for conformance with the technical requirements of the solicitation and the Contractor's RFP proposal. If the Contractor disagrees technically with any comment or comments and does not intend to comply with the comment, he/she must clearly outline, with ample justification, the reasons for noncompliance within five (5) days after receipt of these comments in order that the comment can be resolved. Furnish disposition of all comments, in writing, through DrChecks. The Contractor is cautioned that if it believes the action required by any comment exceeds the requirements of this contract, that it should take no action and notify the COR in writing immediately. The Interim Review conference will be held for each design submittal at the installation. Bring the personnel that developed the design submittal to the review conference. The conference will take place the week after the receipt of the comments by the Contractor. For smaller fast-track packages that involve only a few reviewers, the parties may agree to alternative conferencing methods, such as teleconferencing, or televideo, where available, as determined through Partnering.

3.4.3. Conference Documentation

3.4.3.1. In order to facilitate and accelerate the Government code and contract conformance reviews, identify, track resolution of and maintain all comments and action items generated during the design process and make this available to the designers and reviewers prior to the Interim and subsequent design reviews.

3.4.3.2. The DB Contractor shall prepare meeting minutes and enter final resolution of all comments into DrChecks. Copies of comments, annotated with comment action agreed on, will be made available to all parties before the conference adjourns. Unresolved problems will be resolved by immediate follow-on action at the end of conferences. Incorporate valid comments. The Government reserves the right to reject design document submittals if comments are significant. Participants shall determine if any comments are critical enough to require further design development prior to government concurrence. Participants shall also determine how to proceed in order to obtain government concurrence with the design work presented.

3.5. INTERIM DESIGN REQUIREMENTS

Interim design deliverables shall include drawings, specifications, and design analysis for the part of design that the Contractor considers ready for review.

3.5.1. Drawings

Include comments from any previous design conferences incorporated into the documents to provide an interim design for the “part” submitted.

3.5.2. Design Analyses

3.5.2.1. The designers of record shall prepare and present design analyses with calculations necessary to substantiate and support all design documents submitted. Address design substantiation required by the applicable codes and references and pay particular attention to the following listed items:

3.5.2.2. For parts including sitework, include site specific civil calculations.

3.5.2.3. For parts including structural work, include structural calculations.

(a) Identify all loads to be used for design.

(b) Describe the method of providing lateral stability for the structural system to meet seismic and wind load requirements. Include sufficient calculations to verify the adequacy of the method.

(c) Provide calculations for all principal roof, floor, and foundation members and bracing and secondary members.

(d) Provide complete seismic analyses for all building structural, mechanical, electrical, architectural, and building features as dictated by the seismic zone for which the facility is being constructed.

(e) Computer generated calculations must identify the program name, source, and version. Provide input data, including loads, loading diagrams, node diagrams, and adequate documentation to illustrate the design. The schematic models used for input must show, as a minimum, nodes/joints, element/members, materials/properties, and all loadings, induced settlements/deflections, etc., and a list of load combinations. Include an output listing for maximum/minimum stresses/forces and deflections for each element and the reactions for each loading case and combination.

(f) See also the Security (Anti-Terrorism) requirements below for members subject to Anti-Terrorist Force Protection (ATFP) and Progressive Collapse requirements.

(g) Fully coordinate and integrate the overall structural design between two different or interfacing construction types, such as modular and stick-built or multistory, stacked modular construction. Provide substantiation of structural, consolidation/settlement analysis, etc., as applicable, through the interfaces.

3.5.2.4. For Security (Anti-Terrorism): Provide a design narrative and calculations where applicable, demonstrating compliance with each of the 22 standards in UFC 4-010-01, which includes Design of Buildings to Resist Progressive Collapse (use the most recent version of UFC 4-023-03, regardless of references to any specific version in UFC 4-010-01). Where sufficient standoff distance is not being provided, show calculations for blast resistance of the structural system and building envelope. Show complete calculations for members subjected to ATFP loads, e.g., support members of glazed items (jambs, headers, sills) connections of windows to support members and connections of support members to the rest of the structure. For 3 story and higher buildings, provide calculations to demonstrate compliance with progressive collapse requirements.

3.5.2.5. For parts including architectural work, include building floor area analysis.

3.5.2.6. For parts including mechanical work, include HVAC analysis and calculations. Include complete design calculations for mechanical systems. Include computations for sizing equipment, compressed air systems, air duct design, and U-factors for ceilings, roofs and exterior walls and floors. Contractor shall employ commercially available energy analysis techniques to determine the energy performance of all passive systems and features. Use of hourly energy load computer simulation is required (see paragraph 3.5.5.2 for list of acceptable software). Based on the results of calculations, provide a complete list of the materials and equipment proposed with the manufacturer's published cataloged product installation specifications and roughing-in data.

3.5.2.7. For parts including life safety, include building code analysis and sprinkler and other suppression systems. Notwithstanding the requirements of the Codes, address the following:

(a) A registered fire protection engineer (FPE) must perform all fire protection analyses. Provide the fire protection engineer’s qualifications. See Section 01 10 00, paragraph 5 for qualifications.

(b) Provide all references used in the design including Government design documents and industry standards used to generate the fire protection analysis.

(c) Provide classification of each building in accordance with fire zone, building floor areas and height and number of stories.

(d) Provide discussion and description of required fire protection requirements including extinguishing equipment, detection equipment, alarm equipment and water supply. Alarm and detection equipment shall interface to requirements of Electronic Systems.

(e) Provide hydraulic calculations based on water flow test for each sprinkler system to insure that flow and pressure requirements can be met with current water supply. Include copies of Contractor's water flow testing done to certify the available water source.

3.5.2.8. For parts including plumbing systems:

(a) List all references used in the design.

(b) Provide justification and brief description of the types of plumbing fixtures, piping materials and equipment proposed for use.

(c) Detail calculations for systems such as sizing of domestic hot water heater and piping; natural gas piping; LP gas piping and tanks, fuel oil piping and tanks, etc., as applicable.

(d) When the geotechnical report indicates expansive soils are present, indicate in the first piping design submittal how piping systems will be protected against damage or backfall/backflow due to soil heave (from penetration of slab to the 5 foot building line).

3.5.2.9. For elevator systems:

(a) List all criteria codes, documents and design conditions used.

(b) List any required permits and registrations for construction of items of special mechanical systems and equipment.

3.5.2.10. For parts including electrical work, include lighting calculations to determine maintained foot-candle levels, electrical load analysis and calculations, electrical short circuit and protective device coordination analysis and calculations and arc fault calculations.

3.5.2.11. For parts including telecommunications voice/data (including SIPRNET, where applicable), include analysis for determining the number and placement of outlets

3.5.2.12. For Cathodic Protection Systems, provide the following stamped report by the licensed corrosion engineer or NACE specialist with the first design submission. The designer must be qualified to engage in the practice of corrosion control of buried or submerged metallic surfaces. He/she must be accredited or certified by the National Association of Corrosion Engineers (NACE) as a NACE Accredited Corrosion Specialist or a NACE certified Cathodic Protection Specialist, or must be a registered professional engineer with a minimum of five years experience in corrosion control and cathodic protection, Clearly describe structures, systems or components in soil or water to be protected. Describe methods proposed for protection of each.

3.5.3. Geotechnical Investigations and Reports:

3.5.3.1. The contractor’s licensed geotechnical engineer shall prepare a final geotechnical evaluation report, to be submitted along with the first foundation design submittal. Make this information available as early as possible during the over-the-shoulder progress review process. Summarize the subsurface conditions and provide recommendations for the design of appropriate utilities, foundations, floor slabs, retaining walls, embankments, and pavements. Include compaction requirements for fill and backfill under buildings, sidewalks, other structures and open areas. Recommend foundation systems to be used, allowable bearing pressures for footings, lateral load resistance capacities for foundation systems, elevations for footings, grade beams, slabs, etc. Provide an assessment of post-construction settlement potential including total and differential. Provide recommendations regarding lateral earth pressures (active, at-rest, passive) to be used in the design of retaining walls. Include the recommended spectral accelerations and Site Class for seismic design along with an evaluation of any seismic hazards and recommendations for mitigation, if required. Include calculations to support the recommendations for bearing capacity, settlement, and pavement sections. Include supporting documentation for all recommended

design parameters such as Site Class, shear strength, earth pressure coefficients, friction factors, subgrade modulus, California Bearing Ratio (CBR), etc. Provide earthwork recommendations, expected frost penetration, expected groundwater levels, recommendations for dewatering and groundwater control and the possible presence of any surface or subsurface features that may affect the construction of the project such as sinkholes, boulders, shallow rock, old fill, old structures, soft areas, or unusual soil conditions. Include pH tests, salinity tests, resistivity measurements, etc., required to design corrosion control and grounding systems. Include the raw field data. Arrange a meeting with the Government subsequent to completion and evaluation of the site specific geotechnical exploration to outline any differences encountered that are inconsistent with the Government provided preliminary soils information. Clearly outline differences which require changes in the foundation type, or pavement and earthwork requirements from that possible and contemplated using the Government furnished preliminary soils investigation, which result in a change to the design or construction. Any equitable adjustment is subject to the provisions of the contract's Differing Site Conditions Clause.

3.5.3.2. Vehicle Pavements: The Contractor's geotechnical report shall contain flexible and rigid pavement designs, as applicable for the project, including design CBR and modulus of subgrade reaction and the required compaction effort for subgrades and pavement layers. Provide Information on the types of base course materials available in the area and design strengths.

3.5.3.3. The Contractor and the professional geotechnical engineer consultant shall certify in writing that the design of the project has been developed consistent with the Contractor's final geotechnical report. The certification shall be stamped by the consulting professional geotechnical engineer and shall be submitted with the first design submission. If revisions are made to the initial design submission, a new certification shall be provided with the final design submission.

3.5.4. LEED Documentation:

Assign a LEED Accredited Professional, responsible to track LEED planning, performance and documentation for each LEED credit through construction closeout. Incorporate LEED credits in the plans, specifications and design analyses. Develop LEED supporting documentation as a separable portion of the Design Analysis and provide with each required design submittal. Include the LEED Project checklist for each non-exempt facility (one checklist may be provided for multiple facilities in accordance with the LEED-NC Application Guide for Multiple Buildings and On-Campus Building Projects and the LEED SUBMITTALS (Attachment E, herein) with each submittal. Final design submittal for each portion of the work must include all required design documentation relating to that portion of work (example - all site credit design documents with final site design). Submittal requirements are as indicated in Attachment E, LEED SUBMITTALS. Submit all documentation indicated on Attachment E as due at final design at final design submittal (for fast-track projects with multiple final design submittals, this shall be at the last scheduled final design submittal). All project documentation related to LEED shall conform to USGBC requirements for both content and format, including audit requirements and be separate from other design analyses. Maintain and update the LEED documentation throughout project progress to construction closeout and shall compile product data, receipts, calculations and other data necessary to substantiate and support all credits claimed. The Government may audit any or all individual credits. Audit documentation is not required to be submitted unless requested. These requirements apply to all projects. If the project requires the Contractor to obtain USGBC certification, the Contractor shall also be responsible for obtaining USGBC certification and shall provide written evidence of certification with the construction closeout LEED documentation submittal. Install the USGBC building plaque at the location indicated by the Government upon receipt. If Contractor obtains USGBC interim design review, submit the USGBC review to the Government within 30 days of receipt for information only.

3.5.4.1. LEED Documentation for Technology Solution Set. If the Solicitation provides a Prescriptive Technology Solution Set, use of the Technology Solution set has no effect on LEED documentation requirements. Provide all required LEED documentation, including energy analysis, in accordance with LEED requirements when using the Technology Solution Set.

3.5.5. Energy Conservation:

3.5.5.1. Refer to Section 01 10 00, Paragraph 5. Interim and Final Design submittals shall demonstrate that each building including the building envelope, HVAC systems, service water heating, power, and lighting systems meet the Mandatory Provisions and the Prescriptive Path requirements of ASHRAE 90.1. Use Compliance Documentation forms available from ASHRAE and included in the ASHRAE 90.1 User's Manual for this purpose. The Architectural Section of the Design Analysis shall include completed forms titled "Building Envelope

Compliance Documentation Parts I and II". The Heating Ventilating and Air Conditioning (HVAC) Section of the Design Analysis shall include a completed form titled "HVAC Simplified Approach Option - Part I" if this approach is allowed by the Standard. Otherwise, the HVAC Section of the Design Analysis shall include completed forms titled "HVAC Mandatory Provisions - Part II" and "HVAC Prescriptive Requirements - Part III". The Plumbing Section of the Design Analysis shall include a completed form titled "Service Water Heating Compliance Documentation". The Electrical Section of the Design Analysis shall include an explanatory statement on how the requirements of ASHRAE 90.1-2004 Chapter 8 Power were met. The Electrical Section of the Design Analysis shall also include a completed form titled "Lighting Compliance Documentation".

3.5.5.2. Interim and Final Design submittals which address energy consuming systems, (heating, cooling, service hot water, lighting, power, etc.) must also include calculations in a separate Energy Conservation Section of the Design Analysis which demonstrate and document (a) the baseline energy consumption for the facility or facilities under contract, that would meet the requirements of ANSI/ASHRAE/IESNA Standard 90.1 and (b) the energy consumption of the facility or facilities under contract utilizing the materials and methods required by this construction contract. Use the USGBC Energy and Atmosphere (EA) Credit 1 compliance template / form or an equivalently detailed form for documenting compliance with the energy reduction requirements. This template / form is titled PERFORMANCE RATING METHOD and is available when the project is registered for LEED. The calculation methodology used for this documentation and analysis shall follow the guidelines set forth in Appendix G of ASHRAE 90.1, with two exceptions: a) receptacle and process loads may be omitted from the calculation; and b) the definition of the terms in the formula for Percentage Improvement found in paragraph G1.2 are modified as follows: Baseline Building Performance shall mean the annual energy consumption calculated for a building design intended for use as a baseline for rating above standard design meeting the minimum requirements of the energy standard, and Proposed Building Performance shall mean annual energy consumption calculated for the proposed building design intended for construction. This calculation shall address all energy consuming systems in a single integrated methodology. Include laboratory fume hoods and kitchen ventilation loads in the energy calculation. They are not considered process loads. Individual calculations for heating, cooling, power, lighting, power, etc. systems will not be acceptable. The following building simulation software is acceptable for use in calculating building energy consumption: Hourly Analysis Program (HAP) by Carrier Corp., TRACE 700 by Trane Corp., DOE-2 by US Department of Energy, EnergyPlus by DOD/DOE.

3.5.6. Specifications

Specifications may be any one of the major, well known master guide specification sources (use only one source) such as MASTERSPEC from the American Institute of Architects, SPECTEXT from Construction Specification Institute or Unified Facility Guide Specifications (UFGS using MASTERFORMAT 2004 numbering system), etc. (including specifications from these sources). Manufacturers' product specifications, utilizing CSI's Manu-Spec, three part format may be used in conjunction with the selected specifications. The designers of record shall edit and expand the appropriate Specifications to insure that all project design requirements, current code requirements, and regulatory requirements are met. Specifications shall clearly identify, where appropriate, specific products chosen to meet the contract requirements (i.e., manufacturers' brand names and model numbers or similar product information).

3.5.7. Building Rendering

Present and provide a draft color computer, artist, or hand drawn rendering with the conceptual design submittal of the building exterior. Perspective renderings shall include a slightly overhead view of the entire building to encompass elevations and the roof configuration of the building. After Government review and acceptance, provide a final rendering, including the following:

Three (3) 18" x 24" color prints, framed and matted behind glass with project title underneath the print.

One (1) Image file (high resolution) in JPG format on CD for those in the submittal distribution list.

3.5.8. Interim Building Design Contents

The following list represents what the Government considers should be included in the overall completed design for a facility or project. It is not intended to limit the contractor from providing different or additional information as needed to support the design presented, including the require design analyses discussed above. As the Contractor develops individual design packages and submits them for Interim review, include as much of the applicable

information for an individual design package as is developed at the Interim design level for review purposes. These pieces shall be developed as the design progresses toward the design complete stage.

3.5.8.1. Lawn and Landscaping Irrigation System

3.5.8.2. Landscape, Planting and Turfing

3.5.8.3. Architectural

(a) Design Narrative

(b) Architectural Floor Plans, Typical Wall and Roof Sections, Elevations

(c) Finish schedule

(d) All required equipment

(e) Special graphics requirements

(f) Door and Window Schedules

(g) Hardware sets using BHMA designations

(h) Composite floor plan showing all pre-wired workstations

(i) Structural Interior Design (SID) package: See ATTACHMENT A for specific requirements

(j) Furniture, Fixtures & Equipment (FF&E) design package: See ATTACHMENT B for specific requirements

3.5.8.4. Structural Systems. Include:

(a) Drawings showing principal members for roof and floor framing plans as applicable

(b) Foundation plan showing main foundation elements where applicable

(c) Typical sections for roof, floor, and foundation conditions

3.5.8.5. Plumbing Systems

(a) Show locations and general arrangement of plumbing fixtures and major equipment

(b) Plan and isometric riser diagrams of all areas including hot water, cold water, waste and vent piping. Include natural gas (and meter as required), (natural gas and meter as required), (LP gas), (fuel oil) and other specialty systems as applicable.

(c) Include equipment and fixture connection schedules with descriptions, capacities, locations, connection sizes and other information as required

3.5.8.6. HVAC Systems

(a) Mechanical Floor Plans: The floor plans shall show all principle architectural features of the building which will affect the mechanical design. The floor plans shall also show the following:

(1) Room designations.

(2) Mechanical legend and applicable notes.

(3) Location and size of all ductwork and piping.

(4) Location and capacity of all terminal units (i.e., registers, diffusers, grilles, hydronic baseboards).

(5) Pre-Fabricated Paint Spray Booth (where applicable to project scope)

(6) Paint Preparation Area (where applicable to project scope)

(7) Exhaust fans and specialized exhaust systems.

(8) Thermostat location.

(9) Location of heating/cooling plant (i.e., boiler, chiller, cooling tower, etc).

(10) Location of all air handling equipment.

(11) Air balancing information.

(12) Flue size and location.

(13) Piping diagram for forced hot water system (if used).

(b) Equipment Schedule: Provide complete equipment schedules. Include:

(1) Capacity

(2) Electrical characteristics

(3) Efficiency (if applicable)

(4) Manufacturer's name

(5) Optional features to be provided

(6) Physical size

(7) Minimum maintenance clearances

(a) Details: Provide construction details, sections, elevations, etc., only where required for clarification of methods and materials of design.

(b) HVAC Controls: Submit complete HVAC controls equipment schedules, sequences of operation, wiring and logic diagrams, Input/Output Tables, equipment schedules, and all associated information. See the Statement of Work for additional specific requirements.

3.5.8.7. Fire Protection and Life Safety.

(a) Provide plan for each floor of each building that presents a compendium of the total fire protection features being incorporated into the design. Include the following types of information:

(1) The location and rating of any fire-resistive construction such as occupancy separations, area separations, exterior walls, shaft enclosures, corridors, stair enclosures, exit passageways, etc.

(2) The location and coverage of any fire detection systems

(3) The location and coverage of any fire suppression systems (sprinkler risers, standpipes, etc.)

(4) The location of any other major fire protection equipment

(5) Indicate any hazardous areas and their classification

(6) Schedule describing the internal systems with the following information: fire hazard and occupancy classifications, building construction type, GPM/square foot sprinkler density, area of operation and other as required

(b) Working plans and all other materials submitted shall meet NFPA 13 requirements, with respect to required minimum level of detail.

3.5.8.8. Elevators. Provide:

(a) Description of the proposed control system

(b) Description, approximate capacity and location of any special mechanical equipment for elevators.

3.5.8.9. Electrical Systems.

(a) Electrical Floor Plan(s): Show all principle architectural features of the building which will affect the electrical design. Show the following:

(1) Room designations.

(2) Electrical legend and applicable notes.

(3) Lighting fixtures, properly identified.

(4) Switches for control of lighting.

(5) Receptacles.

(6) Location and designation of panelboards. Clearly indicate type of mounting required (flush or surface) and reflect accordingly in specifications.

(7) Service entrance (conduit and main disconnect).

(8) Location, designation and rating of motors and/or equipment which requires electrical service. Show method of termination and/or connection to motors and/or equipment. Show necessary junction boxes, disconnects, controllers (approximate only), conduit stubs, and receptacles required to serve the motor and/or equipment.

(b) Building Riser Diagram(s) (from pad-mounted transformer to unit load center panelboard): Indicate the types and sizes of electrical equipment and wiring. Include grounding and metering requirements.

(c) Load Center Panelboard Schedule(s): Indicate the following information:

(1) Panelboard Characteristics (Panel Designation, Voltage, Phase, Wires, Main Breaker Rating and Mounting.

(2) Branch Circuit Designations.

(3) Load Designations.

(4) Circuit Breaker Characteristics. (Number of Poles, Trip Rating, AIC Rating)

(5) Branch Circuit Connected Loads (AMPS).

(6) Special Features

(d) Lighting Fixture Schedule(s): Indicate the following information:

(1) Fixture Designation.

(2) General Fixture Description.

(3) Number and Type of Lamp(s).

(4) Type of Mounting.

(5) Special Features.

(e) Details: Provide construction details, sections, elevations, etc. only where required for clarification of methods and materials of design.

3.5.8.10. Electronic Systems including the following responsibilities:

(a) Fire Detection and Alarm System. Design shall include layout drawings for all devices and a riser diagram showing the control panel, annunciator panel, all zones, radio transmitter and interfaces to other systems (HVAC, sprinkler, etc.)

(b) Fire Suppression System Control. Specify all components of the Fire Suppression (FS) System in the FS section of the specifications. Clearly describe how the system will operate and interact with other systems such as the fire alarm system. Include a riser diagram on the drawings showing principal components and interconnections with other systems. Include FS system components on drawing legend. Designate all components shown on floor plans “FS system components” (as opposed to “Fire Alarm components”). Show location of FS control panels, HVAC control devices, sensors, and 120V power panel connections on floor plans. Indicate zoning of areas by numbers (1, 2, 3) and detectors sub-zoned for cross zoning by letter designations (A and B). Differentiate between ceiling mounted and under floor detectors with distinct symbols and indicate sub-zone of each.

(c) Public Address System

(d) Special Grounding Systems. Completely reflect all design requirements in the specifications and drawings. Specifications shall require field tests (in the construction phase), witnessed by the Government, to determine the effectiveness of the grounding system. Include drawings showing existing construction, if any.

(e) Cathodic Protection.

(f) Intrusion Detection, Card Access System

(g) Central Control and Monitoring System

(h) Mass Notification System

(i) Electrical Power Distribution Systems

3.5.8.11. Separate detailed Telecommunications drawings for Information Systems including the following responsibilities:

(a) Telecommunications Cabling

(b) Supporting Infrastructure

(a) Outside Plant (OSP) Cabling - Campus or Site Plans - Exterior Pathways and Inter-Building Backbones

(a) Include a layout of the voice/data outlets (including voice only wall & pay phones) on telecommunication floor plan drawing, location of SIPRNET data outlets (where applicable), and a legend and symbol definition to indicate height above finished floor. Show size of conduit and cable type and size on Riser Diagram. Do not show conduit runs between backboard and outlets on the floor plans. Show underground distribution conduit and cable with sizing from point of presence to entrance facility of building.

(b) Layout of complete building per floor - Serving Zone Boundaries, Backbone Systems, and Horizontal Pathways including Serving Zones Drawings - Drop Locations and Cable ID's

(c) Communication Equipment Rooms - Plan Views - Tech and AMEP/Elevations - Racks and Walls. Elevations with a detailed look at all telecomm rooms. Indicate technology layout (racks, ladder-racks, etc.), mechanical/electrical layout, rack elevation and backboard elevation. They may also be an enlargement of a congested area of T1 or T2 series drawing.

3.6. FINAL DESIGN REVIEWS AND CONFERENCES

A final design review and review conference will be held upon completion of final design at the project installation, or – where equipment is available - by video teleconference or a combination thereof, for any design package to receive Government acceptance to allow release of the design package for construction. For smaller separate design packages, the parties may agree on alternative reviews and conferences (e.g., conference calls and electronic file sharing, etc.) through the Partnering process. Include the final design conference in the project schedule and shall indicate what part of the design work is at 100% completion. The final design conference will be held after the Government has had seven (7) calendar days after receipt of the submission to review the final design package and supporting data. For smaller packages, especially those involving only one or a few design disciplines the parties may agree on a shorter period.

3.7. FINAL DESIGN REQUIREMENTS

Final design deliverables for a design package shall consist of 100% complete drawings, specifications, submittal register and design analyses for Government review and acceptance. The 100% design submission shall consist of drawings, specifications, updated design analyses and any permits required by the contract for each package submitted. In order to expedite the final design review, prior to the conference, ensure that the design configuration management data and all review comment resolutions are up-to-date. Include the 100% SID and 100% FF&E binders for government approval. The Contractor shall have performed independent technical reviews (ITR's) and back-checks of previous comment resolutions, as required by Section 01 45 04.00 10 CONTRACTOR QUALITY CONTROL, including providing documentation thereof.

3.7.1. Drawings

3.7.1.1. Submit drawings complete with all contract requirements incorporated into the documents to provide a 100% design for each package submitted.

3.7.1.2. Prepare all drawings with the Computer-Aided Design and Drafting (CADD)/Computer-Aided Design (CAD) system, organized and easily referenced electronically, presenting complete construction information.

3.7.1.3. Drawings shall be complete. The Contractor is encouraged to utilize graphics, views, notes, and details which make the drawings easier to review or to construct but is also encouraged to keep such materials to those that are necessary.

3.7.1.4. Provide detail drawings that illustrate conformance with the contract. Include room finish schedules, corresponding color/finish/special items schedules, and exterior finish schedules that agree with the submitted SID binders.

3.7.1.5. The design documents shall be in compliance with the latest version of the A/E/C CADD Standard, available at https://cadbim.usace.army.mil/CAD. Use the approved vertical Corps of Engineers title blocks and borders on all drawings with the appropriate firm name included within the title block area.

3.7.1.6. CAD System and Building Information Modeling (BIM) (NOTE: If this is a Single Award or Multiple Award, Indefinite Delivery/Indefinite Quantity Contract, this information will be provided for each task order.)

All CAD files shall be fully compatible with MicroStation V8 or higher. Save all design CAD files as MicroStation V8 or higher files. All submitted BIM Models and associated Facility Data shall be fully compatible with Bentley BIM file format and the USACE Bentley BIM v8 Workspace.

(a) CAD Data Final File Format: During the design development capture geo-referenced coordinates of all changes made to the existing site (facility footprint, utility line installations and alterations, roads, parking areas, etc) as a result of this contract. There is no mandatory methodology for how the geo-referenced coordinates will be captured, however, Engineering and Construction Bulletin No. 2006-15, Subject: Standardizing Computer Aided Design (CAD) and Geographic Information Systems (GIS) Deliverables for all Military Design and Construction Projects identifies the format for final as-built drawings and data sets to be delivered to the government. Close-out requirements at the as-built stage; require final geo-referenced GIS Database of the new facility along with all exterior modifications. The Government will incorporate this data set into the Installation's GIS Masterplan or Enterprise GIS System. See also, Section 01 78 02.00 10 Closeout Submittals.

(b) Electronic Drawing Files: In addition to the native CAD design files, provide separate electronic drawing files (in editable CAD format and Adobe Acrobat PDF version 7.0 or higher) for each project drawing.

(c) Each file (both CAD and PDF) shall represent one complete drawing from the drawing set, including the date, submittal phase, and border. Each drawing file shall be completely independent of any data in any other file, including fonts and shapes not included with the basic CAD software program utilized. Drawing files with external references or special fonts are not acceptable. All displayed graphic elements on all levels of the drawing files shall be part of the project drawing image. The drawing files shall not contain any graphic element that is not part of the drawing image.

(d) Deliver BIM Model and associated Facility Data files in their native format. At a minimum, BIM files shall address major architecture design elements, major structural components, mechanical systems and electrical/communication distribution and elements as defined in Attachment F. See Attachment F for additional BIM requirements.

(e) Drawing Index: Provide an index of drawings sheet in CAD as part of the drawing set, and an electronic list in Microsoft Excel of all drawings on the CD. Include the electronic file name, the sheet reference number, the sheet number, and the sheet title, containing the data for each drawing.

(f) Hard Copies: Plot submitted hard copy drawings directly from the "electronic drawing files" and copy for quantities and sizes indicated in the distribution list at the end of this specification section. The Designers of Record shall stamp, sign and date original hard copy sheets as Released For Construction, and provide copies for distribution from this set.

3.7.2. Design Analyses

3.7.2.1. The designers of record shall update, finalize and present design analyses with calculations necessary to substantiate and support all design documents submitted.

3.7.2.2. The responsible DOR shall stamp, sign and date the design analysis. Identify the software used where, applicable (name, version, vendor). Generally, provide design analyses, individually, in an original (file copy) and one copy for the assigned government reviewer.

3.7.2.3. All disciplines review the LEED design analysis in conjunction with their discipline-specific design analysis; include a copy of the separable LEED design analysis in all design analysis submittals.

3.7.2.4. Do not combine multi-disciplined volumes of design-analysis, unless multiple copies are provided to facilitate multiple reviewers (one copy per each separate design analysis included in a volume).

3.7.3. Specifications

Specifications shall be 100% complete and in final form.

3.7.4. Submittal Register

Prepare and update the Submittal Register and submit it with the 100% design specifications (see Specification Section 01 33 00, SUBMITTAL PROCEDURES) with each design package. Include the required submittals for each specification section in a design package in the submittal register.

3.7.5. Preparation of DD Form 1354 (Transfer of Real Property)

This form itemizes the types, quantities and costs of various equipment and systems that comprise the project, for the purpose of transferring the new construction project from the Corps Construction Division to the Installation's inventory of real property. The Government will furnish the DB Contractor's design manager a DD Form 1354 checklist to use to produce a draft Form 1354. Submit the completed checklist and prepared draft Form DD 1354 with the 100% design in the Design Analysis. The Corps will use these documents to complete the final DD 1354 upon completion of construction.

3.7.6. Acceptance and Release for Construction

3.7.6.1. At the conclusion of the Final Design Review (after resolutions to the comments have been agreed upon between DOR and Government reviewers), the Contracting Officer or the ACO will accept the Final Design Submission for the design package in writing and allow construction to start for that design package. The Government may withhold acceptance until all major corrections have been made or if the final design submission requires so many corrections, even though minor, that it isn't considered acceptably complete.

3.7.6.2. Government review and acceptance of design submittals is for contract conformance only and shall not relieve the Contractor from responsibility to fully adhere to the requirements of the contract, including the Contractor’s accepted contract proposal, or limit the Contractor’s responsibility of design as prescribed under Special Contract Requirement: “Responsibility of the Contractor for Design” or limit the Government’s rights under the terms of the contract. The Government reserves the right to rescind inadvertent acceptance of design submittals containing contract deviations not separately and expressly identified in the submittal for Government consideration and approval.

3.8. DESIGN COMPLETE CONSTRUCTION DOCUMENT REQUIREMENTS

After the Final Design Submission and Review Conference and after Government acceptance of the Final Design submission, revise the design documents for the design package to incorporate the comments generated and resolved in the final review conference, perform and document a back-check review and submit the final, design complete documents. Label the final design complete documents “FOR CONSTRUCTION” or use similar language. In addition to the final drawings and specifications, the following deliverables are required for distribution and field use. The deliverable includes all documentation and supporting design analysis in final form, as well as the final review comments, disposition and the back-check. As part of the quality assurance process, the Government may perform a back-check of the released for construction documentation. Promptly correct any errors or omissions found during the Government back-check. The Government may withhold retainage from progress payments for work or materials associated with a final design package until this submittal has been received and the Government determines that it is complete.

3.9. SUBMITTAL DISTRIBUTION, MEDIA AND QUANTITIES

3.9.1. Submittal Distribution and Quantities

General: The documents which the Contractor shall submit to the Government for each submittal are listed and generally described in preceding paragraphs in this Section. Provide copies of each design submittal and design substantiation as follows (NOTE: If this is a Single Award or Multiple Award, Indefinite Delivery/Indefinite Quantity Contract, this information will be provided for each task order):

Activity and Address	Drawing Size (Full Size) **ANSI D** Full Sets/ *Partial Sets	Design Analyses & Specs Full Sets/ *Partial Sets	Drawing Size (Half Size) **ANSI B** Full Sets/ *Partial Sets	Non-BIM Data CD-ROM or DVD as Necessary (PDF& **.dgn**)	Furniture Submittal (FFE)	Structural Interior Design Submittal	BIM Data DVD (Per Attach F)
Commander, U.S.Army Engineer District **Norfolk District**	2/0	2/0	4/0	2	0	1	1
Commander, U.S.Army Engineer District, Center of Standardization **ATTN: Josh Miller; 819 Taylor St Rm4A05; Zip 76102**	0/0	1/1	1/1	2	2	2	2
Installation	2/0	2/0	2/0	2	1	1	1
U.S.Army Corps of Engineers Construction Area Office	2/0	2/0	2/0	2	2	2	0
Information Systems Engineering Command (ISEC)	0/0	0/1	0/0	1	1 (Electronic only)	N/A	1
Other Offices	1/0	1/0	1/0	2	2	1	0

***NOTE: For partial sets of drawings, specifications and design analyses, see paragraph 3.9.3.3, below.**

****NOTE: When specified below in 3.9.2, furnish Installation copies of Drawings as paper copies, in lieu of the option to provide secure web-based submittals.**

3.9.2. Web based Design Submittals

Web based design submittals will be acceptable as an alternative to the paper copies listed in the Table above, provided a single hard-copy PDF based record set is provided to the Contracting Officer for record purposes. Where the contract requires the Contractor to submit documents to permitting authorities, still provide those authorities paper copies (or in an alternate format where required by the authority). Web based design submittal information shall be provided with adequate security and availability to allow unlimited access those specifically authorized to Government reviewers while preventing unauthorized access or modification. File sizes must be of manageable size for reviewers to quickly download or open on their computers. As a minimum, drawings shall be full scale on American National Standards Institute (ANSI) D sheets (34" x 22"). In addition to the optional website, provide the BIM data submission on DVD to each activity and address noted above in paragraph 3.9.1 for each BIM submission required in Attachment F.

3.9.3. Mailing of Design Submittals

3.9.3.1. Mail all design submittals to the Government during design and construction, using an overnight mailing service. The Government will furnish the Contractor addresses where each copy shall be mailed to after award of the contract (or individual task order if this is an indefinite delivery/indefinite quantity, task order contract). Mail the submittals to five (5) different addresses. Assemble drawing sheets, specs, design analyses, etc. into individual sets; do not combine duplicate pages from individual sets so that the government has to assemble a set.

3.9.3.2. Each design submittal shall have a transmittal letter accompanying it indicating the date, design percentage, type of submittal, list of items submitted, transmittal number and point of contact with telephone number.

3.9.3.3. Provide partial sets of drawings, specifications, design analyses, etc., as designated in the Table in paragraph 3.9.1, to those reviewers who only need to review their applicable portions of the design, such as the various utilities. The details of which office receives what portion of the design documentation will be worked out after award.

3.10. AS-BUILT DOCUMENTS

Provide as-built drawings and specifications in accordance with Section 01 78 02.00 10, CLOSEOUT SUBMITTALS. Update LEED design phase documentation during construction as needed to reflect construction changes and advancing project completion status (example - Commissioning Plan updates during construction phase) and include updated LEED documentation in construction closeout submittal.

ATTACHMENT A
STRUCTURAL INTERIOR DESIGN (SID) REQUIREMENTS

1.0 GENERAL INFORMATION

Structural Interior Design includes all building related elements and components generally part of the building itself, such as wall finishes, ceilings finishes, floor coverings, marker/bulletin boards, blinds, signage and built in casework. Develop the SID in conjunction with the furniture footprint.

2.0 STRUCURAL INTERIOR DESIGN (SID) REQUIREMENTS FOR THE INTERIM AND FINAL DESIGN SUBMITTALS

2.1. FORMAT AND SCHEDULE

Prepare and submit for approval an interior and exterior building finishes scheme for an interim design submittal. The DOR shall meet with and discuss the finish schemes with the appropriate Government officials prior to preparation of the schemes to be presented. Present original sets of the schemes to reviewers at an interim design conference.

At the conclusion of the interim phase, after resolutions to the comments have been agreed upon between DOR and Government reviewers, the Contractor may proceed to final design with the interior finishes scheme presented.

The SID information and samples are to be submitted in 8 ½" x 11" format using three ring binders with pockets on the inside of the cover. When there are numerous pages with thick samples, use more than one binder. Large D-ring binders are preferred to O-ring binders. Use page protectors that are strong enough to keep pages from tearing out. Anchor large or heavy samples with mechanical fasteners, Velcro, or double-faced foam tape rather than rubber cement or glue. Fold out items must have a maximum spread of 25 ½". Provide cover and spine inserts sheets identifying the document as "Structural Interior Design" package. Include the project title and location, project number, Contractor/A/E name and phone number(s), submittal stage and date.

Design submittal requirements include, but are not limited to:

2.1.1. Narrative of the Structural Interior Design Objectives

The SID shall include a narrative that discusses the building related finishes. Include topics that relate to base standards, life safety, sustainable design issues, aesthetics, durability and maintainability, discuss the development and features as they relate to the occupants requirements and the building design.

2.1.2. Interior Color Boards

Identify and key each item item on the color boards to the contract documents to provide a clear indication of how and where each item will be used. Arrange finish samples to the maximum extent possible by room type in order to illustrate room color coordination. Label all samples on the color boards with the manufacturer's name, patterns and colors name and number. Key or code samples to match key code system used on contract drawings.

Material and finish samples shall indicate true pattern, color and texture. Provide photographs or colored photocopies of materials or fabrics to show large overall patterns in conjunction with actual samples to show the actual colors. Finish samples must be large enough to show a complete pattern or design where practical.

Color boards shall include but not be limited to original color samples of the following:

All walls finishes and ceiling finishes, including corner guards, acrylic wainscoting and wall guards/chair rail finishes

All tile information, including tile grout color and tile patterns.

- All flooring finishes, including patterns.
- All door, door frame finishes and door hardware finishes
- All signage, wall base, toilet partitions, locker finishes and operable/folding partitions and trim

- All millwork materials and finishes (cabinets, counter tops, etc.)
- All window frame finishes and window treatments (sills, blinds, etc.)

Color board samples shall reflect all actual finish textures, patterns and colors required as specified. Patterned samples shall be of sufficient size to adequately show pattern and its repeat if a repeat occurs.

2.1.3. Exterior Color Boards

Prepare exterior finishes color boards in similar format as the interior finishes color boards, for presentation to the reviewers during an interim design conference. Provide original color samples of all exterior finishes including but not limited to the following:

- All Roof Finishes
- All Brick and Cast Stone Samples
- All Exterior Insulation and Finish Samples
- All Glass Color Samples
- All Exterior Metals Finishes
- All Window & Door Frame Finishes
- All Specialty Item Finishes, including trim

Identify each item on the exterior finishes color boards and key to the building elevations to provide a clear indication of how and where each item will be used.

2.2. STRUCTURAL INTERIOR DESIGN DOCUMENTS

2.2.1. General

Structural interior design related drawings must indicate the placement of extents of SID material, finishes and colors and must be sufficiently detailed to define all interior work. The following is a list of minimum requirements:

2.2.2. Finish Color Schedule

Provide finish color schedule(s) in the contract documents. Provide a finish code, material type, manufacturer, series, and color designations. Key the finish code to the color board samples and drawings.

2.2.3. Interior Finish Plans

Indicate wall and floor patterns and color placement, material transitions and extents of interior finishes.

2.2.4. Furniture Footprint Plans

Provide furniture footprint plans showing the outline of all freestanding and systems furniture for coordination of all other disciplines.

2.2.5. Interior Signage

Include interior signage plans or schedules showing location and quantities of all interior signage. Key each interior sign to a quantitative list indicating size, quantity of each type and signage text.

2.2.6. Interior Elevations, Sections and Details

Indicate material, color and finish placement.

ATTACHMENT B
FURNITURE, FIXTURES & EQUIPMENT (FF&E) REQUIREMENTS

1.0 FF&E REQUIREMENTS FOR THE INTERIM AND FINAL DESIGN SUBMITTALS

1.1. FORMAT AND SCHEDULE

Prepare and submit for approval a comprehensive FF&E scheme for an interim design submittal. The Contractor's interior designer, not a furniture dealer, shall develop the design. FF&E is the selection, layout, specification and documentation of furniture includes but is not limited to workstations, seating, tables, storage and shelving, filing, trash receptacles, clocks, framed artwork, artificial plants, and other accessories. Contract documentation is required to facilitate pricing, procurement and installation. The FF&E package is based on the furniture footprint developed in the Structural Interior Design (SID) portion of the interior design. Develop the FF&E package concurrently with the building design to ensure that there is coordination between the electrical outlets, switches, J-boxes, communication outlets and connections, and lighting as appropriate. In addition, coordinate layout with other building features such as architectural elements, thermostats, location of TV's, GF/GI equipment (for example computers, printers, copiers, shredders, faxes), etc. Locate furniture in front of windows only if the top of the item falls below the window and unless otherwise noted, do not attach furniture including furniture systems to the building. If project has SIPRNET and/or NIPRNET, coordinate furniture layout with SIPRNET and NIPRNET separation requirements. Verify that access required by DOIM for SIPRNET box and conduit is provided. The DOR shall interview appropriate Government personnel to determine FF&E requirements for furniture and furnishings prior to preparation of the scheme to be presented. Determine FFE items and quantities by, but not limited to: (1) the number of personnel to occupy the building, (2) job functions and related furniture/office equipment to support the job function, (3) room functions, (4) rank and grade. Present original sets of the scheme to reviewers at an interim design conference upon completion of the interim architectural submittal or three months prior to the submittal of the final FF&E package (whichever comes first).

Design may proceed to final with the FF&E scheme presented at the conclusion of the interim phase, after resolutions to the comments have been agreed upon between DOR and Government reviewers.

Provide six copies of the electronic versions of all documents upon completion of the final architectural submittal or ten months prior to the contract completion date (whichever comes first), to ensure adequate time for furniture acquisition. Provide unbound, electronic drawings in CAD and BIM. Provide all files needed to v,/iew complete drawings. Submit all text documents in Microsoft Word or Excel..

Submit three copies of the final and complete FF&E information and samples in 8 ½" x 11" format using three ring binders with pockets on the inside of the cover upon completion of the final architectural submittal or ten months prior to the contract completion date (whichever comes first). Use more than one binder when there are numerous pages with thick samples. Large D-ring binders are preferred to O-ring binders. Use page protectors that are strong enough to keep pages from tearing out for upholstery and finish boards. Anchor large or heavy samples with mechanical fasteners, Velcro, or double-faced foam tape rather than rubber cement or glue. Fold out items must have a maximum spread of 25 ½". Provide cover and spine inserts sheets identifying the document as "Furniture, Fixtures & Equipment" package and include the project title and location, project number, Contractor/A/E name and phone number(s), submittal stage and date.

Provide electronic copies of all documents upon completion of the final architectural submittal or ten months prior to the contract completion date (whichever comes first), to ensure adequate time for furniture acquisition. Provide six compact disks with all drawings files needed to view the complete drawings unbound and in the latest version AutoCAD. Provide six additional compact disks of all text documents in Microsoft Word or Excel.

Design submittal requirements include, but are not limited to:

1.1.1. Narrative of Interior Design Objectives

Provide a narrative description of the furniture, to include functional, safety and ergonomic considerations, durability, sustainability, aesthetics, and compatibility with the building design.

1.1.2. Furniture Order Form

Prepare one Furnishings Order Form for each item specified in the design. This form identifies all information required to order each individual item. In addition to the project name and location, project number, and submittal phase, the order form must include:

(a) Furniture item illustration and code

(b) Furniture item name

(c) Job name, location, and date

(d) General Services Administration (GSA) FSC Group, part, and section

(e) Manufacturer, Product name and Product model number or National Stock Number (NSN)

(f) Finish name and number (code to finish samples)

(g) Fabric name and number, minimum Wyzenbeek Abrasion Test double rubs (code to fabric samples)

(h) Dimensions

(i) Item location by room number and room name

(j) Quantity per room

(k) Total quantity

(l) Special instructions for procurement ordering and/or installation (if applicable)

(m) Written Product Description: include a non-proprietary paragraph listing the salient features of the item to include but not limited to:

(1) required features and characteristics

(2) ergonomic requirements

(3) functional requirements

(4) testing requirements

(5) furniture style

(6) construction materials

(7) minimum warranty

The following is an example for “m” features and characteristics, ergonomic requirements and functional requirements:

Chair Description:

(1) Mid-Back Ergonomic Task Chair

(2) Pneumatic Gaslift; Five Star Base

(3) Mesh Back; Upholstered Seat

(4) Height and Width Adjustable Task Arms:

a. Arm Height: 6”- 11” (+-1/2”)

b. Arm Width: 2”– 4” adjustment

(5) Height Adjustable Lumbar Support

(6) Adjustable Seat Height 16”-21” (+- 1”)

(7) Sliding Seat Depth Adjustment 15”-18” (+-1”)

(8) Standard Hard Casters (for carpeted areas)

(9) Overall Measurements:

a. Overall width: 25” - 27”

b. Overall depth: 25”– 28”

(10) Must have a minimum of the following adjustments (In addition to the above):

a. 360 Degree Swivel

b. Knee-Tilt with Tilt Tension

c. Back angle

d. Forward Tilt

e. Forward Tilt and Upright Tilt Lock

For projects with systems furniture, also provide a written description of the following minimum requirements:

(1) Type furniture systems (panel, stacking panels, spine wall, desk based system, or a combination)

(2) Minimum noise reduction coefficient (NRC)

(3) Minimum sound transfer coefficient (STC)

(4) Minimum flame spread and smoke development

(5) UL testing for task lighting and electrical system

(6) Panel widths and heights and their locations (this may be done on the drawings)Worksurface types and sizes (this may be done on the drawings)

(7) Worksurface edge type

(8) Varying panel/cover finish materials and locations (locations may be shown on the drawings)

(9) Storage requirements

(10) Keyboard requirements

(11) Lock and keying requirements

(12) Accessory components (examples: tack boards, marker boards, paper management)

(13) Electrical and communication raceway requirement; type, capacity and location (base, beltline, below and/or above beltline)

(14) Locations of communication cables (base, beltline, below and/or above beltline, top channel)

(15) Types of electrical outlets

(16) Types of communication jacks; provided and installed by others

(17) Locations of electrical outlets and communication jacks (this may be done on the drawings)

(18) Type of cable (examples: Cat. 5, Cat. 6, fiber optic; UTP or STP, etc.) system needs to support; provided and installed by others

1.1.3. Alternate Manufacturer List

Provide a table consisting of major furniture items that lists the manufacturers products specified on the Order Form and two alternate manufacturers. Major furniture items include, but are not limited to, casegoods, furniture systems, seating, and tables. Organize matrix by item code and item name. Supply alternates that are available on GSA Schedule and meet the requirements of the Furniture Order Form. One of the two alternates must be from UNICOR if possible. Provide manufacturer name address, telephone number, product series and product name for each alternate manufacturer.

1.1.4. FF&E Procurement List

Provide a table that lists all FF&E furniture, mission unique equipment and building Contractor Furnished/Contractor Installed (CF/CI) items. Give each item a code and name and designate whether item will be procured as part of the FF&E furniture, mission unique equipment or the building construction contract. Use the item code to key all FF&E documents including location plans, color boards, data sheets, cost estimate, etc.

1.1.5. Points of Contact (POCs)

Provide a comprehensive list of POCs needed to implement the FF&E package. This would include but not be limited to appropriate project team members, using activity contacts, interior design representatives, construction contractors and installers involved in the project. In addition to name, address, phone, fax and email, include each contact's job function. Divide the FF&E package into different sections based on this listing, applies to order forms and cost estimates.

1.1.6. Color Boards

Provide color boards for all finishes and fabrics for all FF&E items. Finishes to be included but not limited to paint, laminate, wood finish, fabric, etc.

1.1.7. Itemized Furniture Cost Estimate

Provide an itemized cost estimate of furnishings keyed to the plans and specifications of products included in the package. This cost estimate should be based on GSA price schedules. The cost estimate must include separate line items for general contingency, installation, electrical hook-up for systems furniture or other furniture requiring hardwiring by a licensed electrician, freight charges and any other related costs. Installation and freight quotes from vendors should be use in lieu of a percentage allowance when available. Include a written statement that the pricing is based on GSA schedules. An estimate developed by a furniture dealership may be provided as support information for the estimate, but must be separate from the contractor provided estimate.

1.2. INTERIOR DESIGN DOCUMENTS

1.2.1. Overall Furniture and Area Plans

Provide floor Plans showing locations and quantities of all freestanding, and workstation furniture proposed for each floor of the building. Key each room to a large scale Furniture Placement Plan showing the furniture configuration, of all furniture. Provide enlarged area plans with a key plan identifying the area in which the building is located. Key all the items on the drawings by furniture item code. Do not provide manufacturer specific information such as product names and numbers on drawings, Drawings shall be non-proprietary. This is typical for FFE on all plans, including those mentioned below.

1.2.2. Workstation Plans

Show each typical workstation configuration in plan view, elevations or isometric view. Drawings shall illustrate panels and all major components for each typical workstation configuration. Identify workstations using the same numbering system as shown on the project drawings. Key components to a legend on each sheet which identifies and describes the components along with dimensions. Provide the plan, elevations and isometric of each typical workstation together on the same drawing sheet.

1.2.3. Panel Plans

Show panel locations and critical dimensions from finished face of walls, columns, panels including clearances and aisle widths. Key panel assemblies to a legend which shall include width, height, configuration of frames, panel fabric and finishes (if there are different selections existing within a project), powered or non-powered panel and wall mount locations.

1.2.4. Desk Plans

Provide typical free standing desk configurations in plan view, elevation or isometric view and identify components to clearly represent each desk configuration.

1.2.5. Reflected Ceiling Plans

Provide typical plans showing ceiling finishes and heights, lighting fixtures, heating ventilation and air conditioning supply and return, and sprinkler head placement for coordination of furniture.

1.2.6. Electrical and Telecommunication Plans

Show power provisions including type and locations of feeder components, activated outlets and other electrical componentsShow locations and quantities of outlets for workstations. Clearly identify different outlets, i.e. electrical, LAN and telecommunication receptacles indicating each type proposed. Show wiring configuration, (circuiting, switching, internal and external connections) and provide as applicable.

1.2.7. Artwork Placement Plans

Provide an Artwork Placement Plan to show location of artwork, assign an artwork item code to each piece of artwork. As an alternative, artwork can be located on the Furniture Plans. Provide a schedule that identifies each piece by room name and number. Provide installation instructions; include mounting height.

1.2.8. Window Drapery Plans

Provide Interior Window Drapery Plans. Key each drapery treatment to a schedule showing color, pattern, material, drapery size and type, draw direction, location and quantities.

1.3. FURNITURE SELECTION

1.3.1. Select furniture from the GSA Schedules. Specify furniture available open market when an item is not available on the GSA Schedules. Provide justification fort items not available on the GSA Schedules.

1.3.2. To the greatest extent possible when specifying furniture work within a manufacturer's family of furniture for selections, example: Steelcase, Turnstone, Brayton International, Metro, and Vecta are all Steelcase companies. Each alternate should also be specified from a manufacturer's family of furniture, example: first set of alternates would be specified from Knoll's family of furniture and the second from Herman Miller family of furniture. It may be necessary to make some selections from other than a manufacturer's family of furniture if costs are not reasonable for particular items, some items are not available or appropriate for the facility or the items are not on GSA Schedule. If this occurs, consider specifying product from an open line that is accessible by numerous dealerships. Select office furniture including case goods, tables, storage, seating, etc. that is compatible in style, finish and color. Select furniture that complies with ANSI/BIFMA and from manufacturer's standard product line as shown in the most recent published price list and/or amendment and not custom product.

1.4. CONSTRUCTION

1.4.1. Provide knee space at workstations and tables that is not obstructed by panels/legs that interfere with knee space of seated person and provide desks, storage and tables with leveling devices to compensate for uneven floors.

1.4.2. Provide worksurface tops constructed to prevent warpage. Provide user friendly features such as radius edges. Do not use sharp edges and exposed connections and ensure the underside of desks, tables and worksurfaces are completely and smoothly finished. Provide abutting worksurfaces that mate closely and are of equal heights when used in side-by-side configurations in order to provide a continuous and level worksurface.

1.4.3. Drawers shall stay securely closed when in the closed position and protect wires from damage during drawer operation. Include a safety catch to prevent accidental removal when fully open

1.4.4. Unless otherwise noted, specify lockable desks and workstations and storage of steel construction. Use tempered glass glazing when glazing is required.

1.5. FINISHES AND UPHOLSTERY

1.5.1. Specify neutral colors for casegoods, furniture systems, storage and tables. Specify desk worksurfaces and table tops that are not too light or too dark in color and have a pattern to help hide soiling. Accent colors are allowed in break and lounge areas. Keep placement of furniture systems panel fabric accent colors to a minimum. All finishes shall be cleanable with ordinary household cleaning solutions.

1.5.2. Use manufacturer's standard fabrics; including textile manufacturers fabrics that have been graded into the furniture manufactures fabric grades and are available through their GSA Schedule. Customers Own Material

(COM) can be used in headquarter buildings in command suites with executive furniture. Coordinate specific locations with Corps of Engineers Interior Designer.

1.5.3. Specify seating upholstery that meets Wyzenbeek Abrasion Test, 55,000 minimum rubs. Specify a soil retardant finish for woven fabrics if Crypton or vinyl upholstery is not provided for seating in dining areas. Use manufacturer's standard fabrics. This includes textile manufacturers fabrics that have been graded into the furniture manufactures fabric grades and are available through their GSA Schedule. Specify upholstery and finish colors and patterns that help hide soiling. Specify finishes that can be cleaned with ordinary household cleaning solutions.

1.6. ACCESSORIES

1.6.1. Specify all accessories required for completely finished furniture installation. Provide filing cabinets and storage for office supplies. Provide tack surfaces at workstations with overhead storage. Provide tackable surfaces at workstations with overhead storage.

1.6.2. Not Used.

1.6.3. Workstations are to be equipped with stable keyboard trays that have height adjustability, tilting capability, including negative tilt, have a mouse pad at same height as the keyboard tray that can accommodate both left and right handed users, and retractable under worksurface.

1.7. MISSION UNIQUE EQUIPMENT

Funding for FF&E furniture items and mission unique equipment (MUE) items are from two different sources. Separate the designs and procurement documentation for FFE items and MUE. MUE includes, but is not limited to, items such as industrial shelving, workbenches, appliances, fitness equipment, IT equipment and supporting carts. The User will purchase and install mission unique equipment items, unless otherwise noted. Identify locations of known MUE items such as industrial shelving, workbenches, appliances, etc. for space planning purposes.

1.8. SUSTAINABILITY

1.8.1. For all designs provided regardless of facility type, make every effort to implement all aspects of sustainability to the greatest extent possible for all the selections made in the FF&E package. This includes but is not limited to the selection of products that consider: **Material Chemistry and Safety of Inputs** (What chemicals are used in the construction of the selections?); **Recyclability** (Do the selections contain recycled content?); **Disassembly** (Can the selections be disassembled at the end of their useful life to recycle their materials?).

1.8.2. Make selections to the greatest extent possible of products that possess current McDonough Braungart Design Chemistry (MBDC) certification or other "third-party" certified Cradle to Cradle program, Forest Stewardship Council (FSC) certification, GREENGAURD certification or similar "third-party" certified products consisting of low-emitting materials.

1.9. FURNITURE SYSTEMS

1.9.1. General.

Where appropriate, design furniture systems in open office areas. Coordinate style and color of furniture systems with other storage, seating, etc. in open office areas. Minimize the number of workstation typicals and the parts and pieces required for the design to assist in future reconfiguration and inventorying.

1.9.2. Connector Systems.

Specify a connector system that allows removal of a single panel or spine wall within a typical workstation configuration without requiring disassembly of the workstation or removal of adjacent panels. Specify connector system with tight connections and continuous visual seals. When Acoustical panels are used, provide connector system with continuous acoustical seals. Specify concealed clips, screws, and other construction elements, where possible.

1.9.3. Panels and Spine Walls

Specify panels and spine walls with hinged or removable covers that permit easy access to the raceway when required but are securely mounted and cannot be accidentally dislodged under normal conditions. Panels shall be capable of structurally supporting more than 1 fully loaded component per panel per side. Raceways are to be an integral part of the panel and must be able to support lay-in cabling and have a large capacity for electrical and IT. Do not thread cables through the frame.

1.9.4. Electrical And Information/Technology (IT)

Design furniture with electrical systems that meets requirements of UL 1286 when powered panels are required and UL approved task lights that meet requirements of NFPA 70. Dependent on user requirements and Section 01 10 00, paragraph 3 requirements, it is recommended that workstation electrical and IT wiring entry come from the building walls to eliminate the use of power poles and access at the floor. Design electrical and IT systems that are easily accessed in the spine wall and panels without having to move return panels and components. Electrical and IT management will be easily accessible by removable wall covers which can be removed while workstation components are still attached. Specify connector system that has continuation of electrical and IT wiring within workstations and workstation to workstation.

1.9.5. Pedestals

Specify pedestals that are interchangeable from left to right, and right to left, and retain pedestal locking system capability.

1.10. EXECUTIVE FURNITURE

1.10.1. Design for executive furniture in command areas, coordinate specific locations with Corps of Engineers Interior Designer. Use upgraded furniture, upholsteries and finishes in command suites. This includes but is not limited to wood casegoods, seating and tables. Select executive furniture casegoods from a single manufacturer and style line, to include workstations, credenzas, filing, and storage, etc.

1.10.2. Specify furniture with wood veneer finish (except worksurfaces) with mitered solid wood edge of same wood type. Provide worksurface plastic laminate that closely matches adjacent wood veneer. Other executive office furniture such as seating, tables, executive conference room furniture, etc. shall be compatible in style, finish and color with executive furniture casegoods.

1.11. SEATING

1.11.1. General

Specify appropriate chair casters and glides for the floor finish where the seating is located. Universal casters that are appropriate for both hard surface flooring and carpet are preferred. All seating shall support up to a minimum of 250 lbs.

1.11.2. Desk and Guest Seating

Select ergonomic desk chairs with casters, non-upholstered adjustable arms, waterfall front, swivel, tilt, variable back lock, adjustable back height or adjustable lumbar support, pneumatic seat height adjustment, and padded, contoured upholstered seat and back. Desk and guest chair backs may be other than upholstered such as mesh fabric if it is ergonomically designed, forms to back and is comfortable. Depending on scale of desk chair provide seat pan forward and back adjustment to increase or decrease depth of seat pan. All desk chairs shall have an adjustable seat height range of 4 1/2", range to include 16 1/2-20". Select guest chairs that are compatible in style, finish and color with the desk chairs.

1.11.3. Conference Room Seating

At tables, select ergonomic conference seating with casters, non-upholstered arms, waterfall front, swivel, tilt, pneumatic seat height adjustment, and padded, contoured seat and back, unless otherwise noted. Select arm height and/or design that allows seating to be moved up closely to the table top. Conference chair backs may be other than upholstered such as mesh fabric if it is ergonomically designed, forms to back and is comfortable. Perimeter conference chairs shall be compatible in style, finish and color with conference seating at the tables.

1.11.4. Lounge, Waiting and Reception Area Seating

Select seating with arms and cushioned, upholstered seat and back. In heavy use areas, arms shall be easily cleaned such as non-upholstered arms or upholstered arms with wood arm caps unless otherwise noted.

1.11.5. Break Room Seating

Select stackable seating that is easily cleaned. Seating shall be appropriate for table and counter heights as applicable with non-upholstered arms if arms are required. Chairs shall have metal legs and composite materials for seats.

1.11.6. Lounge, Waiting and Reception Furniture.

Design for end and coffee tables with plastic laminate tops that are compatible in style finish and color with the seating.

1.12. FILING AND STORAGE.

Select storage and shelving units that meet customer's functional load requirements for stored items. Specify counterweights for filing cabinets when required by the manufacturer for stability. File drawers shall allow only one drawer to be opened at a time. Provide heavy duty storage and shelving if information is not available.

1.13. TRAINING TABLES.

Don't use plastic laminate self edge. Training tables shall be reconfigurable, moveable and storable; lighter weight folding with dollies or castered as necessary. Specify dollies if required.

1.14. FURNITURE WARRANTIES.

Specify manufacturer's performance guarantees or warranties that include parts, labor and transportation as follows:

Furniture System, unless otherwise noted – 10 year minimum
Furniture System Task Lights – 2 year minimum, excluding bulbs
Furniture System Fabric – 3 year minimum
Desks - 10 year minimum
Seating, unless otherwise noted - 10 year minimum
Seating Mechanisms and Pneumatic Cylinders - 10 years
Fabric - 3 years minimum
Filing and Storage - 10 year minimum
Tables, unless otherwise noted - 10 year minimum
Table Mechanisms – 5 year
Table Ganging Device - 1 year
Items not listed above - 1 year minimum

ATTACHMENT C
TRACKING COMMENTS IN DRCHECKS

1.0 General

The Government and DB Contractor shall set up the project in Dr Checks. Throughout the design process, the parties shall enter, track, and back-check comments using the DrChecks system. Government reviewers enter design review comments into DrChecks. Designers of Record shall annotate comments timely and specifically to indicate exactly what action will be taken or why the action is not required. Comments considered critical by the conference participants shall be flagged as such.

2.0 DrChecks Review Comments

The Contractor and the Government shall monitor DrChecks to assure all comments are annotated and agreed to by the designers and reviewers prior to the next submittal. The DrChecks comments and responses shall be printed and included in the design analysis for record.

2.1. Conference participants (reviewers) will expect coordination between Design Analysis calculations and the submitted design. Reviewers will also focus on the design submittal's satisfaction of the contract requirements.

2.2. The Designers of Record shall answer each comment in DrChecks with a formal response prior to the next submittal, clearly indicating what action will be taken and what drawing/spec will change. Designers of Record are encouraged to directly contact reviewers to discuss and agree to the formal comment responses rather than relying only on DrChecks and review meetings to discuss comments. With the next design conference, reviewers will back-check answers to the comments against the submittal, in addition to reviewing additional design work.

2.3. Comments that, in the DB Contractor's opinion, require effort outside the scope of the contract shall be clearly indicated as such in DrChecks. The DB Contractor shall not proceed with work outside the contract until a modification to the contract is properly executed, if one is necessary.

3.0 DrChecks Initial Account Set-Up

To initialize an office's use of DrChecks, choose a contact person within the office to call the DrChecks Help Desk at 800-428-HELP, M-F, 8AM-5PM, Central time. This POC will be given an office password to distribute to others in the office. Individuals can then go to the hyperlink at http://www.projnet.org and register as a first time user. Upon registration, each user will be given a personal password to the DrChecks system.

3.1. Once the office and individuals are registered, the COE's project manager or lead reviewer will assign the individuals and/or offices to the specific project for review. At this point, persons assigned can make comments, annotate comments, and close comments, depending on their particular assignment.

4.0 DrChecks Reviewer Role

The Contractor is the technical reviewer and the Government is the compliance reviewer of the DB designers design documents. Each reviewer enters their own comments into the Dr Checks system. To enter comments:

4.1. Log into DrChecks.

4.2. Click on the appropriate project.

4.3. Click on the appropriate review conference. An Add comment screen will appear.

4.4. Select or fill out the appropriate sections (particularly comment discipline and type of document for sorting) of the comment form and enter the comment in the space provided.

4.5. Click the Add Comment button. The comment will be added to the database and a fresh screen will appear for the next comment you have.

4.6. Once comments are all entered, exit DrChecks by choosing “My Account” and then Logout.

5.0 DrChecks Comment Evaluation

The role of the designers of record is to evaluate and respond to the comments entered by the Government reviewers and by the DB Contractor. To respond to comments:

5.1. Log into DrChecks.

5.2. Click on the appropriate project.

5.3. Under “Evaluate” click on the number under “Pending”.

5.4. Locate the comments that require your evaluation. (Note: If you know the comment number you can use the Quick Pick window on your home page in DrChecks; enter the number and click on go.)

5.5. Select the appropriate evaluation (concur, non-concur, for information only, or check and resolve) and add the response.

5.6. Click on the Add button. The evaluation will be added to the database and a fresh screen will appear with the next comment.

5.7. Once evaluations are all entered, exit DrChecks by choosing “My Account” and then Logout.

6.0 DrChecks Back-check

At the following design conference, participants will back-check comment annotations against newly presented documents to verify that the designers' responses are acceptable and completed. The Contractor and Government reviewers shall either enter additional back-check comments, as necessary or close those that are resolved as a result of the design conferences:

6.1. Log into DrChecks.

6.2. Click on the appropriate project.

6.3. Under “My Backcheck” click on the number under “Pending”.

6.4. If you agree with the designer’s response select “Close Comment” and add a closing response if desired.

6.5. If you do not agree with the designer’s response or the submittal does not reflect the response given, select “Issue Open”, enter additional information.

6.6. Click on the Add button. The back-check will be added to the database and a fresh screen will appear with the next comment.

6.7. Once back-checks are all entered, exit DrChecks by choosing “My Account” and then Logout. The design is completed and final when there are no pending comments to be evaluated and there are no pending or open comments under back-check.

ATTACHMENT D
SAMPLE FIRE PROTECTION AND LIFE SAFETY CODE REVIEW

Instructions: Use the information outlined in this document to provide the minimum requirement for development of Fire Protection and Life Safety Code submittals for all building projects. Additional and supplemental information may be used to further develop the code review. Insert N/A after criteria, which may be “not applicable”.

1.0 SAMPLE FIRE PROTECTION AND LIFE SAFETY CODE REVIEW

1.1. Project Name (insert name and location)

1.2. Applicable Codes and Standards

1.2.1. Unified Facilities Criteria (UFC): 3-600-01, Design: Fire Protection Engineering For Facilities

1.2.2. International Building Code (IBC) for fire resistance requirements, allowable floor area, building height limitations and building separation distance requirements, except as modified by UFC 3-600-01.

1.2.3. National Fire Protection Association (NFPA) 101 Life Safety Code (latest edition), for building egress and life safety and applicable criteria in UFC 3-600-01.

1.2.4. ADA and ABA Accessiblity Guidelines. For Buildings and Facilities See Section 01 10 00, Paragraph 3 for facility specific criteria.

1.3. Occupancy Classification
IBC chapters 3 and 4

1.4. Construction Type
IBC chapter 6

1.5. Area Limitations
IBC chapter 5, table 503

1.6. Allowable Floor Areas
IBC section 503, 505

1.7. Allowable area increases
IBC section 506, 507

1.8. Maximum Height of Buildings
IBC section 504

1.9. Fire-resistive substitution

1.10. Occupancy Separations
IBC table 302.3.2

1.11. Fire Resistive Requirements

1.11.1. Exterior Walls - [_____] hour rating, IBC table 601, 602

1.11.2. Interior Bearing walls - [_____] hour rating

1.11.3. Structural frame - [_____] hour rating

1.11.4. Permanent partitions - [_____] hour rating

1.11.5. Shaft enclosures - [_____] hour rating

1.11.6. Floors & Floor-Ceilings - [_____] hour rating

1.11.7. Roofs and Roof Ceilings - [_____] hour rating

1.12. Automatic Sprinklers and others used to determine the need for automatic Extinguishing Equipment, Extinguishing Systems, Foam Systems, Standpipe

1.12.1. UFC 3-600-01, chapters 4 and 6 systems, wet chemical systems, etc. State which systems are required and to what criteria they will be designed.

1.12.2. UFC 3-600-01, Appendix B Occupancy Classification. Note the classification for each room. This may be accomplished by classifying the entire building and noting exceptions for rooms that differ (E.g. The entire building is Light Hazard except boiler room and storage rooms which are [_____], etc.)

1.12.3. UFC 3-600-01, Chapter 3 Sprinkler Design Density, Sprinkler Design Area, Water Demand for Hose Streams (supply pressure and source requirements).

1.12.4. UFC 3-600-01, Chapter 4 Coverage per sprinkler head. Extended coverage sprinkler heads are not permitted.

1.12.5. Available Water Supply. Provide the results of the water flow tests showing the available water supply static pressure and residual pressure at flow. Based on this data and the estimated flow and pressure required for the sprinkler system, determine the need for a fire pump.

1.12.6. NFPA 13, Para. 8.16.4.6.1. Provide backflow preventer valves as required by the local municipality, authority, or water purveyor. Provide a test valve located downstream of the backflow preventer for flow testing the backflow preventer at full system demand flow. Route the discharge to an appropriate location outside the building.

1.13. Kitchen Cooking Exhaust Equipment

Describe when kitchen cooking exhaust equipment is provided for the project. Type of extinguishing systems for the equipment should be provided. per NFPA 96. Show all interlocks with manual release switches, fuel shutoff valves, electrical shunt trips, exhaust fans, and building alarms.

1.14. Portable Fire Extinguishers, fire classification and travel distance. per NFPA 10

1.15. Enclosure Protection and Penetration Requirements. - Opening Protectives and Through Penetrations

1.15.1. IBC Section712, 715 and Table 715.3. Mechanical rooms, exit stairways, storage rooms, janitor [_____] hour rating. IBC Table 302.1.1

1.15.2. Fire Blocks, Draft Stops, Through Penetrations and Opening Protectives

1.16. Fire Dampers. Describe where fire dampers and smoke dampers are to be used (IBC Section 716 and NFPA 90A}. State whether isolation smoke dampers are required at the air handler.

1.17. Detection Alarm and Communication. UFC 3-600-01, (Chapter 5); NFPA 101 para. 3.4 (chapters 12-42); NFPA 72

1.18. Mass Notification. Describe building/facility mass notification system (UFC 4-021-01) type and type of base-wide mass notification/communication system. State whether the visible notification appliances will be combined with the fire alarm system or kept separate. (Note: Navy has taken position to combine visible notification appliances with fire alarm).

1.19. Interior Finishes (classification). NFPA 101.10.2.3 and NFPA 101.7.1.4

1.20. Means of Egress

1.20.1. Separation of Means of Egress, NFPA 101 chapters 7 and 12-42; NFPA101.7.1.3

1.20.2. Occupant Load, NFPA101.7.3.1 and chapters 12-42.

1.20.3. Egress Capacity (stairs, corridors, ramps and doors) NFPA101.7.3.3

1.20.4. Number of Means of Egress, NFPA101.7.4 and chapters 12-42.

1.20.5. Dead end limits and Common Path of Travel, NFPA 101.7.5.1.6 and chapters 12-42.

1.20.6. Accessible Means of Egress (for accessible buildings), NFPA101.7.5.4

1.20.7. Measurement of Travel Distance to Exits, NFPA101.7.6 and chapters 12-42.

1.20.8. Discharge from Exits, NFPA101.7.7.2

1.20.9. Illumination of Means of Egress, NFPA101.7.8

1.20.10. Emergency Lighting, NFPA101.7.9

1.20.11. Marking of Means of Egress, NFPA101.7.10

1.21. Elevators, UFC 3-600-01, Chapter 6; IBC and ASME A17.1 - 2000,(Safety Code for Elevators and Escalators)

1.22. Accessibility Requirements, ADA and ABA Accessibility Guidelines for Buildings and Facilities

1.23. Certification of Fire Protection and Life Safety Code Requirements. (Note: Edit the Fire team membership if necessary). Preparers of this document certify the accuracy and completeness of the Fire Protection and Life Safety features for this project in accordance with the attached completed form(s).

1.24. Designer of Record. Certification of Fire protection and Life Safety Code Requirements. (Note: Edit the Fire team members if necessary). Preparers of this document certify the accuracy and completeness of the Fire Protection and Life Safety features of this project.

Fire Protection Engineer of Record:

_____

Signature and Stamp

Date

OR

Architect of Record:

_____

Signature and Stamp

Date

Mechanical Engineer of Record:

_____

Signature and Stamp

Date

Electrical Engineer of Record:

_____

Signature/Date

ATTACHMENT E
LEED SUBMITTALS

LEED Credit Paragraph	Contractor Check Here if Credit is Claimed	**LEED-NC v3 Submittals (OCT09)**		Provide for Credit Audit Only		Date Submitted (to be filled in by Contractor)	Government Reviewer's Use
PAR		**FEATURE**	**DUE AT**		**REQUIRED DOCUMENTATION**	**DATE**	**REV**
GENERAL							
	GENERAL - All calculations shall be in accordance with LEED 2009 Reference Guide.						
	GENERAL: Obtain excel version of this spreadsheet at http://en.sas.usace.army.mil/enWeb, "Engineering Criteria".						
	GENERAL - For all credits, narrative/comments may be added to describe special circumstances or considerations regarding the project's credit approach.						
	GENERAL - Include all required LEED drawings indicated below in contract drawings with applicable discipline drawings, labeled For Reference Only.						
	NOTE: Each submittal indicated with "**" differs from LEED certified project submittals by either having a different due date or being an added submittal not required by GBCI.						
	NOTE: Projects seeking LEED certification need only submit to GBCI whatever documentation is acceptable to GBCI (for example, licensed professional certifications). This checklist identifies what must be submitted to the Government for internal review purposes. Government review of LEED documentation in no way supercedes or modifies the requirements and rulings of of GBCI for purposes of compliance with project requirement to obtain LEED certifiaction.						
	GENERAL - Audit documentation may include but is not limited to what is indicated in this table.						
			Closeout		List of all Final Design submittals revised after final design to reflect actual closeout conditions. Revised Final Design submittals. - OR - Statement confirming that no changes have been made since final design that effect final design submittal documents.		Proj Engr (PE)
CATEGORY 1 - SUSTAINABLE SITES							
SSPR1		Construction Activity Pollution Prevention (PREREQUISITE)	**Final Design		List of drawings and specifications that address the erosion control, particulate/dust control and sedimentation control measures to be implemented.		CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
			**Final Design		Narrative that indicates which compliance path was used (NPDES or Local standards) and describes the measures to be implemented on the project. If a local standard was followed, provide specific information to demonstrate that the local standard is equal to or more stringent than the NPDES program.		CIV
SS1		Site Selection	Final Design		Statement confirming that project does not meet any of the prohibited criteria.		CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
			Final Design	X	LEED Site plan drawing that shows all proposed development, line depicting boundary of all bodies of water and/or wetlands within 100 feet of project boundary and a line depicting 5' elevation above 100 year flood line that falls within project boundary. Not required if neither condition applies.		CIV
SS2		Development Density & Community Connectivity	Final Design		Option 1: LEED Site vicinity plan showing project site and surrounding development. Show density boundary or note drawing scale.		CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
			Final Design		Option 1: Table indicating, for project site and all surrounding sites within density radius (keyed to site vicinity plan), site area and building area. Project development density calculation. Density radius calculation. Development density calculation within density radius.		CIV
			Final Design		Option 2: LEED Site vicinity plan showing project site, the 1/2 mile community radius, pedestrian walkways and the locations of the residential development(s) and Basic Services surrounding the project site.		CIV
			Final Design		Option 2: List (including business name and type) of all Basic Services facilities within the 1/2 mile radius, keyed to site vicinity plan.		CIV
SS3		Brownfield Redevelopment	Final Design		Narrative describing contamination and the remediation activities included in project. Include statement indicating how site was determined to be a brownfield.		CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
SS4.1		Alternative Transportation: Public Transportation Access	Final Design		Statement indicating which option for compliance applies. State whether public transportation is existing or proposed and, if proposed, cite source of this information.		CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
			Final Design		Option 1: LEED Site vicinity plan showing project site, mass transit stops and pedestrian path to them with path distance noted.		CIV
			Final Design		Option 2: LEED Site vicinity plan showing project site, bus stops and pedestrian path to them with path distance noted.		CIV
SS4.2		Alternative Transportation: Bicycle Storage & Changing Rooms	Final Design		FTE calculation. Bicycle storage spaces calculation. Shower/changing facilities calculation.		CIV
			Final Design		List of drawings that show the location(s) of bicycle storage areas. Statement indicating distance from building entrance.		CIV
			Final Design		List of drawings that show the location(s) of shower/changing facilities and, if located outside the buiding, statement indicating distance from building entrance.		CIV

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PAR		**FEATURE**	**DUE AT**		**REQUIRED DOCUMENTATION**	**DATE**	**REV**
SS4.3		Alternative Transportation: Low Emitting & Fuel Efficient Vehicles	Final Design		Statement indicating which option for compliance applies. FTE calculation. Statement indicating total parking capacity of site.		CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
			Final Design		Option 1: Low-emission & fuel-efficient vehicle calculation.		CIV
			Final Design		Option 1: List of drawings and specification references that show location and number of preferred parking spaces for low-emission & fuel-efficient vehicles and signage.		CIV
			Final Design		Option 1: Statement indicating quantity, make, model and manufacturer of low-emission & fuel-efficient vehicles to be provided. Statement confirming vehicles are zero-emission or indicating ACEEE vehicle scores.		CIV
			Final Design		Option 2: Low-emission & fuel-efficient vehicle parking calculation.		CIV
			Final Design		Option 2: List of drawings and specification references that show location and number of preferred parking spaces and signage.		CIV
			Final Design		Option 3: Low-emission & fuel-efficient vehicle refueling station calculation.		CIV
			Final Design		Option 3: List of drawings and specifications indicating location and number of refueling stations, fuel type and fueling capacity for each station for an 8-hour period.		CIV
			Closeout	X	Option 3: Construction product submittals indicating what was provided and confirming compliance with respect to fuel type and fueling capacity for each station for an 8-hour period.		CIV
SS4.4		Alternative Transportation: Parking Capacity	Final Design		Statement indicating which option for compliance applies.		CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
			Final Design		Option 1: Preferred parking calculation including number of spaces required, total provided, preferred spaces provided and percentage.		CIV
			Final Design		Option 2: FTE calculation. Preferred parking calculation including number of spaces provided, preferred spaces provided and percentage.		CIV
			Final Design		Options 1 and 2: List of drawings and specification references that show location and number of preferred parking spaces and signage.		CIV
			Final Design		Option 3: Narrative indicating number of spaces required and provided and describing infrastructure and support programs with description of project features to support them.		CIV
SS5.1		Site Development: Protect or Restore Habitat	**Final Design		Option 1: List of drawing and specification references that convey site disturbance limits.		CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
			**Final Design		Option 2: LEED site plan drawing that delineates boundaries of each preserved and restored habitat area with area (sf) noted for each.		CIV
			**Final Design		Option 2: Percentage calculation of restored/preserved habitat to total site area. List of drawings and specification references that convey restoration planting requirements.		CIV
SS5.2		Site Development: Maximize Open Space	Final Design		Option 2: LEED site plan drawing delineating boundary of vegetated open space adjacent to building with areas of building footprint and designated open space noted.		CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
SS6.1		Stormwater Design: Quantity Control	Final Design		Statement indicating which option for compliance applies.		CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
			Final Design		Option 1: Indicate pre-development and post-development runoff rate(cfs) and runoff quantity (cf) -OR - Narrative describing site conditions, measures and controls to be implemented to prevent excessive stream velocities and erosion.		CIV
			Final Design		Option 2: Indicate pre-development and post-development runoff rate(cfs) and runoff quantity (cf). Indicate percent reduction in each.		CIV
SS6.2		Stormwater Design: Quality Control	Final Design		For non-structural controls, list all BMPs used and, for each, describe the function of the BMP and indicate the percent annual rainfall treated. List all structural controls and, for each, describe the pollutant removal and indicate the percent annual rainfall treated.		CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
SS7.1		Heat Island Effect: Non-Roof	**Final Design		LEED site plan drawing indicating locations and quantities of each paving type, including areas of shaded pavement. Percentage calculation indicating percentage of reflective/shaded/open grid area.		CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.		CIV

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PAR		**FEATURE**	**DUE AT**		**REQUIRED DOCUMENTATION**	**DATE**	**REV**
SS7.2		Heat Island Effect: Roof	Final Design		Option 1: Percentage calculation indicating percentage of SRI compliant roof area. List of drawings and specification references that convey SRI requirements and roof slopes.		ARC
			Final Design		Option 1: List of specified roof materials indicating, for each, type, manufacturer, product name and identification if known, SRI value and roof slope.		ARC
			**Closeout		Option 1: List of installed roof materials indicating, for each, manufacturer, product name and identification, SRI value and roof slope.		PE
			Closeout	X	Option 1: Manufacturer published product data or certification confirming SRI		PE
			Final Design		Option 2: Percentage calculation indicating percentage of vegetated roof area.		ARC
			Final Design		Option 3: Combined reflective and green roof calculation.		ARC
			Final Design		Option 3: List of specified roof materials indicating, for each, type, manufacturer, product name and identification if known, SRI value and roof slope.		ARC
			**Closeout		Option 3: List of installed roof materials indicating, for each, manufacturer, product name and identification, SRI value and roof slope.		PE
			Closeout	X	Option 3: Manufacturer published product data or certification confirming SRI		PE
SS8		Light Pollution Reduction	Final Design		Interior Lighting: List of drawings and specification references that convey interior lighting requirements (location and type of all installed interior lighting, location of non-opaque exterior envelope surfaces, allowing confirmation that maximum candela value from interiorfixtures does not intersect non-opaque building envelope surfaces). - OR - List of drawings and specification references that show automatic lighting controls compliance with credit requirement.		ELEC
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.		ELEC
			Final Design		Exterior Lighting: List of drawings and specification references that convey exterior lighting requirements (location and type of all site lighting and building façade/landscape lighting).		ELEC
			Final Design		Exterior Site Lighting Power Density (LPD): Tabulation for exterior site lighting indicating, for each location identification or description, units of measure, area or distance of the location, actual LPD using units consistent with ASHRAE 90.1, and the ASHRAE allowable LPD for that type of location. Percentage calculation of actual versus allowable LPD for all site lighting.		ELEC
			Final Design		Exterior Building Facade/Landscape Lighting Power Density (LPD): Tabulation for exterior building facade/landscape lighting indicating, for each location identification or description, units of measure, area or distance of the location, actual LPD using units consistent with ASHRAE 90.1, and the ASHRAE allowable LPD for that type of location. Percentage calculation of actual versus allowable LPD for all building facade/landscape lighting.		ELEC
			Final Design		Exterior Lighting IESNA Zone: Indicate which IESNA zone is applicable to the project.		ELEC
			Final Design		Exterior Lighting Site Lumen table indicating, for each fixture type, quantity installed, initial lamp lumens per luminaire, initial lamp lumens above 90 degrees from Nadir, total lamp lumens and total lamp lumens above 90 degrees. Percentage of site lamp lumens above 90 degrees from nadir to total lamp lumens.		ELEC
			Final Design		Exterior Lighting Narrative describing analysis used for addressing requirements for light trespass at site boundary and beyond.		ELEC
CATEGORY 2 – WATER EFFICIENCY							
WEPR1		Water Use Reduction: 20% Reduction	Final Design		Statement confirming which occupancy breakdown applies (default or special). For special occupancy breakdown, indicate source and explanation for ratio.		MEC
			Final Design		Occupancy calculation including male/female numbers for FTEs, visitors, students, customers, residential and other type occupants/users		MEC
			Final Design		Statement indicating percent of male restrooms with urinals. Statement indicating annual days of operation.		MEC

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			Final Design		Baseline flush fixture calculation spreadsheet indicating, for each fixture type, gender, flush rate, daily uses per person for each occupant type identified in occupancy calculation and annual baseline flush fixture water usage.		MEC
			Final Design		Design case flush fixture calculation spreadsheet indicating, for each fixture type, gender, fixture manufacturer, fixture model number, flush rate, percent of occupants using this fixture type, daily uses per person for each occupant type identified in occupancy calculation and annual design case flush fixture water usage.		MEC
			Closeout	X	Manufacturer published product data or certification confirming fixture water usage.		PE
WE1.1		Water Efficient Landscaping: Reduce by 50%	Final Design		Statement indicating which option for compliance applies.		CIV
			**Final Design		Delineation and labeling of "LEED Project site boundary" on site plan.		CIV
			Final Design		Calculation indicating, for baseline and design case, total water applied, total potable water applied, total non-potable water applied. Design case percent potable water reduction. If nonpotable water is used, indicate source of nonpotable water.		CIV
			Final Design		List of landscape plan drawings.		CIV
			Final Design		Narrative describing landscaping and irrigation design strategies, including water use calculation methodology used to determine savings and, if non-potable water is used, specific information about source and available quantity.		CIV
WE1.2		Water Efficient Landscaping: No Potable Water Use or No Irrigation	Same as WE1.1		Same as WE1.1		CIV
WE2		Innovative Wastewater Technologies	Final Design		Statement confirming which option for compliance applies.		MEC
			Final Design		Statement confirming which occupancy breakdown applies (default or special). For special occupancy breakdown, indicate source and explanation for ratio.		MEC
			Final Design		Occupancy calculation including male/female numbers for FTEs, visitors, students, customers, residential and other type occupants/users		MEC
			Final Design		Statement indicating percent of male restrooms with urinals. Statement indicating annual days of operation.		MEC
			Final Design		Baseline flush fixture calculation spreadsheet indicating, for each fixture type, gender, flush rate, daily uses per person for each occupant type identified in occupancy calculation and annual baseline flush fixture water usage.		MEC
			Final Design		Design case flush fixture calculation spreadsheet indicating, for each fixture type, gender, fixture manufacturer, fixture model number, flush rate, percent of occupants using this fixture type, daily uses per person for each occupant type identified in occupancy calculation and annual design case flush fixture water usage.		MEC
			Final Design		Option 1: If onsite non-potable water is used, identify source(s), indicate annual quantity from each source and indicate total annual quantity from all onsite non-potable water sources.		MEC
			Final Design		Option 1: Summary calculation indicating baseline annual water consumption, design case annual water consumption, non-potable annual water consumption and total percentage annual water savings.		MEC
			Final Design		Option 2: Statement confirming on-site treatment of all generated wastewater to tertiary standards and all treated wastewater is either infiltrated or used on-site.		MEC
			Final Design		Option 2: List of drawing and specification references that convey design of on-site wastewater treatment features.		CIV
			Final Design		Option 2: On-site water treatment quantity calculation indicating all on-site wastewater source(s), annual quantity treated, annual quantity infiltrated and annual quantity re-used on site from each source and totals for annual quantity treated, annual quantity infiltrated and annual quantity re-used on site from all sources.		CIV
			Final Design		Option 2: Wastewater summary calculation indicating design case annual flush fixture water usage, annual on-site water treatment and percentage sewage convyance reduction.		MEC
			Final Design		Narrative describing project strategy for reduction of potable water use for sewage conveyance, including specific information on reclaimed water usage and treated wastewater usage.		MEC
WE3		Water Use Reduction: 30% - 40% Reduction	Same as WEPR1		Same as WEPR1		MEC
CATEGORY 3 – ENERGY AND ATMOSPHERE							

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EAPR1		Fundamental Commissioning of the Building Energy Systems (PREREQUISITE)	**Final Design		**Owner's Project Requirements document		ALL
			**Final Design		**Basis of Design document for commissioned systems		MEC, ELEC
			**Final Design		**Commissioning Plan		MEC, ELEC
			Closeout		Statement confirming all commissioning requirements have been incorporated into construction documents.		PE
			Closeout		Commissioning Report		PE
EAPR2		Minimum Energy Performance (PREREQUISITE)	Final Design		Statement listing the mandatory provisions of ASHRAE 90.1 that project meets relative to compliance with this prerequisite and indicating which compliance path was used.		MEC ELEC ARC
			Final Design		Statement indicating which compliance path option applies.		MEC
			Final Design		Option 1: Statement confirming simulation software capabilities and confirming assumptions and methodology.		MEC
			Final Design		Option 1: General information including simulation program, principal heating source, percent new construction and renovation, weather file, climate zone and Energy Star Target Finder score.		MEC
			Final Design		Option 1: Space summary listing, for each building use, the conditioned area, unconditioned area and total area and include total area for each category		MEC
			Final Design		Option 1: List of all simulation output advisory message data and show difference between baseline and proposed design		MEC
			Final Design		Option 1: Comparison summary for energy model inputs including description of baseline and design case energy model inputs, showing both by element type		MEC
			Final Design		Option 1: Energy type summary lising, for each energy type, utility rate description, units of energy and units of demand		MEC
			Final Design		Option 1: Statement indicating whether project uses on-site renewable energy. If yes, list all sources and indicate, for each source, backup energy type, annual energy generated, rated capacity and renewable energy cost		MEC
			Final Design		Option 1: If analysis includes exceptional calculation methods, statement describing how exceptional calculation measure cost savings is determined		MEC
			Final Design		Option 1: If analysis includes exceptional calculation methods, for each exceptional calculation method indicate energy types and, for each energy type, annual energy savings, annual cost savings, and brief descriptive narrative		MEC
			Final Design		Option 1: Baseline performance rating compliance report table indicating, for each energy end use, whether it is a process load, energy type, annual and peak energy demand for all four orientations. For each orientation indicate total annual energy use for each orientation and total annual process energy use.		MEC
			Final Design		Option 1: Baseline energy cost table indicating, for each energy type, annual cost for all four orientations and building total energy cost.		MEC
			Final Design		Option 1: Proposed Design performance rating compliance report table indicating, for each energy end use, whether it is a process load, energy type, annual and peak energy demand, baseline annual and peak energy demand and percent savings. Indicate total annual energy use and total annual process energy use for both proposed design and baseline and percent savings.		MEC
			Final Design		Option 1: Proposed Design energy cost table indicating, for each energy type, annual cost for all four orientations and building total energy cost.		MEC
			Final Design		Option 1: Energy cost and consumption by energy type report indicating, for each energy type, proposed design and baseline annual use and annual cost, percent savings annual use and annual cost. Indicate for renewable energy annual energy generated and annual cost. Indicate exceptional calculations annual energy savings and annual cost savings. Indicate building total annual energy use, annual energy cost for proposed design and baseline and indicate percent savings annual energy use and annual energy cost.		MEC

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			Final Design		Option 1: Compliance summaries from energy simulation software. If software does not produce compliance summaries provide output summaries and example input summaries for baseline and proposed design supporting data in the tables. Output summaries must include simulated energy consumption by end use and total energy use and cost by energy type. Example input summaries should represent most common systems and must include occupancy, use pattern, assumed envelope component sizes and descriptive features and assumed mechanical equipment types and descriptive features		MEC
			Final Design		Option 1: Energy rate tariff from project energy providers (only if not using LEED Reference Guide default rates)		MEC
EAPR3		Fundamental Refrigerant Management (PREREQUISITE)	Final Design		Statement indicating which option for compliance applies.		MEC
			Final Design		Option 2: Narrative describing phase out plan, including specific information on phase out dates and refrigerant quantities.		MEC
EA1		Optimize Energy Performance	Final Design		Statement indicating which compliance path option applies.		MEC
			Final Design		Option 1: Statement confirming simulation software capabilities and confirming assumptions and methodology.		MEC
			Final Design		Option 1: General information including simulation program, principal heating source, percent new construction and renovation, weather file, climate zone and Energy Star Target Finder score.		MEC
			Final Design		Option 1: Space summary listing, for each building use, the conditioned area, unconditioned area and total area and include total area for each category		MEC
			Final Design		Option 1: List of all simulation output advisory message data and show difference between baseline and proposed design		MEC
			Final Design		Option 1: Comparison summary for energy model inputs including description of baseline and design case energy model inputs, showing both by element type		MEC
			Final Design		Option 1: Energy type summary lising, for each energy type, utility rate description, units of energy and units of demand		MEC
			Final Design		Option 1: Statement indicating whether project uses on-site renewable energy. If yes, list all sources and indicate, for each source, backup energy type, annual energy generated, rated capacity and renewable energy cost		MEC
			Final Design		Option 1: If analysis includes exceptional calculation methods, statement describing how exceptional calculation measure cost savings is determined		MEC
			Final Design		Option 1: If analysis includes exceptional calculation methods, for each exceptional calculation method indicate energy types and, for each energy type, annual energy savings, annual cost savings, and brief descriptive narrative		MEC
			Final Design		Option 1: Baseline performance rating compliance report table indicating, for each energy end use, whether it is a process load, energy type, annual and peak energy demand for all four orientations. For each orientation indicate total annual energy use for each orientation and total annual process energy use.		MEC
			Final Design		Option 1: Baseline energy cost table indicating, for each energy type, annual cost for all four orientations and building total energy cost.		MEC
			Final Design		Option 1: Proposed Design performance rating compliance report table indicating, for each energy end use, whether it is a process load, energy type, annual and peak energy demand, baseline annual and peak energy demand and percent savings. Indicate total annual energy use and total annual process energy use for both proposed design and baseline and percent savings.		MEC
			Final Design		Option 1: Proposed Design energy cost table indicating, for each energy type, annual cost for all four orientations and building total energy cost.		MEC
			Final Design		Option 1: Energy cost and consumption by energy type report indicating, for each energy type, proposed design and baseline annual use and annual cost, percent savings annual use and annual cost. Indicate for renewable energy annual energy generated and annual cost. Indicate exceptional calculations annual energy savings and annual cost savings. Indicate building total annual energy use, annual energy cost for proposed design and baseline and indicate percent savings annual energy use and annual energy cost.		MEC

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			Final Design		Option 1: Compliance summaries from energy simulation software. If software does not produce compliance summaries provide output summaries and example input summaries for baseline and proposed design supporting data in the tables. Output summaries must include simulated energy consumption by end use and total energy use and cost by energy type. Example input summaries should represent most common systems and must include occupancy, use pattern, assumed envelope component sizes and descriptive features and assumed mechanical equipment types and descriptive features		MEC
			Final Design		Option 1: Energy rate tariff from project energy providers (only if not using LEED Reference Guide default rates)		MEC
EA2.1		On-Site Renewable Energy	Final Design		Statement indicating which compliance path option applies.		ELEC
			Final Design		List all on-site renewable energy sources and indicate, for each source, backup energy type, annual energy generated, rated capacity and renewable energy cost. Indicate total annual energy use (all sources), total annual energy cost (all sources) and percent renewable energy cost.		ELEC MEC
			Final Design		Option 1: Indicate, for renewable energy,proposed design total annual energy generated and annual cost.		ELEC MEC
			Final Design		Option 2: Indicate CBECS building type and building gross area. Provide the following CBECS data: median annual electrical intensity, median annual non-electrical fuel intensity, average electric energy cost, average non-electric fuel cost, annual electric energy use and cost, annual non-electric fuel use and cost.		ELEC MEC
			Final Design		Option 2: Narrative describing renewable systems and explaining calculation method used to estimate annual energy generated, including factors influencing performance.		ELEC MEC
EA2.2		On-Site Renewable Energy	Same as EA2.1		Same as EA2.1		ELEC MEC
EA2.3		On-Site Renewable Energy	Same as EA2.1		Same as EA2.1		ELEC MEC
EA3		Enhanced Commissioning	**Final Design		**Owner's Project Requirements document (OPR)		ALL
			**Final Design		**Basis of Design document for commissioned systems (BOD)		ELEC MEC
			**Final Design		**Commissioning Plan		ELEC MEC
			Closeout		Statement confirming all commissioning requirements have been incorporated into construction documents.		PE
			Closeout		**Commissioning Report		PE
			**Final Design		Statement by CxA confirming Commissioning Design Review		
			Closeout		Statement by CxA confirming review of Contractor submittals for compliance with OPR and BOD		PE
			Closeout		**Systems Manual		PE
			Closeout		Statement by CxA confirming completion of O&M staff and occupant training		PE
			Closeout		**Scope of work for post-occupancy review of building operation, including plan for resolution of outstanding issues		PE
			**Predesign		Statement confirming CxA qualifications and contractual relationships relative to work on this project, demonstrating that CxA is an independent third party.		MEC
EA4		Enhanced Refrigerant Management	Final Design		Refrigerant impact calculation table with all building data and calculation values as shown in LEED 2009 Reference Guide Example Calculations		MEC
			Final Design		Narrative describing any special circumstances or explanatory remarks		
			Closeout	X	Cut sheets highlighting refrigerant data for all HVAC components.		PE
EA5		Measurement & Verification	Closeout		Statement indicating which compliance path option applies.		PE
			Closeout		Measurement and Verification Plan including Corrective Action Plan		PE
			Closeout		**Scope of work for post-occupancy implementation of M&V plan including corrective action plan.		PE
EA6		Green Power	Closeout		Statement indicating which compliance path option applies.		PE
			Closeout		Option 1: Indicate proposed design total annual electric energy usage		PE
			Closeout		Option 2: Indicate actual total annual electric energy usage		PE
			Closeout		Option 3: Calculation indicating building type, total gross area, median electrical intensity and annual electric energy use		PE

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			Closeout		Green power provider summary table indicating, for each purchase type, provider name, annual quantity green power purchased and contract term. Indicate total annual green power use and indicate percent green power		PE
			Closeout		Narrative describing how Green Power or Green Tags are purchased		PE
CATEGORY 4 – MATERIALS AND RESOURCES							
MRPR1		Storage & Collection of Recyclables (PREREQUISITE)	Final Design		Statement confirming that recycling area will accommodate recycling of plastic, metal, paper, cardboard and glass. Narrative indicating any other materials addressed and coordination with pickup.		ARC
MR1.1		Building Reuse: Maintain 55% of Existing Walls, Floors & Roof	**Final Design		If project includes a building addition, confirm that area of building addition does not exceed 2x the area of the existing building.		ARC
			**Final Design		Spreadsheet listing, for each building structural/envelope element, the existing area and reused area. Total percent reused.		ARC
MR1.2		Building Reuse: Maintain 75% of Existing Walls, Floors & Roof	Same as MR1.1		Same as MR1.1		ARC
MR1.3		Building Reuse: Maintain 95% of Existing Walls, Floors & Roof	Same as MR1.1		Same as MR1.1		ARC
MR1.4		Building Reuse: Maintain 50% of Interior Non-Structural Elements	**Final Design		If project includes a building addition, confirm that area of building addition does not exceed 2x the area of the existing building.		ARC
			**Final Design		Spreadsheet listing, for each building interior non-structural element, the existing area and reused area. Total percent reused.		ARC
MR2.1		Construction Waste Management: Divert 50% From Disposal	**Preconstruction		Waste Management Plan		PE
			**Construction Quarterly and Closeout		Spreadsheet calculations indicating material description, disposal/diversion location (or recycling hauler), weight, total waste generated, total waste diverted, diversion percentage		PE
			**Construction Quarterly and Closeout		Receipts/tickets for all items on spreadsheet		PE
MR2.2		Construction Waste Management: Divert 75% From Disposal	Same as MR2.1		Same as MR2.1		PE
MR3.1		Materials Reuse: 5%	Closeout		Statement indicating total materials value and whether default or actual.		PE
			Closeout		Spreadsheet calculations indicating, for each reused/salvaged material, material description, source or vendor, cost. Total reused/salvaged materials percentage.		PE
MR3.2		Materials Reuse: 10%	Same as MR3.1		Same as MR3.1		PE
MR4.1		Recycled Content: 10% (post-consumer + 1/2 pre-consumer)	Closeout		Statement indicating total materials value and whether default or actual.		PE
			Closeout		Spreadsheet calculations indicating, for each recycled content material, material name/description, manufacturer, cost, post-consumer recycled content percent, pre-consumer recycled content percent, source of recycled content data. Total post-consumer content materials cost, total pre-consumer content materials cost, total combined recycled content materials cost, recycled content materials percentage.		PE
			Final Design or NLT Preconstruction		**Purchasing Plan consisting of spreadsheet indicated above, filled in with estimated quantities to show strategy for achieving goal.		PE
			Closeout	X	Manufacturer published product data or certification, confirming recycled content percentages in spreadsheet		PE
MR4.2		Recycled Content: 20% (post-consumer + 1/2 pre-consumer)	Same as MR4.1		Same as MR4.1		PE
MR5.1		Regional Materials:10% Extracted, Processed & Manufactured Regionally	Closeout		Statement indicating total materials value and whether default or actual.		PE
			Closeout		Spreadsheet calculations indicating, for each regional material, material name/description, manufacturer, cost, percent compliant, harvest distance, manufacture distance, source of manufacture and harvest location data. Total regional materials cost, regional materials percentage.		PE
			Preconstruction		**Purchasing Plan consisting of spreadsheet indicated above, filled in with estimated quantities to show strategy for achieving goal.		PE
			Closeout	X	Manufacturer published product data or certification confirming regional material percentages in spreadsheet		PE

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MR5.2		Regional Materials:20% Extracted, Processed & Manufactured Regionally	Same as MR5.1		Same as MR5.1		PE
MR6		Rapidly Renewable Materials	Closeout		Statement indicating total materials value and whether default or actual.		PE
			Closeout		Spreadsheet calculations indicating, for each rapidly renewable material, material name/description, manufacturer, cost, rapidly renewable content percent, rapidly renewable product value. Total rapidly renewable product value, rapidly renewable materials percentage.		PE
			Final Design		**Purchasing Plan consisting of spreadsheet indicated above, filled in with estimated quantities to show strategy for achieving goal.		ARC
			Closeout	X	Manufacturer published product data or certification confirming rapidly renewable material percentages in spreadsheet		PE
MR7		Certified Wood	Closeout		Statement indicating total materials value and whether default or actual.		PE
			Closeout		Spreadsheet calculations indicating, for each certified wood material, material name/description, vendor, cost, wood component percent, certified wood percent of wood component, FSC chain of custody certificate number. Total certified wood product value, certified wood materials percentage.		PE
			Final Design or NLT Preconstruction		**Purchasing Plan consisting of spreadsheet indicated above, filled in with estimated quantities to show strategy for achieving goal.		PE
			Closeout	X	Vendor invoices, FSC chain of custody certificates and anufacturer published product data or certification confirming all certified wood materials percentages in spreadsheet.		PE
INDOOR ENVIRONMENTAL QUALITY							
EQPR1		Minimum IAQ Performance (PREREQUISITE)	Final Design		Statement indicating which option for compliance applies, stating applicable criteria/requirement, and confirming that project has been designed to meet the applicable requirements.		MEC
			Final Design		Narrative describing the project's ventilation design, including specifics about fresh air intake volumes and special considerations.		MEC
EQPR2		Environmental Tobacco Smoke (ETS) Control (PREREQUISITE)	Final Design		Statement indicating which option for compliance applies, stating applicable criteria/requirement, and confirming that project has been designed to meet the applicable requirements.		ARC
			Final Design		List of drawing and specification references that convey conformance to applicable requirements (signage, exhaust system, room separation details, etc).		ARC
EQ1		Outdoor Air Delivery Monitoring	Final Design		Statement indicating which option for compliance applies and confirming that project has been designed to meet the applicable requirements.		MEC
			Final Design		List of drawing and specification references that convey conformance to applicable requirements.		MEC
			Final Design		Narrative describing the project's ventilation design and CO2 monitoring system, including specifics about monitors, operational parameters and setpoints.		MEC
			Closeout	X	Cut sheets for CO2 monitoring system.		PE
EQ2		Increased Ventilation	Final Design		Statement indicating which option for compliance applies and confirming that project has been designed to meet the applicable requirements.		MEC
			Final Design		Narrative describing the project's ventilation design, including specifics about zone fresh air intake volumes and demonstrating compliance.		MEC
			Final Design		Option 2: Narrative describing design method used for determining natural ventilation design, including calculation methodology/model results and demonstrating compliance.		MEC
			Final Design		List of drawing and specification references that convey conformance to applicable requirements.		MEC
EQ3.1		Construction IAQ Management Plan: During Construction	**Preconstruction		Construction IAQ Management Plan		PE
			Closeout		Statement confirming whether air handling units were operated during construction		PE
			Closeout		Dated jobsite photos showing examples of IAQ management plan practices being implemented. Label photos to indicate which practice they demonstrate. Minimum one photo of each practice at each building.		PE

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			Closeout		Spreadsheet indicating, for each filter installed during construction, the manufacturer, model number, MERV rating, location installed, and if it was replaced immediately prior to occupancy.		PE
EQ3.2		Construction IAQ Management Plan: Before Occupancy	**Preconstruction		Construction IAQ Management Plan		PE
			Closeout		Statement indicating which option for compliance applies and confirming that required activities have occurred that meet the applicable requirements.		PE
			Closeout		Option 1a: Narrative describing the project's flushout process, including specifics about temperature, airflow and duration, special considerations (if any) and demonstrating compliance.		PE
			Closeout		Option 1b: Narrative describing the project's pre-occupancy and post-occupancy flushout processes, including specifics about temperature, airflow and duration, special considerations (if any) and demonstrating compliance.		PE
			Closeout		Option 2: Narrative describing the project's IAQ testing process, including specifics about contaminants tested for, locations, remaining work at time of test, retest parameters and special considerations (if any).		PE
			Closeout		Option 2: IAQ testing report demonstrating compliance.		PE
EQ4.1		Low Emitting Materials: Adhesives & Sealants	Closeout		Spreadsheet indicating, for each applicable indoor adhesive, sealant and sealant primer used, the manufacturer, product name/model number, VOC content, LEED VOC limit, and source of VOC data.		PE
			Closeout		Spreadsheet indicating, for each applicable indoor aerosol adhesive, the manufacturer, product name/model number, VOC content, LEED VOC limit, and source of VOC data - OR - Statement confirming no indoor aerosol adhesives were used for the project.		PE
			Closeout	X	Manufacturer published product data or certification confirming material VOCs in spreadsheet		PE
EQ4.2		Low Emitting Materials: Paints & Coatings	Closeout		Spreadsheet indicating, for each applicable indoor paint and coating used, the manufacturer, product name/model number, VOC content, LEED VOC limit, and source of VOC data.		PE
			Closeout		Spreadsheet indicating, for each applicable indoor anti-corrosive/anti-rust paint and coating used, the manufacturer, product name/model number, VOC content, LEED VOC limit, and source of VOC data - OR - Statement confirming no indoor anti-corrosive/anti-rust paints were used for the project .		PE
			Closeout	X	Manufacturer published product data or certification confirming material VOCs in spreadsheet		PE
EQ4.3		Low Emitting Materials: Flooring Systems	Closeout		Spreadsheet indicating, for each indoor flooring system used, the manufacturer, product name/model number, if it meets LEED requirement (yes/no) and source of LEED compliance data.		PE
			Closeout		Spreadsheet indicating, for each indoor carpet cushion used, the manufacturer, product name/model number, if it meets LEED requirement (yes/no) and source of LEED compliance data - OR - Statement confirming no indoor carpet cushion was used for the project.		PE
			Closeout	X	Manufacturer published product data or certification confirming material compliance label in spreadsheet		PE
EQ4.4		Low Emitting Materials: Composite Wood & Agrifiber Products	Closeout		Spreadsheet indicating, for each indoor composite wood and agrifiber product used, the manufacturer, product name/model number, if it contains added urea formaldehyde (yes/no) and source of LEED compliance data.		PE
			Closeout	X	Manufacturer published product data or certification confirming material urea formaldehyde in spreadsheet		PE
EQ5		Indoor Chemical & Pollutant Source Control	Closeout		Spreadsheet indicating, for each permanent entryway system used, the manufacturer, product name/model number and description of system.		PE
			Final Design		List of drawing and specification references that convey locations and installation methods for entryway systems.		ARC
			Final Design		Spreadsheet indicating, for each chemical use area, the room number, room name, description of room separation features (walls, floor/ceilings, openings) and pressure differential from surrounding spaces with doors closed - OR - Statement confirming that project includes no chemical use areas and that no hazardous cleaning materials are needed for building maintenance.		ARC MEC
			Final Design		If project includes chemical use areas: List of drawing and specification references that convey locations of chemical use areas, room separation features and exhaust system.		ARC MEC

LEED Credit Paragraph	Contractor Check Here if Credit is Claimed	**LEED-NC v3 Submittals (OCT09)**		Provide for Credit Audit Only		Date Submitted (to be filled in by Contractor)	Government Reviewer's Use
PAR		**FEATURE**	**DUE AT**		**REQUIRED DOCUMENTATION**	**DATE**	**REV**
			Final Design		If project includes places where water and chemical concentrate mixing occurs: List of drawing and specification references that convey provisions for containment of hazardous liquid wastes OR - Statement confirming that project includes no places where water and chemical concentrate mixing occurs.		ARC MEC
			Closeout		If project includes chemical use areas: Spreadsheet indicating, for AHUs/mechanical ventilation equipment serving occupied areas, the manufacturer, model number, MERV rating, location installed, and if it was replaced immediately prior to occupancy (yes/no) - OR - Statement confirming that project does not use mechanical equipment for ventilation of occupied areas.		PE
EQ6.1		Controllability of Systems: Lighting	Final Design		Calculation indicating total number of individual workstations, number of workstations with individual lighting controls and the percentage of workstations with individual lighting controls.		ELEC
			Final Design		For each shared multi-occupant space, provide a brief description of lighting controls.		ELEC
			Final Design		Narrative describing lighting control strategy, including type and location of individual controls and type and location of controls in shared multi-occupant spaces.		ELEC
EQ6.2		Controllability of Systems: Thermal Comfort	Final Design		Calculation indicating total number of individual workstations, number of workstations with individual thermal comfort controls and the percentage of workstations with individual thermal comfort controls.		MEC
			Final Design		For each shared multi-occupant space, provide a brief description of thermal comfort controls.		MEC
			Final Design		Narrative describing thermal comfort control strategy, including type and location of individual and shared multi-occupant controls.		MEC
EQ7.1		Thermal Comfort: Design	Final Design		Design criteria spreadsheet indicating, for spring, summer, fall and winter, maximum indoor space design temperature, minimum indoor space design temperature and maximum indoor space design humidity.		MEC
			Final Design		Narrative describing method used to establish thermal comfort control conditions and how systems design addresses the design criteria, including compliance with the referenced standard.		MEC
EQ7.2		Thermal Comfort: Verification	Final Design		Narrative describing the scope of work for the thermal comfort survey, including corrective action plan development		MEC
			Final Design		List of drawing and specification references that convey permanent monitoring system.		MEC
EQ8.1		Daylight & Views: Daylight 75% of Spaces	Final Design		Option 2: Table indicating all regularly occupied spaces with space area and space area with compliant daylight zone. Sum of regularly occupied areas and regularly occupied areas withcompliant daylight zone. Percentage calculation of areas withcompliant daylight zone to total regularly occupied areas.		ARC
			Final Design		Option 1: Simulation model method, software and output data		ELEC
			Final Design		Option 1: Table indicating all regularly occupied spaces with space area, space area with minimum 25 footcandles daylighting illumination, and method of providing glare control. Sum of regularly occupied areas and regularly occupied areas with 25 fc daylighting. Percentage calculation of areas with 25 fc daylighting to total regularly occupied areas.		ELEC
			Final Design		For all occupied spaces excluded from the calculation, provide narrative indicating reasons for excluding the space.		ARC
			Final Design		List of drawing and specification references that convey exterior glazed opening head and sill heights, glazing performance properties and glare control/sunlight redirection devices.		ARC
			Closeout	X	Manufacturer published product data or certification confirming glazing Tvis in spreadsheet		PE
EQ8.2		Daylight & Views: Views for 90% of Spaces	Final Design		Table indicating all regularly occupied spaces with space area and space area with access to views. Sum of regularly occupied areas and regularly occupied areas with access to views. Percentage calculation of areas with views to total regularly occupied areas.		ARC
			Final Design		For all occupied spaces excluded from the calculation, provide narrative indicating reasons for excluding the space.		ARC
			Final Design		LEED Floor plan drawings showing line of sight diagramming of views areas in each regularly occupied space. List of drawing/specification references that convey exterior glazed opening head and sill heights.		ARC
INNOVATION & DESIGN PROCESS							

LEED Credit Paragraph	Contractor Check Here if Credit is Claimed	**LEED-NC v3 Submittals (OCT09)**		Provide for Credit Audit Only		Date Submitted (to be filled in by Contractor)	Government Reviewer's Use
PAR		**FEATURE**	**DUE AT**		**REQUIRED DOCUMENTATION**	**DATE**	**REV**
IDc1.1		Innovation in Design	Final Design		Narrative decribing intent, requirement for credit, project approach to the credit. List of drawings and specification references that convey implementation of credit. All other documentation that validates claimed credit.		
IDc1.2		Innovation in Design	Final Design				
IDc1.3		Innovation in Design	Final Design				
IDc1.4		Innovation in Design	Final Design				
IDc2		LEED Accredited Professional	Final Design		Narrative indicating name of LEED AP, company name of LEED AP, description of LEED AP's role and responsiblilities in the project.		ARC

ATTACHMENT F
Version 02-03-2010

BUILDING INFORMATION MODELING REQUIREMENTS

1.0 Section 1 - Submittal Format

1.1. Design Deliverables. Develop all designs using Building Information Modeling (BIM) and Computer Aided Design (CAD) software. Design submittal drawings shall be ANSI D size, suitable for half-size scaled reproduction.

2.0 Section 2 – Design Requirements

2.1. BIM Model and Facility Data. Contractor shall use BIM application(s) and software(s) to develop project designs. "Facility Data" is defined as associated intelligent attribute data. The "Model" is defined as 3D graphics that includes Facility Data and output as described in the paragraph 'Output' below. Contractors will use the Model to produce accurate Construction Documents. For each Center of Standardization (CoS) facility type included in this project, all BIM Models and associated Facility Data shall be submitted in Bentley Systems BIM [Not Supplied - SubmittalReqCADDSystem : BENTLEY_VERSION] with associated USACE Bentley BIM Workspace (which includes specific standard BIM libraries and definitions). This Workspace can be downloaded from the CAD/BIM Technology Center. [Where available, the workspace will be specific to this CoS Facility Standard Design. The Contractor will be provided a baseline multi-discipline BIM Project Model for the CoS Facility Standard Design type, where such a model exists (for the purposes of site adaptation).] The USACE Bentley BIM Workspace is dependent on specific versions of the Bentley BIM suite of products and only the versions of the software that are listed in the Contractor instructions included with the USACE BIM Workspace are permitted to be used.

2.1.1. Reference. Refer to ERDC TR-06-10, "U.S. Army Corps of Engineers Building Information Modeling Road Map" from the CAD/BIM Technology Center website for more information on the USACE BIM implementation goals.

2.2. Drawings. Deliver CAD files used for the creation of the Construction Documents Drawings per requirements in Section 01 33 16, the criteria of the USACE Fort Worth District District, and as noted herein. Specification of a CAD file format for these Drawings does not limit which BIM application(s) or software(s) may be used for project development and execution.

2.2.1. IFC Support. The Contractor's selected BIM application(s) and software(s) must support the IFC (Industry Foundation Class - see www.iai-tech.org). Submit any deviations from or additions to the IFC property sets for any new spaces, systems, and equipment for Government approval.

2.2.2. Submittal Requirements. BIM submittals shall be fully interoperable, compatible, and editable with the Bentley BIM tools. Use the specified version of the USACE Bentley BIM Workspace and conform to the requirements of **Sections 3 and 4 below**.

2.2.3. BIM Project Execution Plan.

2.2.3.1. Develop a BIM Project Execution Plan ("Plan" or "PxP") documenting the BIM and analysis technologies selected for the Project Model (integrated with the AEC CAD Standard) from concept development through As-Builts as a design, production, coordination, construction, and documentation tool and the collaborative process by which it shall be executed. See Section 7 for additional guidance on developing the Plan.

2.2.4. BIM Requirements..

2.2.4.1. Facility Data. Develop the Facility Data consisting of a set of intelligent elements for the Model (e.g., doors, air handlers, electrical panels). This Facility Data shall include all material definitions and attributes that are necessary for the Project facility design and construction. Additional data in support of Section 6 Contractor Electives is encouraged.

2.2.4.2. Model Content. The Model and Facility Data shall include, at a minimum, the requirements of Section 4 below.

2.2.4.3. Model Granularity. Models may vary in level of detail for individual elements within a model, but at a minimum must include all features that would be included on a quarter inch (1/4" = 1'0") scaled drawing (e.g. at least 1/16th, 1/8th and 1/4th), or appropriately scaled civil drawings.

2.2.4.4. Output. Submitted CAD drawings (e.g., plans, elevations, sections, schedules, details, etc.) shall be derived (commonly known as extractions, views or sheets) and maintained from the submitted Model and Facility Data.

2.3. Quality Control. Implement quality control (QC) parameters for the Model, including:

2.3.1. Model Standards Checks. QC validation used to ensure that the Project Facility Data set has no undefined, incorrectly defined or duplicated elements. Report non-compliant elements and corrective action plan to correct non-compliant elements. Provide the government with detailed justification and request government approval for any non-compliant element which the contractor proposes to be allowed to remain in the Model.

2.3.2. CAD Standards Checks. QC checking performed to ensure that the fonts, dimensions, line styles, levels and other construction document formatting issues are followed per the A/E/C CADD Standard.

2.3.3. Other Parameters. Develop such other QC parameters as Contractor deems appropriate for the Project and provide to the Government for concurrence.

2.4. Design and Construction Reviews. Perform design and construction reviews at each submittal stage under Section 3 to test the Model, including:

2.4.1. Visual Checks. Checking to ensure the design intent has been followed and that there are no unintended elements in the Model.

2.4.2. Interference Management Checks. Locate conflicting spatial data in the Model where two elements are occupying the same space. Log hard interferences (e.g., mechanical vs. structural or mechanical vs. mechanical overlaps in the same location) and soft interferences, (e.g., conflicts regarding equipment clearance, service access, fireproofing, insulation) in a written report and resolve.

2.4.3. IFC Coordination View. Provide an IFC Coordination View in IFC Express format for all deliverables. Provide exported property set data for all IFC supported named building elements.

2.4.4. Other Parameters. Develop such other Review parameters as the Contractor deems appropriate for the Project and provide to the Government for concurrence..

3.0 Section 3 – Design Stage Submittal Requirements

3.1. General Submittal Requirements.

3.1.1. Provide submittals in compliance with BIM Project Execution Plan deliverables at stages as described hereinafter.

3.1.2. At each Stage in Paragraphs 3.3 through 3.6, provide a Contractor-certified written report confirming that consistency checks as identified in Paragraphs 2.3 and 2.4 have been completed. This report shall be discussed as part of the review process and shall address cross-discipline interferences, if any.

3.1.3. At each Stage in Paragraphs 3.3 through 3.6, provide the Government with:

- The Model, Facility Data, Workspace and CAD Data files in native Bentley BIM/CAD.

- A 3-D interactive review format of the Model in Bentley Navigator, Autodesk Navisworks, Adobe 3D PDF 7.0 (or later), Google Earth KMZ or other format per Plan requirements. The file format for reviews can change between submittals.

- A list of all submitted files. The list should include a description, directory, and file name for each file submitted. For all CAD sheets, include the sheet title and sheet number. Identify files that have been produced from the submitted Model and Facility Data.

3.2. Initial Design Conference Submittal.

3.2.1. Submit a digital copy of the Plan where, in addition to Paragraph 3.1.4, the USACE Geographic District BIM Manager will coordinate with the USACE CoS BIM Manager to confirm acceptability of the Plan or advise as to additional processes or activities necessary to be incorporated.

3.2.2. Within thirty (30) days after the approval of the Plan, conduct a demonstration to review the Plan for clarification, and to verify the functionality of Model technology workflow and processes. If modifications are required, the Contractor shall complete the modifications and resubmit the Plan and perform subsequent demonstration for Government acceptance. There will be no payment for design or construction until the Plan is acceptable to the Government. The Government may also withhold payment for design and construction for unacceptable performance in executing the approved Plan.

3.3. Interim Design Submittals.

3.3.1. BIM and CAD Data. The Model shall include the requirements identified in Paragraph 2.2.4 as applicable to the Interim Design package(s).

3.4. Final Design Submissions and Design Complete Submittals.

3.4.1. BIM and CAD Data. The Model shall include the requirements identified in Paragraph 2.2.4. Acceptance according to Paragraph 3.1.4 is required before commencement of construction, as described in Paragraph 3.7.6 of Section 01 33 16.

3.5. Construction Submittals – Over-The-Shoulder Progress Reviews. Periodic quality control meetings or construction progress review meetings shall include quality control reviews on the implementation and use of the Model, including interference management and design change tracking information.

3.6. Final As-Builts BIM and CAD Data Submittal. Submit the final Model, Facility Data, and CAD files reflecting as-built conditions for Government Approval, as specified in Section 01 78 02.00 10, PROJECT CLOSEOUT.

4.0 Section 4 – BIM Model Minimum Requirements and Output

4.1. General Provisions. The deliverable Model shall be developed to include the systems described below as they would be built and the processes of installing them, and to reflect final as-built conditions. The deliverable model at the interim design stage and at the final design stage (“released for construction”) shall be developed to include as many of the systems described below as are necessary and appropriate at that design stage.

4.2. Architectural/Interior Design. The Architectural systems Model may vary in level of detail for individual elements, but at a minimum must include all features that would be included on a quarter inch (1/4”=1’0”) scaled drawing. Additional minimum Model requirements include:

4.2.1. Spaces. The Model shall include spaces defining accurate net square footage and net volume, and holding data for the room finish schedule for including room names and numbers. Include Programmatic Information provided by the Government or validated program to verify design space against programmed space, using this information to validate area quantities.

4.2.2. Walls and Curtain Walls. Each wall shall be depicted to the exact height, length, width and ratings (thermal, acoustic, fire) to properly reflect wall types. The Model shall include all walls, both interior and exterior, and the necessary intelligence to produce accurate plans, sections and elevations depicting these design elements.

4.2.3. Doors, Windows and Louvers. Doors, windows and louvers shall be depicted to represent their actual size, type and location. Doors and windows shall be modeled with the necessary intelligence to produce accurate window and door schedules.

4.2.4. Roof. The Model shall include the roof configuration, drainage system, penetrations, specialties, and the necessary intelligence to produce accurate plans, building sections and generic wall sections where roof design elements are depicted.

4.2.5. Floors. The floor slab shall be developed in the structural Model and then referenced by the architectural Model for each floor of the Project building.

4.2.6. Ceilings. All heights and other dimensions of ceilings, including soffits, ceiling materials, or other special conditions shall be depicted in the Model with the necessary intelligence to produce accurate plans, building sections and generic wall sections where ceiling design elements are depicted.

4.2.7. Vertical Circulation. All continuous vertical components (i.e., non-structural shafts, architectural stairs, handrails and guardrails) shall be accurately depicted and shall include the necessary intelligence to produce accurate plans, elevations and sections in which such design elements are referenced.

4.2.8. Architectural Specialties and Woodwork. All architectural specialties (i.e., toilet room accessories, toilet partitions, grab bars, lockers, and display cases) and woodwork (i.e., cabinetry and counters) shall be accurately depicted with the necessary intelligence to produce accurate plans, elevations and sections in which such design elements are referenced.

4.2.9. Signage. The Model shall include all signage and the necessary intelligence to produce accurate plans and schedules.

4.2.10. Schedules. Provide door, window, hardware sets using BHMA designations, flooring, wall finish, and signage schedules from the Model, indicating the type, materials and finishes used in the design.

4.3. Furniture. The furniture systems Model may vary in level of detail for individual elements within a Model, but at a minimum must include all features that would be included on a quarter inch (1/4”=1’0”) scaled drawing, and have necessary intelligence to produce accurate plans. Representation of furniture elements is to be 2D. Contractor may provide a minimal number of 3D representations as examples. Examples of furniture include, but are not limited to, desks, furniture systems, seating, tables, and office storage.

4.3.1. Furniture Coordination. Furniture that makes use of electrical, data or other features shall include the necessary intelligence to produce coordinated documents and data.

4.4. Equipment. The Model may vary in level of detail for individual elements within a Model. Equipment shall be depicted to meet layout requirements with the necessary intelligence to produce accurate plans and minimum schedules depicting their configuration. Examples of equipment include but are not limited to copiers, printers, refrigerators, ice machines and microwaves.

4.4.1. Schedules. Provide furniture and equipment schedules from the model indicating the materials, finishes, mechanical, and electrical requirements.

4.5. Structural. The structural systems Model may vary in level of detail for individual elements, but at a minimum must include all features that would be included on a quarter inch (1/4”=1’0”) scaled drawing. Additional minimum Model requirements include:

4.5.1. Foundations. All necessary foundation and/or footing elements, with necessary intelligence to produce accurate plans and elevations

4.5.2. Floor Slabs. Structural floor slabs shall be depicted, including all necessary recesses, curbs, pads, closure pours, and major penetrations accurately depicted.

4.5.3. Structural Steel. All steel columns, primary and secondary framing members, and steel bracing for the roof and floor systems (including decks), including all necessary intelligence to produce accurate structural steel framing plans and related building/wall sections.

4.5.4. Cast-in-Place Concrete. All walls, columns, and beams, including necessary intelligence to produce accurate plans and building/wall sections depicting cast-in-place concrete elements.

4.5.5. Expansion/Contraction Joints. Joints shall be accurately depicted.

4.5.6. Stairs. The structural Model shall include all necessary openings and framing members for stair systems, including necessary intelligence to produce accurate plans and building/wall sections depicting stair design elements.

4.5.7. Shafts and Pits. The structural Model shall include all necessary shafts, pits, and openings, including necessary intelligence to produce accurate plans and building/wall sections depicting these design elements.

4.6. Mechanical. The mechanical systems Model may vary in level of detail for individual elements, but at a minimum must include all features that would be included on a quarter inch (1/4”=1’0”) scaled drawing. Small diameter (less than 1-1/2” NPS) field-routed piping is not required in the model. Additional minimum Model requirements include:

4.6.1. HVAC. All necessary heating, ventilating, air-conditioning and specialty equipment, including air distribution ducts for supply, return, and ventilation and exhaust ducts, including control system, registers, diffusers, grills and hydronic baseboards with necessary intelligence to produce accurate plans, elevations, building/wall sections and schedules.

4.6.1.1. Mechanical Piping. All necessary piping and fixture layouts, and related equipment, including necessary intelligence to produce accurate plans, elevations, building/wall sections, and schedules.

4.6.2. Plumbing. All necessary plumbing piping and fixture layouts, floor and area drains, and related equipment, including necessary intelligence to produce accurate plans, elevations, building/wall sections, riser diagrams, and schedules.

4.6.3. Equipment Clearances. All HVAC and Plumbing equipment clearances shall be modeled for use in interference management and maintenance access requirements.

4.6.4. Elevator Equipment. The Model shall include the necessary equipment and control system, including necessary intelligence to produce accurate plans, sections and elevations depicting these design elements.

4.7. Electrical/Telecommunications. The electrical systems Model may vary in level of detail for individual elements, but at a minimum must include all features that would be included on a quarter inch (1/4”=1’0”) scaled drawing. Small diameter (less than 1-1/2”Ø) field-routed conduit is not required in the model. Additional minimum Model requirements include:

4.7.1. Interior Electrical Power and Lighting. All necessary interior electrical components (i.e., lighting, receptacles, special and general purpose power receptacles, lighting fixtures, panelboards, cable trays and control systems), including necessary intelligence to produce accurate plans, details and schedules. Lighting and power built into furniture/equipment shall be modeled.

4.7.2. Special Electrical Systems. All necessary special electrical components (i.e., security, Mass Notification, Public Address, nurse call and other special occupancies, and control systems), including necessary intelligence to produce accurate plans, details and schedules.

4.7.3. Grounding Systems. Grounding Systems. All necessary grounding components (i.e., lightning protection systems, static grounding systems, communications grounding systems, bonding), including necessary intelligence to produce accurate plans, details and schedules.

4.7.4. Communications. All existing and new communications service controls and connections, both above ground and underground with necessary intelligence to produce accurate plans, details and schedules. Cable tray routing shall be modeled without detail of cable contents.

4.7.5. Exterior Building Lighting. All necessary exterior lighting with necessary intelligence to produce accurate plans, elevations and schedules. The exterior building lighting Model shall include all necessary lighting, relevant existing and proposed support utility lines and equipment required with necessary intelligence to produce accurate plans, details and schedules.

4.7.6. Equipment Clearances. The model shall incorporate and define all electrical and communications working spaces, clearances, and required access

4.8. Fire Protection. The fire protection system Model may vary in level of detail for individual elements, but at a minimum must include all features that would be included on a quarter inch (1/4”=1’0”) scaled drawing. Additional minimum Model requirements include:

4.8.1. Fire Protection System. All relevant fire protection components (i.e., branch piping, sprinkler heads, fittings, drains, pumps, tanks, sensors, control panels) with necessary intelligence to produce accurate plans, elevations, building/wall sections, riser diagrams, and schedules. All fire protection piping shall be modeled.

4.8.2. Fire Alarms. Fire alarm/mass notification devices and detection system shall be indicated with necessary intelligence to produce accurate plans depicting them.

4.9. Civil. The civil Model may vary in level of detail for individual elements, but at a minimum must include all features that would be included on a one inch (1”=100’) scaled drawing. Additional minimum Model requirements include:

4.9.1. Terrain (DTM). All relevant site conditions and proposed grading, including necessary intelligence to produce accurate Project site topographical plans and cross sections.

4.9.2. Drainage. All existing and new drainage piping, including upgrades thereto, including necessary intelligence to produce accurate plans and profiles for the Project site.

4.9.3. Storm Water and Sanitary Sewers. All existing and new sewer structures and piping, including upgrades thereto, on the Project site with necessary connections to mains or other distribution points as appropriate, including necessary intelligence to produce accurate plans and profiles for the Project site.

4.9.4. Utilities. All necessary new utilities connections from the Project building(s) to the existing or newly-created utilities, and all existing above ground and underground utility conduits, including necessary intelligence to produce accurate plans and site-sections.

4.9.5. Roads and Parking. All necessary roadways and parking lots or parking structures, including necessary intelligence to produce accurate plans, profiles and cross-sections.

5.0 Section 5 - Ownership and Rights in Data

5.1. Ownership. The Government has ownership of and rights at the date of Closeout Submittal to all CAD files, BIM Model, and Facility Data developed for the Project in accordance with FAR Part 27, clauses incorporated in Section 00 72 00, Contract Clauses and Special Contract Requirement 1.14 GOVERNMENT RE-USE OF DESIGN (Section 00 73 00). The Government may make use of this data following any deliverable.

6.0 Section 6 – Contractor Electives

6.1. Applicable Criteria. If the Contractor elected to include one or more of the following features as an elective in its accepted contract proposal for additional credit during the source selection, as described in the proposal submission requirements and evaluation criteria, the following criteria are requirements, as applicable to those elective feature(s).

6.2. COBIE Compliance. The Model and Facility Data for the Project shall fulfill Construction Operations Building Information Exchange (COBIE) requirements as defined by the Whole Building Design Guide organization, including all requirements for the indexing and submission of Portable Document Format (PDF) and other appropriate file formats that would otherwise be printed and submitted in compliance with Project operations and maintenance handover requirements.

6.3. Project Scheduling using the Model. In the BIM Execution Plan and during the Preliminary BIM Execution Plan Review, provide an overview of the use of BIM in the development and support of the project construction schedule.

6.3.1. Submittal Requirements. During the Submittal stages, the Contractor shall deliver the construction schedule with information derived from the Model.

6.3.1.1. Construction Submittals – Over-The-Shoulder Progress Reviews. Periodic quality control meetings or construction progress review meetings shall include quality control reviews on the implementation and use of the Model for project scheduling.

6.4. Cost Estimating. In the BIM Execution Plan and during the Preliminary BIM Execution Plan Review, provide an overview of the use of BIM in the development and support of cost estimating requirements, or other applications such as cost analysis and estimate validation.

6.4.1. Submittal Requirements. During the Submittal stages, the Contractor shall deliver cost estimating information derived from the Model.

6.4.2. Project completion. At project completion, the Contractor shall provide an MII (Micro Computer Aided Cost Estimating System Generation II) Cost Estimate which follows the USACE Cost Engineering Military Work Breakdown System (WBS), a modified Uniformat, to at least the sub-systems level and uses quantity information supplied directly from BIM output to the maximum extent possible, though other "Gap" quantity information will be included as necessary for a complete and accurate cost estimate.

6.4.2.1. Sub system level extracted quantities from the BIM for use within the estimate shall be provided according to how detailed line items or tasks should be installed/built so that accurate costs can be developed and/or reflected. Therefore, when developing a BIM, the designer shall be cognizant of what tasks need to be separated appropriately at the beginning stages of model development, such as tasks done on the first floor versus the same task on higher floors that will be more labor intensive and therefore need to have a separate quantity and be priced differently. Tasks and their extracted quantities from the BIM shall be broken done by their location (proximity in the structure) as well as the complexity of its installation.

6.4.2.2. At all design stages it shall be understood that BIM output as described in this document will not generate all quantities that are necessary in order to develop a complete and accurate cost estimate of the project based on the design. An example of this would be plumbing that is less than 1.5" diameter and therefore not expected to be modeled due to granularity; this information is commonly referred to as The Gap. Quantities from The Gap and their associated costs shall be included in the final project actual cost estimates as well.

6.5. Other Analyses and Reports. Structural, energy and efficiency, EPACT 2005 & EISA 2007, lighting design, daylighting, electrical power, psychrometric processing, shading, programming, LEED, fire protection, code compliance, Life Cycle Cost, acoustic, plumbing.

7.0 Section 7 – BIM Project Execution Plan Template

7.1. Contractors will utilize the latest version of the USACE BIM PROJECT EXECUTION PLAN (USACE PxP) Template to develop an acceptable Plan. The template can be downloaded from the CAD/BIM Technology Center website.

ATTACHMENT G
DESIGN SUBMITTAL DIRECTORY AND SUBDIRECTORY FILE ARRANGEMENT

Organize electronic design submittal files in a subdirectory/file structure in accordance with the following table. The Contractor may suggest a slightly different structure, subject to the discretion of the government.

Design Submittal Directory and Subdirectory File Arrangement.

Directory	Sub-Directory	Sub-Directory or Files	Files
Submittal/Package Name	Narratives	PDF file or files with updated design narrative for each applicable design discipline	
	Drawings	PDF (subdirectory)	Single PDF file with all applicable drawing sheets - bookmarked by sheet number and name
		BIM (subdirectory) See Attachment F.	BIM project folder (with files) per the USACE Workspace. Include an Excel drawing index file with each drawing sheet listed by sheet #, name and corresponding dgn file name (Final Design & Design Complete only)
	Design Analysis & Calculations	Individual PDF files containing design analysis and calculations for each discipline applicable to the submittal	
		PDF file with Fire Protection and Life Safety Code Review checklist	
	LEED	PDF file with updated Leed Check List	
		PDF file or files with LEED Templates for each point with applicable documentation included in each file.	
		LEED SUBMITTALS	
	Energy Analysis	PDF with baseline energy consumption analysis	
		PDF with actual building energy consumption analysis	
	Specifications	Single PDF file with table of contents and all applicable specifications sections.	
		Submittal Register (Final Design & Design Complete submittal only)	
	Design Quality Control	PDF file or files with DQC checklist(s) and/or statements	
	Building Rendering(s)	PDF file of rendering for each building type included in contract (Final Design & Design Complete).	

SECTION 01 45 04.00 10
CONTRACTOR QUALITY CONTROL

1.0 GENERAL

1.1. REFERENCES

1.2. PAYMENT

2.0 PRODUCTS (NOT APPLICABLE)

3.0 EXECUTION

3.1. GENERAL REQUIREMENTS

3.2. QUALITY CONTROL PLAN

3.3. COORDINATION MEETING

3.4. QUALITY CONTROL ORGANIZATION

3.5. SUBMITTALS AND DELIVERABLES

3.6. CONTROL

3.7. TESTS

3.8. COMPLETION INSPECTION

3.9. DOCUMENTATION

3.10. NOTIFICATION OF NONCOMPLIANCE

1.0 GENERAL

1.1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Refer to the latest edition, as of the date of the contract solicitation.

- ASTM INTERNATIONAL (ASTM)
- ASTM D 3740 Minimum Requirements for Agencies

  Engaged in the Testing and/or Inspection
  of Soil and Rock as Used in Engineering
  Design and Construction
- ASTM E 329 Agencies Engaged in the Testing

  and/or Inspection of Materials Used in
  Construction
- U.S. ARMY CORPS OF ENGINEERS (USACE)

  ER 1110-1-12 Quality Management

1.2. PAYMENT

There will be no separate payment for providing and maintaining an effective Quality Control program. Include all costs associated therewith in the applicable unit prices or lump-sum prices contained in the Contract Line Item Schedule.

2.0 PRODUCTS (Not Applicable)

3.0 EXECUTION

3.1. GENERAL REQUIREMENTS

The Contractor is responsible for quality control and shall establish and maintain an effective quality control system in compliance with the Contract Clause titled "Inspection of Construction." The quality control system shall consist of plans, procedures, and organization necessary to produce an end product, which complies with the contract requirements. The system shall cover all design and construction operations, both onsite and offsite, and shall be keyed to the proposed design and construction sequence. The site project superintendent is responsible for the quality of work on the job and is subject to removal by the Contracting Officer for non-compliance with the quality requirements specified in the contract. The site project superintendent in this context shall be the highest level manager responsible for the overall construction activities at the site, including quality and production. The site project superintendent shall maintain a physical presence at the site at all times, except as otherwise acceptable to the Contracting Officer, and shall be responsible for all construction and construction related activities at the site.

3.2. QUALITY CONTROL PLAN

Furnish for Government review, not later than 30 days after receipt of notice to proceed, the Contractor Quality Control (CQC) Plan proposed to implement the requirements of the Contract Clause titled "Inspection of Construction." The plan shall identify personnel, procedures, control, instructions, tests, records, and forms to be used. The Government will consider an interim plan for the first 30 days of operation. Design and construction may begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of work to be started. The Government will not permit work outside of the features of work included in an accepted interim plan to begin until acceptance of a CQC Plan or another interim plan containing the additional features of work to be started. Where the applicable Code issued by the International Code Council calls for an inspection by the Building Official, the Contractor shall include the inspections in the Quality Control Plan and shall perform the inspections. The Designer of Record shall develop a program for any special inspections required by the applicable International Codes and the Contractor shall perform these inspections, using qualified inspectors. Include the special inspection plan in the QC Plan.

3.2.1. Content of the CQC Plan

The CQC Plan shall include, as a minimum, the following to cover all design and construction operations, both onsite and offsite, including work by subcontractors, fabricators, suppliers, and purchasing agents subcontractors, designers of record, consultants, architect/engineers (AE), fabricators, suppliers, and purchasing agents:

3.2.1.1. A description of the quality control organization. Include a chart showing lines of authority and an acknowledgment that the CQC staff shall implement the three phase control system for all aspects of the work specified. A CQC System Manager shall report to the project superintendent or someone higher in the contractor's organization.

3.2.1.2. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function. Also include those responsible for performing and documenting the inspections required by the International Codes and the special inspection program developed by the designer of record.

3.2.1.3. A copy of the letter to the CQC System Manager, signed by an authorized official of the firm, which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop work which is not in compliance with the contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities. Furnish copies of these letters.

3.2.1.4. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers, and purchasing agents subcontractors, designers of record, consultants, architect engineers (AE), offsite fabricators, suppliers, and purchasing agents. These procedures shall be in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

3.2.1.5. Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test. Use only Government approved Laboratory facilities.

3.2.1.6. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests including documentation.

3.2.1.7. Procedures for tracking design and construction deficiencies from identification through acceptable corrective action. These procedures shall establish verification that identified deficiencies have been corrected.

3.2.1.8. Reporting procedures, including proposed reporting formats.

3.2.1.9. A list of the definable features of work. A definable feature of work is a task, which is separate and distinct from other tasks, has separate control requirements, and may be identified by different trades or disciplines, or it may be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable feature of work, there are frequently more than one definable feature under a particular section. This list will be agreed upon during the coordination meeting.

3.2.1.10. A list of all inspections required by the International Codes and the special inspection program required by the code and this contract.

3.2.2. Additional Requirements for Design Quality Control (DQC) Plan

The following additional requirements apply to the Design Quality Control (DQC) plan:

3.2.2.1. The Contractor's QCP Plan shall provide and maintain a Design Quality Control (DQC) Plan as an effective quality control program which will assure that all services required by this design-build contract are performed and provided in a manner that meets professional architectural and engineering quality standards. As a minimum, competent, independent reviewers identified in the DQC Plan shall review all documents. Use personnel who were not involved in the design effort to produce the design to perform the independent technical review (ITR). The ITR is intended as a quality control check of the design. Include, at least, but not necessarily limited to, a review of the contract requirements (the accepted contract or task order proposal and amended RFP), the basis of design, design calculations, the design configuration management documentation and check the design documents for

errors, omissions, and for coordination and design integration. The ITR team is not required to examine, compare or comment concerning alternate design solutions but should concentrate on ensuring that the design meets the contract requirements. Correct errors and deficiencies in the design documents prior to submitting them to the Government.

3.2.2.2. Include in the DQC Plan the discipline-specific checklists to be used during the design and quality control of each submittal. Submit these completed checklists at each design phase as part of the project documentation.

3.2.2.3. A Design Quality Control Manager, who has the responsibility of being cognizant of and assuring that all documents on the project have been coordinated, shall implement the DQC Plan This individual shall be a person who has verifiable engineering or architectural design experience and is a registered professional engineer or architect. Notify the Government, in writing, of the name of the individual, and the name of an alternate person assigned to the position.

3.2.3. Acceptance of Plan

Government acceptance of the Contractor's plan is required prior to the start of design and construction. Acceptance is conditional and will be predicated on satisfactory performance during the design and construction. The Government reserves the right to require the Contractor to make changes in his CQC Plan and operations including removal of personnel, as necessary, to obtain the quality specified.

3.2.4. Notification of Changes

After acceptance of the CQC Plan, notify the Government in writing of any proposed change. Proposed changes are subject to Government acceptance.

3.3. COORDINATION MEETING

After the Postaward Conference, before start of design or construction, and prior to acceptance by the Government of the CQC Plan, the Contractor and the Government shall meet and discuss the Contractor's quality control system. Submit the CQC Plan for review a minimum of 7 calendar days prior to the Coordination Meeting. During the meeting, a mutual understanding of the system details shall be developed, including the forms for recording the CQC operations, design activities, control activities, testing, administration of the system for both onsite and offsite work, and the interrelationship of Contractor's Management and control with the Government's Quality Assurance. The Government will prepare minutes of the meeting for signature by both parties. . The minutes shall become a part of the contract file. There may be occasions when either party will call for subsequent conferences to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures which may require corrective action by the Contractor.

3.4. QUALITY CONTROL ORGANIZATION

3.4.1. Personnel Requirements

The requirements for the CQC organization are a CQC System Manager, a Design Quality Manager, and sufficient number of additional qualified personnel to ensure contract compliance. The CQC organization shall also include personnel identified in the technical provisions as requiring specialized skills to assure the required work is being performed properly. The Contractor's CQC staff shall maintain a presence at the site at all times during progress of the work and have complete authority and responsibility to take any action necessary to ensure contract compliance. The CQC staff shall be subject to acceptance by the Contracting Officer. Provide adequate office space, filing systems and other resources as necessary to maintain an effective and fully functional CQC organization. Promptly furnish complete records of all letters, material submittals, shop drawing submittals, schedules and all other project documentation to the CQC organization. The CQC organization shall be responsible to maintain these documents and records at the site at all times, except as otherwise acceptable to the Contracting Officer.

3.4.2. CQC System Manager

Identify as CQC System Manager an individual within the onsite work organization who shall be responsible for overall management of CQC and have the authority to act in all CQC matters for the Contractor. The CQC System

Manager shall be a graduate engineer, graduate architect, or a BA/BS graduate of an ACCE accredited construction management college program. The CQC system Manager may alternately be an engineering technician with at least 2 years of college and an ICC certification as a Commercial Building Inspector (Residential Building Inspector certification will be required for Military Family Housing projects). In addition, the CQC system manager shall have a minimum of 5 years construction experience on construction similar to this contract. The CQC System Manager shall be on the site at all times during construction and shall be employed by the prime Contractor. Assign the CQC System Manager no other duties (except may also serve as Safety and Health Officer, if qualified and if allowed by Section 00 73 00). Identify an alternate for the CQC System Manager in the plan to serve in the event of the System Manager's absence. The requirements for the alternate shall be the same as for the designated CQC System Manager but the alternate may have other duties in addition to serving in a temporary capacity as the acting QC manager.

3.4.3. CQC Personnel

3.4.3.1. In addition to CQC personnel specified elsewhere in the contract provide specialized CQC personnel to assist the CQC System Manager in accordance with paragraph titled Area Qualifications.

3.4.3.2. These individuals may be employees of the prime or subcontractor; be responsible to the CQC System Manager; **are not intended to be full time, but must be physically present at the construction site during work on their areas of responsibility**; have the necessary education and/or experience in accordance with the experience matrix listed herein. These individuals may perform other duties but must be allowed sufficient time to perform their assigned quality control duties as described in the Quality Control Plan. **One person may cover more than one area, provided that they are qualified to perform QC activities for the designated areas below and provided that they have adequate time to perform their duties:**

3.4.4. Experience Matrix

3.4.4.1. Area Qualifications

3.4.4.1.1. Civil - Graduate Civil Engineer or (BA/BS) graduate in construction management with 4 years experience in the type of work being performed on this project or engineering technician with 5 yrs related experience.

3.4.4.1.2. Mechanical - Graduate Mechanical Engineer or (BA/BS) graduate in construction management with 4 yrs related experience or engineering technician with an ICC certification as a Commercial Mechanical Inspector with 5 yrs related experience.

3.4.4.1.3. Electrical - Graduate Electrical Engineer or (BA/BS) graduate in construction management with 4 yrs related experience or engineering technician with an ICC certification as a Commercial Electrical Inspector with 5 yrs related experience.

3.4.4.1.4. Structural - Graduate Structural Engineer or (BA/BS) graduate in construction management with 4 yrs related experience or person with an ICC certification as a Reinforced Concrete Special Inspector and Structural Steel and Bolting Special Inspector (as applicable to the type of construction involved) with 5 yrs related experience.

3.4.4.1.5. Plumbing - Graduate Mechanical Engineer or (BA/BS) graduate in construction management with 4 yrs related experience, or person with an ICC certification as a Commercial Plumbing Inspector with 5 yrs related experience.

3.4.4.1.6. Concrete, Pavements and Soils Materials Technician (present while performing tests) with 2 yrs experience for the appropriate area

3.4.4.1.7. Testing, Adjusting and Balancing Specialist must be a member (TAB) Personnel of AABC or an experienced technician of the firm certified by the NEBB (present while testing, adjusting, balancing).

3.4.4.1.8. Design Quality Control Manager Registered Architect or Professional Engineer (not required on the construction site)

3.4.4.1.9. Registered Fire Protection Engineer with 4 years related experience or engineering technician with 5 yrs related experience (but see requirements for Fire Protection Engineer of Record to witness final testing in Section 01 10 00, paragraph 5.10, Fire Protection).

3.4.4.1.10. QC personnel assigned to the installation of the telecommunication system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification. In lieu of BICSI certification, QC personnel shall have a minimum of 5 years experience in the installation of the specified copper and fiber optic cable and components. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. QC personnel shall witness and certify the testing of telecommunications cabling and equipment.

3.4.5. Additional Requirement

In addition to the above experience and/or education requirements the CQC System Manager shall have completed the course entitled "Construction Quality Management for Contractors". This course is periodically offered at To Be Determined. Inquire of the District or Division sponsoring the course for fees and other expenses involved, if any, for attendance at this course.

3.4.6. Organizational Changes

When it is necessary to make changes to the CQC staff, the Contractor shall revise the CQC Plan to reflect the changes and submit the changes to the Contracting Officer for acceptance.

3.5. SUBMITTALS AND DELIVERABLES

Make submittals as specified in Section 01 33 00 ***SUBMITTAL PROCEDURES***. The CQC organization shall certify that all submittals and deliverables are in compliance with the contract requirements.

3.6. CONTROL

Contractor Quality Control is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. The CQC organization shall conduct at least three phases of control for each definable feature of the construction work as follows:

3.6.1. Preparatory Phase

Perform this phase prior to beginning work on each definable feature of work, after all required plans/documents/materials are approved/accepted, and after copies are at the work site. This phase shall include:

3.6.1.1. A review of each paragraph of applicable specifications, reference codes, and standards. Make a copy of those sections of referenced codes and standards applicable to that portion of the work to be accomplished in the field at the preparatory inspection. Maintain these copies in the field, available for use by Government personnel until final acceptance of the work.

3.6.1.2. A review of the contract drawings.

3.6.1.3. A check to assure that all materials and/or equipment have been tested, submitted, and approved.

3.6.1.4. Review of provisions that have been made to provide required control inspection and testing.

3.6.1.5. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the contract.

3.6.1.6. A physical examination of required materials, equipment, and sample work to assure that they are on hand, conform to approved shop drawings or submitted data, and are properly stored.

3.6.1.7. A review of the appropriate activity hazard analysis to assure safety requirements are met.

3.6.1.8. Discussion of procedures for controlling quality of the work including repetitive deficiencies. Document construction tolerances and workmanship standards for that feature of work.

3.6.1.9. A check to ensure that the portion of the plan for the work to be performed has been accepted by the Contracting Officer.

3.6.1.10. Discussion of the initial control phase.

3.6.1.11. Notify the Government at least 24 hours in advance of beginning the preparatory control phase. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. Document the results of the preparatory phase actions by separate minutes prepared by the CQC System Manager and attached to the daily CQC report. The Contractor shall instruct applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.

3.6.2. Initial Phase

Accomplish this phase at the beginning of a definable feature of work. Include the following actions:

3.6.2.1. Check work to ensure that it is in full compliance with contract requirements. Review minutes of the preparatory meeting.

3.6.2.2. Verify adequacy of controls to ensure full contract compliance. Verify required control inspection and testing.

3.6.2.3. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with required sample panels as appropriate.

3.6.2.4. Resolve all differences.

3.6.2.5. Check safety to include compliance with and upgrading of the Accident Prevention plan and activity hazard analysis. Review the activity analysis with each worker.

3.6.2.6. Notify the Government at least 24 hours in advance of beginning the initial phase. The CQC System Manager shall prepare and attach to the daily CQC report separate minutes of this phase. Indicate exact location of initial phase for future reference and comparison with follow-up phases.

3.6.2.7. Repeat the initial phase any time acceptable specified quality standards are not being met.

3.6.3. Follow-up Phase

Perform daily checks to assure control activities, including control testing, are providing continued compliance with contract requirements, until completion of the particular feature of work. The checks shall be made a matter of record in the CQC documentation. Conduct final follow-up checks and correct deficiencies prior to the start of additional features of work which may be affected by the deficient work. Do not build upon nor conceal non-conforming work.

3.6.4. Additional Preparatory and Initial Phases

Conduct additional preparatory and initial phases on the same definable features of work if: the quality of on-going work is unacceptable; if there are changes in the applicable CQC staff, onsite production supervision or work crew; if work on a definable feature is resumed after a substantial period of inactivity; or if other problems develop.

3.7. TESTS

3.7.1. Testing Procedure

Perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements and project design documents. Upon request, furnish to the Government

duplicate samples of test specimens for possible testing by the Government. Testing includes operation and/or acceptance tests when specified. The Contractor shall procure the services of a Corps of Engineers approved testing laboratory, or establish an approved testing laboratory at the project site. The Contractor may elect to use a laboratory certified and accredited by the Concrete and cement Reference Laboratory (CCRL) or by AASHTO Materials Reference Laboratory (AMRL) for testing procedures that those organizations certify. The Contractor shall perform the following activities and record and provide the following data:

3.7.1.1. Verify that testing procedures comply with contract requirements and project design documents.

3.7.1.2. Verify that facilities and testing equipment are available and comply with testing standards.

3.7.1.3. Check test instrument calibration data against certified standards.

3.7.1.4. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.

3.7.1.5. Include results of all tests taken, both passing and failing tests, recorded on the CQC report for the date taken. Include specification paragraph reference, location where tests were taken, and the sequential control number identifying the test. If approved by the Contracting Officer, actual test reports may be submitted later with a reference to the test number and date taken. Provide an information copy of tests performed by an offsite or commercial test facility directly to the Contracting Officer. Failure to submit timely test reports as stated may result in nonpayment for related work performed and disapproval of the test facility for this contract.

3.7.2. Testing Laboratories

3.7.2.1. Capability Check

The Government reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt, and steel shall meet criteria detailed in ASTM D 3740 and ASTM E 329.

3.7.2.2. Capability Recheck

If the selected laboratory fails the capability check, the Government will assess the Contractor a charge of $1,375 to reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the contract amount due the Contractor.

3.7.3. Onsite Laboratory

The Government reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests, and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

3.7.4. Furnishing or Transportation of Samples for Government Quality Assurance Testing

The Contractor is responsible for costs incidental to the transportation of samples or materials. Deliver samples of materials for test verification and acceptance testing by the Government to the Corps of Engineers Laboratory, f.o.b., at the following address:

- For delivery by mail:

  Not Required

  N/A

  N/A

  N/A
- For other deliveries:

  Not Required

N/A

N/A

N/A

The area or resident office will coordinate, exact delivery location, and dates for each specific test.

3.8. COMPLETION INSPECTION

3.8.1. Punch-Out Inspection

Near the end of the work, or any increment of the work established by a time stated in the SPECIAL CONTRACT REQUIREMENTS Clause, "Commencement, Prosecution, and Completion of Work", or by the specifications, the CQC Manager shall conduct an inspection of the work. Prepare a punch list of items which do not conform to the approved drawings and specifications and include in the CQC documentation, as required by paragraph DOCUMENTATION. The list of deficiencies shall include the estimated date by which the deficiencies will be corrected. The CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected. Once this is accomplished, the Contractor shall notify the Government that the facility is ready for the Government Pre-Final inspection.

3.8.2. Pre-Final Inspection

As soon as practicable after the notification above, the Government will perform the pre-final inspection to verify that the facility is complete and ready to be occupied. A Government Pre-Final Punch List may be developed as a result of this inspection. The Contractor's CQC System Manager shall ensure that all items on this list have been corrected before notifying the Government, so that a Final inspection with the customer can be scheduled. Correct any items noted on the Pre-Final inspection in a timely manner. Accomplish these inspections and any deficiency corrections required by this paragraph within the time slated for completion of the entire work or any particular increment of the work if the project is divided into increments by separate completion dates.

3.8.3. Final Acceptance Inspection

The Contractor's Quality Control Inspection personnel, plus the superintendent or other primary management person, and the Contracting Officer's Representative shall attend the final acceptance inspection. Additional Government personnel including, but not limited to, those from Base/Post Civil Facility Engineer user groups and major commands may also attend. The Government will formally schedule the final acceptance inspection based upon results of the Pre-Final inspection. Provide notice to the Government at least 14 days prior to the final acceptance inspection and include the Contractor's assurance that all specific items previously identified to the Contractor as being unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date scheduled for the final acceptance inspection. Failure of the Contractor to have all contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection cost in accordance with the contract clause titled "Inspection of Construction".

3.9. DOCUMENTATION

3.9.1. Maintain current records providing factual evidence that required quality control activities and/or tests have been performed. These records shall include the work of subcontractors and suppliers using government-provided software, QCS (see Section 01 45 01.10). The report includes, as a minimum, the following information:

3.9.1.1. Contractor/subcontractor and their area of responsibility.

3.9.1.2. Operating plant/equipment with hours worked, idle, or down for repair.

3.9.1.3. Work performed each day, giving location, description, and by whom. When Network Analysis (NAS) is used, identify each phase of work performed each day by NAS activity number.

3.9.1.4. Test and/or control activities performed with results and references to specifications/drawings requirements. Identify the applicable control phase (Preparatory, Initial, Follow-up). List deficiencies noted, along with corrective action.

3.9.1.5. Quantity of materials received at the site with statement as to acceptability, storage, and reference to specifications/drawings requirements.

3.9.1.6. Submittals and deliverables reviewed, with contract reference, by whom, and action taken.

3.9.1.7. Offsite surveillance activities, including actions taken.

3.9.1.8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.

3.9.1.9. Instructions given/received and conflicts in plans and/or specifications.

3.9.1.10. Provide documentation of design quality control activities. For independent design reviews, provide, as a minimum, identity of the ITR team, the ITR review comments, responses and the record of resolution of the comments.

3.9.2. Contractor's verification statement.

These records shall indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in the work and workmanship comply with the contract. Furnish the original and one copy of these records in report form to the Government daily within 24 hours after the date covered by the report, except that reports need not be submitted for days on which no work is performed. As a minimum, submit one report for every 7 days of no work and on the last day of a no work period. Account for all calendar days throughout the life of the contract. The first report following a day of no work shall be for that day only. The CQC System Manager shall sign and date reports. The report shall include copies of test reports and copies of reports prepared by all subordinate quality control personnel. The Contractor may submit these forms electronically, in lieu of hard copy.

3.10. NOTIFICATION OF NONCOMPLIANCE

The Contracting Officer will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

End of Section 01 45 04.00 10

SECTION 01 50 02.0003
TEMPORARY CONSTRUCTION FACILITIES

1.0 OVERVIEW

1.1. GENERAL REQUIREMENTS

1.3. BULLETIN BOARD, PROJECT SIGN, AND PROJECT SAFETY SIGN

1.0 OVERVIEW

1.1. GENERAL REQUIREMENTS

1.1.1. This section contains requirements specifically applicable to this task order. The requirements of Base ID/IQ contract Section 01 50 02 apply to this task order, except as otherwise specified herein.

1.3. BULLETIN BOARD, PROJECT SIGN, AND PROJECT SAFETY SIGN

1.3.1. Bulletin Board (As Specified in Base contract)

1.3.2. Project and Safety Signs (Added to Stress standardization of signs, in the event that the Base ID/IQ Section 01 50 02 does not contain this information)

Erect a project sign and a site safety sign with informational details as provided by the Government at the Post award conference, within 15 days prior to any work activity on project site. Update the safety sign data daily, with light colored metallic or non-metallic numerals. Remove the signs from the site upon completion of the project. Engineer Pamphlet EP 310-1-6a contains the standardized layout and construction details for the signs. It can be found through a GOOGLE Search or try http://www.usace.army.mil/publications/eng-pamphlets/ep310-1-6a/s-16.pdf.

End of Section 01 50 02.0003

SECTION 01 57 23

TEMPORARY STORM WATER POLLUTION CONTROL
04/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 4439	(2004) Geosynthetics
ASTM D 4491	(1999a; R 2004e1) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(2004) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 2003) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(2004) Determining Apparent Opening Size of a Geotextile
ASTM D 4873	(2002) Identification, Storage, and Handling of Geosynthetic Rolls and Samples

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 832-R-92-005	(1992) Storm Water Management for Construction Activities Developing Pollution Preventions and Plans and Best Management Practices

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 122.26	Storm Water Discharges (Applicable to State NPDES Programs, see section 123.25)

1.2 GENERAL REQUIREMENTS

The work consists of implementing the storm water pollution prevention measures to prevent sediment from entering streams or water bodies as specified in this Section in conformance with the requirements of Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION, and the requirements of the National Pollution Discharge Elimination System (NPDES) permit attached to that Section.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When

used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Storm Water Pollution Prevention Plan; G
Storm Water Notice of Intent; G

Pollution prevention plan and Notice of intent for NPDES coverage under the general permit for construction activities

SD-06 Test Reports

Storm Water Inspection Reports for General Permit; G
Erosion and Sediment Controls

SD-07 Certificates

Mill Certificate or Affidavit

Certificate attesting that the Contractor has met all specified requirements.

1.4 EROSION AND SEDIMENT CONTROLS

The controls and measures required by the Contractor are described below.

1.4.1 Stabilization Practices

The stabilization practices to be implemented include temporary seeding, mulching, geotextiles, sod stabilization, vegetative buffer strips, erosion control matts, protection of trees, preservation of mature vegetation, . On the daily CQC Report, record the dates when the major grading activities occur, (e.g., clearing and grubbing, excavation, embankment, and grading); when construction activities temporarily or permanently cease on a portion of the site; and when stabilization practices are initiated. Except as provided in paragraphs UNSUITABLE CONDITIONS and NO ACTIVITY FOR LESS THAN 21 DAYS, stabilization practices must be initiated as soon as practicable, but no more than 14 days, in any portion of the site where construction activities have temporarily or permanently ceased.

1.4.1.1 Unsuitable Conditions

Where the initiation of stabilization measures by the fourteenth day after construction activity temporarily or permanently ceases or is precluded by unsuitable conditions caused by the weather, initiate stabilization practices as soon as practicable after conditions become suitable.

1.4.1.2 No Activity for Less Than 21 Days

When the total time period in which construction activity is temporarily ceased on a portion of the site is 21 days minimum, stabilization practices do not have to be initiated on that portion of the site until 14 days have elapsed after construction activity temporarily ceased.

1.4.1.3 Burnoff

Burnoff of the ground cover is not permitted.

1.4.1.4 Protection of Erodible Soils

Immediately finish the earthwork brought to a final grade, as indicated or specified. Immediately protect the side slopes and back slopes upon completion of rough grading. Plan and conduct earthwork to minimize the duration of exposure of unprotected soils.

1.4.2 Erosion, Sediment and Stormwater Control

a. Submit "Erosion and Sediment Controls" (E&S) (form provided at the pre-construction conference) to the Contracting Officer once every 7 calendar days and within 24 hours of a storm event that produces 0.5 inch or more of rain.

1.4.2.1 Storm Water Notice of Intent for Construction Activities

Submit a Storm Water Notice of Intent for NPDES coverage under the general permit for construction activities and a Storm Water Pollution Prevention Plan (SWPPP), when applicable, for the project to the Contracting Officer prior to the commencement of work. A Storm Water Pollution Prevention Plan shall be required For project sites greater than 1 acre in size (including all temporary access roads, trailer sites, storage areas, and any other disturbed area associated with the project). The SWPPP must meet the requirements of the EPA or the State of Virginia, whichever is applicable, general permit for storm water discharges from construction sites. Submit the SWPPP along with any required Notice of Intents, Notice of Termination, and appropriate permit fees, via the Contracting Officer, to the appropriate Federal or State agency for approval, a minimum of 14 calendar days prior to the start of any land disturbing activities. Maintain an approved copy of the SWPPP at the construction on-site office, and continually update as regulations require, to reflect current site conditions. Include within the SWPPP:

(1) Identify potential sources of pollution which may be reasonably expected to affect the quality of storm water discharge from the site.

(2) Describe and ensure implementation of practices which will be used to reduce the pollutants in storm water discharge from the site.

(3) Ensure compliance with terms of the EPA or State of Virginia, whichever is applicable, general permit for storm water discharge.

(4) Select applicable best management practices from EPA 832-R-92-005.

(5) Include a completed copy of the Registration Statement, BMP Inspection Report Template, and Notice of Termination except for the effective date.

(6) Storm Water Pollution Prevention Measures and Notice of Intent 40 CFR 122.26, EPA 832-R-92-005. Provide a "Storm Water Pollution Prevention Plan" (SWPPP) for the project, when applicable. The SWPPP will meet the requirements of the EPA or State of Virginia, wihichever is applicable,

(7) Storm Water Pollution Prevention Measures and Notice of

Intent 40 CFR 122.26, EPA 832-R-92-005. Provide a "Storm Water Pollution Prevention Plan" (SWPPP) for the project. The SWPPP will meet the requirements of the State of Virginia general permit for storm water discharges from construction activities. Submit the SWPPP to the Contracting Officer for review, approval and signature a minimum of 15 days prior to the start of any land disturbing activities. Maintain an approved copy of the SWPPP at the construction on-site office, and continually update as regulations require, to reflect current site conditions.]

(8) Following SWPPP approval, submit Registration Statement and appropriate permit fees to the Virginia Department of Conservation and Recreation (DCR) before any land disturbing activities begin. Coverage under the permit begins on the day the Registration Statement and fee are: (1) post marked by mail, (2) registered online at the DCR's website, or (3) hand delivered to the DCR office. The Contractor is responsible for all associated fees; contact DCR to determine applicable fees.

(10) Information on the permit application, SWPPP requirements, Registration Statement, BMP Inspection Reports, and Notice of Termination can be found in the Virginia Permit Regulation 9 VAC 25-180. The Registration Statement, Notice of Termination, and permit fee forms can be found on the DCR website http://www.dcr.state.va.us/sw/vsmp.htm. This website also contains the permit regulations and information on how to obtain coverage online.

1.4.3 Structural Practices

Implement structural practices to divert flows from exposed soils, temporarily store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Structural practices must be implemented in a timely manner during the construction process to minimize erosion and sediment runoff. Include the following devices; Show location and details of installation and construction on the drawings.

1.4.3.1 Silt Fences

If used, provide silt fences as a temporary structural practice to minimize erosion and sediment runoff. Properly installed silt fences to effectively retain sediment immediately after completing each phase of work where erosion would occur in the form of sheet and rill erosion (e.g. clearing and grubbing, excavation, embankment, and grading). Install silt fences in the locations indicated on the drawings. Obtain approval from the Contracting Officer prior to final removal of silt fence barriers .

1.4.3.2 Straw Bales

If used, provide bales of straw as a temporary structural practice to minimize erosion and sediment runoff. If bales are used, properly place the bales to effectively retain sediment immediately after completing each phase of work (e.g., clearing and grubbing, excavation, embankment, and grading) in each independent runoff area (e.g., after clearing and grubbing in a area between a ridge and drain, place the bales as work progresses, remove/replace/relocate the bales as needed for work to progress in the drainage area). Show on the drawings areas where straw bales are to be used. The Contracting Officer will approve the final removal of straw bale barriers. Provide rows of bales of straw as follows:

a. Along the downhill perimeter edge of all areas disturbed.

b. Along the top of the slope or top bank of drainage ditches, channels, swales, etc. that traverse disturbed areas.

c. Along the toe of all cut slopes and fill slopes of the construction areas.

d. Perpendicular to the flow in the bottom of existing drainage ditches, channels, swales, etc. that traverse disturbed areas or carry runoff from disturbed areas. SSpace rows a maximum of 60 meters (200 feet) apart in drains with slopes equal to or less than 5 percent and 30 meters (100 feet) apart in drains with slopes steeper than 5 percent. If drainage ditches have slopes above and below the 5 percent limit the spacing show on the drawings..

e. Perpendicular to the flow in the bottom of new drainage ditches, channels, and swales. Space rows a maximum of 60 meters (200 feet) apart in drains with slopes equal to or less than 5 percent and 30 meters (100 feet) apart in drains with slopes steeper than 5 percent. If drainage ditches have slopes above and below the 5 percent limit the spacing show on the drawings..

f. At the entrance to culverts that receive runoff from disturbed areas.

1.4.3.3 Diversion Dikes

If used, build diversion dikes with a maximum channel slope of 2 percent and adequately compacted to prevent failure. The minimum height measured from the top of the dike to the bottom of the channel must be 18 inches. The minimum base width must be 6 feet and the minimum top width must be 2 feet. Ensure that the diversion dikes are not damaged by construction operations or traffic. Locate diversion dikes on the drawings.

1.4.4 Sediment Basins

If used, trap sediment in temporary (unlesspermanent are required) sediment basins. Select a basin size to accommodate the runoff of the specified local storm year. Pump dry and remove the accumulated sediment, after each storm. Use a paved weir or vertical overflow pipe for overflow. Remove collected sediment from the site. Institute effluent quality monitoring programs. Prepare BMP Inspection Reports as required by the general permit. If required by the permit, include those inspection reports.

1.4.5 Vegetation and Mulch

a. If used, provide temporary protection on sides and back slopes as soon as rough grading is completed or sufficient soil is exposed to require erosion protection. Protect slopes by accelerated growth of permanent vegetation, temporary vegetation, mulching, or netting. Stabilize slopes by hydroseeding, anchoring mulch in place, covering with anchored netting, sodding, or such combination of these and other methods necessary for effective erosion control.

b. Seeding: If used, provide new seeding where ground is disturbed.

Include topsoil or nutriment during the seeding operation necessary to establish, or reestablish, a suitable stand of grass. The seeding operation will be as specified in UFGS Guide Specification 32 92 19 SEEDING.

1.5 DELIVERY, STORAGE, AND HANDLING

Identify, store and handle filter fabric in accordance with ASTM D 4873.

PART 2 PRODUCTS

2.1 COMPONENTS FOR SILT FENCES

2.1.1 Filter Fabric

The geotextile must comply with the requirements of ASTM D 4439, and consist of polymeric filaments which are formed into a stable network such that filaments retain their relative positions. The filament must consist of a long-chain synthetic polymer composed of at least 85 percent by weight of ester, propylene, or amide, and contain stabilizers and/or inhibitors added to the base plastic to make the filaments resistance to deterioration due to ultraviolet and heat exposure. Synthetic filter fabric must contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 to 120 degrees F. The filter fabric must meet the following requirements:

FILTER FABRIC FOR SILT SCREEN FENCE

PHYSICAL PROPERTY	TEST PROCEDURE	STRENGTH REQUIREMENT
Grab Tensile	ASTM D 4632	100 lbs. min.
Elongation (percent)		30 percent max.
Trapezoid Tear	ASTM D 4533	55 lbs. min.
Permittivity	ASTM D 4491	0.2 sec-1
AOS (U.S. Std Sieve)	ASTM D 4751	20-100

2.1.2 Silt Fence Stakes and Posts

Use either wooden stakes or steel posts for fence construction. Wooden stakes utilized for silt fence construction, must have a minimum cross section of 2 by 2 inches when oak is used and 4 by 4 inches when pine is used, and have a minimum length of 5 feet. Steel posts (standard "U" or "T" section) utilized for silt fence construction, must have a minimum weight of 1.33 pounds/linear foot and a minimum length of 5 feet.

2.1.3 Mill Certificate or Affidavit

Provide a mill certificate or affidavit attesting that the fabric and factory seams meet chemical, physical, and manufacturing requirements specified above. The mill certificate or affidavit must specify the actual Minimum Average Roll Values and identify the fabric supplied by roll identification numbers. Submit a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the filter fabric.

2.1.4 Identification Storage and Handling

Filter fabric must be identified, stored and handled in accordance with ASTM D 4873.

2.2 COMPONENTS FOR STRAW BALES

The straw in the bales must be stalks from oats, wheat, rye, barley, rice, or from grasses such as byhalia, bermuda, etc., furnished in air dry condition. The bales must have a standard cross section of 14 by 18 inches. Wire-bound or string-tie all bales. The Contractor may use either wooden stakes or steel posts to secure the straw bales to the ground. Wooden stakes utilized for this purpose, must have a minimum dimensions of 2 by 2 inches in cross section and have a minimum length of 3 feet. Steel posts (standard "U" or "T" section) utilized for securing straw bales, must have a minimum weight of 1.33 pounds/linear foot and a minimum length of 3 feet.

PART 3 EXECUTION

3.1 INSTALLATION OF SILT FENCES

Extend silt fences a minimum of 16 inches above the ground surface and not exceed 34 inches above the ground surface. Filter fabric must be from a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are unavoidable, splice together filter fabric at a support post, with a minimum 6 inch overlap, and securely sealed. Excavate trench approximately 4 inches wide and 4 inches deep on the upslope side of the location of the silt fence. The 4 by 4 inch trench must be backfilled and the soil compacted over the filter fabric. Remove silt fences upon approval by the Contracting Officer.

3.2 INSTALLATION OF STRAW BALES

Place the straw bales in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another. Install straw bales so that bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings. Entrench and backfill the barrier. Excavate a trench the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. After the bales are staked and chinked (gaps filled by wedging with straw), backfill the excavated soil against the barrier. Conform the backfill soil with the ground level on the downhill side and build up to 4 inches against the uphill side of the barrier. Scatter loose straw over the area immediately uphill from a straw bale barrier to increase barrier efficiency. Securely anchored each bale by at least two stakes driven through the bale. Drive the first stake or steel post in each bale toward the previously laid bale to force the bales together. Stakes or steel pickets must be driven a minimum 18 inches deep into the ground to securely anchor the bales.

3.3 FIELD QUALITY CONTROL

Maintain the temporary and permanent vegetation, erosion and sediment control measures, and other protective measures in good and effective operating condition by performing routine inspections to determine condition and effectiveness, by restoration of destroyed vegetative cover, and by repair of erosion and sediment control measures and other protective measures. Use the following procedures to maintain the protective measures.

3.3.1 Silt Fence Maintenance

Inspect the silt fences in accordance with paragraph, entitled "Inspections," of this section. Any required repairs shall be made promptly. Pay close attention to the repair of damaged silt fence resulting from end runs and undercutting. Should the fabric on a silt fence decompose or become ineffective, and the barrier is still necessary, replace the fabric promptly. Remove sediment deposits when deposits reach one-third of the height of the barrier. Remove a silt fence when it is no longer required. The immediate area occupied by the fence and any sediment deposits must be shaped to an acceptable grade. The areas disturbed by this shaping must be seeded in accordance with UFGS Guide Specification 32 05 33 LANDSCAPE ESTABLISHMENT, except that the coverage requirements in paragraph, entitled "Establishment" of this section do not apply.

3.3.2 Straw Bale Maintenance

Inspect straw bale barriers in accordance with paragraph, entitled "Inspections". Pay close attention to the repair of damaged bales, end runs and undercutting beneath bales. Necessary repairs to barriers or replacement of bales must be accomplished promptly. Remove sediment deposits when deposits reach one-half of the height of the barrier. At the each end of each row turn bales uphill when used to retain sediment. Remove a straw bale barrier when it is no longer required. The immediate area occupied by the bales and any sediment deposits must be shaped to an acceptable grade. The areas disturbed by this shaping must be seeded in accordance with UFGS Guide Specification 32 92 19 SEEDING.

3.3.3 Diversion Dike Maintenance

Inspect diversion dikes in accordance with paragraph, entitled "Inspections,"of this section. Pay close attention to the repair of damaged diversion dikes and accomplish necessary repairs promptly. When diversion dikes are no longer requiredshape to an acceptable grade. The areas disturbed by this shaping must be seeded in accordance with UFGS Guide Specification 32 92 19 SEEDING.

3.4 INSPECTIONS

3.4.1 General

Inspect disturbed areas of the construction site, areas that have not been finally stabilized used for storage of materials exposed to precipitation, stabilization practices, structural practices, other controls, and area where vehicles exit the site at least once every seven (7) calendar days and within 24 hours of the end of any storm that produces 0.5 inches or more rainfall at the site. Conduct inspections at least once every month where sites have been finally stabilized.

3.4.2 Inspections Details

Inspect disturbed areas and areas used for material storage that are exposed to precipitation for evidence of, or the potential for, pollutants entering the drainage system. Observe erosion and sediment control measures to ensure that they are operating correctly. Inspect discharge locations or points to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Inspect locations where vehicles exit the site for evidence of offsite sediment tracking.

3.4.3 Inspection Reports

For each inspection conducted, prepare a report summarizing the scope of the inspection, name(s) and qualifications of personnel making the inspection, the date(s) of the inspection, maintenance performed, and actions taken. Furnish the report to the Contracting Officer within 24 hours of the inspection as a part of the Contractor's daily CQC REPORT. A copy of the inspection report must be maintained on the job site.

-- End of Section --

US Army Corps of Engineers.

Preliminary Subsurface Exploration and Geotechnical Engineering Report

WARRIOR TRANSITION UNIT
PN 071539

FORT EUSTIS

NEWPORT NEWS, VIRGINIA

March 2010

PREPARED BY:
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U.S. Army Corps of Engineers
803 Front Street
Norfolk, VA 23510

PRELIMINARY SUBSURFACE EXPLORATION AND GEOTECHNICAL REPORT

WARRIOR IN TRANSITION UNIT
PN 071539

FT EUSTIS, VIRGINIA

INTRODUCTION

The purpose of this report is to establish preliminary site subsurface conditions and provide general geotechnical considerations to bidders such that they can reasonably bid the project referenced in the Request for Proposal (RFP). The US Army Corps of Engineers Norfolk District (Corps) contracted Engineering & Testing Services, Inc (ETS) to perform the preliminary subsurface investigation which included a preliminary field investigation and soils laboratory testing. The results of ETS's investigation and subsurface conditions encountered are detailed in the ETS Geotechnical Engineering Service Report (ETS Report), dated 8 February 2010 (Appendix B). The Corps performed geotechnical evaluations based on the data provided by ETS and our general knowledge of conditions at Ft. Eustis. General design and construction considerations are presented herein.

The subsurface conditions and considerations in this report are based upon limited explorations and laboratory testing and are not intended for use in the design phase of the project. No environmental testing or sampling was performed as part of this work. Inquiries on the environmental history of this site can be made to the Fort Eustis, Dept. Public Works (DPW), Environmental Section. The Design-Build (DB) contractor's team shall include a licensed geotechnical engineer to interpret the site and subsurface conditions and to develop earthwork and foundation requirements and design parameters on which to base the Contractor's proposal. If the contractor deems that additional subsurface investigation or laboratory analysis is required to better characterize the site in order to base the bid on, it shall be performed prior to the award under the direction of a licensed geotechnical engineer and shall be the full responsibility of the Contractor. The Contractor to whom the contract is awarded, along with his geotechnical engineer will be required to perform a site specific geotechnical report as required in the RFP.

PROJECT AND SITE DESCRIPTION

Existing Conditions[1]

The proposed project site is situated within an open field encompassed between Madison Avenue, 25th Street and Sternberg Avenue at the Fort Eustis Military Reservation. Temporary trailer offices and its associated parking lot currently occupy the northwest corner of the proposed site, at the vicinity of the proposed 4-story barracks building. An existing gravel parking area is also situated at the northern corner of the site near the intersection of Madison Avenue and 25th Street.

Predominantly, the project site consists of an open grass covered field with rolling topography. An existing swale, draining southeast toward the Warwick River extends approximately from 25th Street between two existing parking areas, to the southern end of the proposed site within the existing tree line. Large decaying tree stumps and miscellaneous fill materials were also observed scattered throughout the project site surface areas.

From visual observations, multiple areas of the proposed site appeared previously developed. Underground utilities were also noted to be present within the vicinity of the proposed building locations. Existing site drainage is accomplished by surface water run-off via the existing swale toward Warwick River and infiltration into the ground.

Proposed Development

The proposed development consists of a 4-story barracks building, a 2-story Company Head Quarters building, and a Soldier & Family Support Center (SFAC) facility. Development outside of the building footprints will include roadways, parking, associated utilities, and two stormwater management ponds.

SUBSURFACE INVESTIGATION

Field investigation

ETS performed a preliminary geotechnical field investigation between 4 and 8 January 2010, consisting of fifteen (15) Standard Penetration Test (SPT) borings and two (2) Dilatometer Test (DMT) borings. A detailed description of the ETS's field investigation program and the logs of the SPT and DMT borings can be found in the ETS Report in Appendix B.

The investigation locations were marked in the field by a hand held Global Positioning System (GPS) device. The approximate investigation locations are shown on the boring

[1] Excerpt from ETS Geotechnical Engineering Service Report titled "*Proposed Ft. Eustis – WTU Exploration – PN 071539*", dated February 8, 2010. See Appendix A for the report in its entirety.

location map in Appendix A of this report. Based on the method used to locate the boring locations, the shown locations should be considered approximate. Boring elevations at the ground surface were interpolated between plan contours shown on the site plan and are accurate only to the degree implied by the method used for their determination. Approximate boring elevations are tabulated in Table A in Appendix A.

The boring location plan included in the ETS report shows boring locations in relation to the preliminary conceptual site layout used in early design meetings. However, the site layout had changed since the completion of the field investigation. The Offeror shall be aware that the building footprint location shown in the attached drawings may change during the final design process.

Laboratory Testing

Laboratory testing on both the bulk samples and the spilt-spoon samples was completed by ETS. Properties of the subsurface soils were determined by the following laboratory tests:

- Moisture Content
- Atterberg Limits
- Sieve Analysis
- California Bearing Ratio (CBR)

All laboratory tests were performed in accordance with ASTM standards. Test results and data are included in the ETS Report in Appendix B.

SUBSURFACE CONDITIONS

A general description of soil strata encountered at the project site is discussed in the ETS Report *Section 5.0 – Subsurface Soil Conditions* and Section *6.0 – Groundwater Observations* in Appendix B of this report.

GROUNDWATER CONDITIONS

The depth to groundwater at the time of the subsurface exploration was estimated to be between 6 ft and 12 ft and cave-in depths within the boring holes were observed at depths of approximately 1 to 4.5 ft. This estimate is based on visual observations of saturated soil samples collected during the exploration.

Clays encountered in the soil borings can cause perched groundwater to be encountered higher then the above estimated depths. Perched conditions occur when groundwater is prevented from draining deeper into the subsurface by layers of

relatively impermeable material. Dewatering of shallow excavations may be necessary if perched groundwater is encountered.

Depending on the time of year, deeper excavations for the utility construction activities will most likely require dewatering in order to keep the bottom of deeper excavations dry and stable. In order to stabilize wet excavation subgrades prior to backfilling, a layer of open-graded crushed stone, similar to VDOT No. 57, may be placed at the bottom of the excavation once all wet and loose material has been removed.

The depth to groundwater encountered at the time of exploration does not necessarily represent the conditions that will be encountered during construction. Groundwater levels are expected to fluctuate based on variations of rainfall, tides, temperature, perched conditions, and other similar factors.

FOUNDATION DESIGN CONSIDERATIONS

NOTE: At the time this report was prepared, final design values pertaining to building loads and possible site grading (cut and fill)l were not yet determined.

Based upon the preliminary geotechnical data, a shallow foundation system bearing on satisfactory natural ground or controlled structural fill may be used to support the proposed buildings with the service column and wall loads up to 125 kips and 5 kips, respectively. The allowable soil bearing capacity for the shallow foundation footings is estimated to be on the order of 2,500 pounds per square foot (psf). Minimum widths for continuous footings (wall footings) should be 2 ft and for column footings, 3 ft. Footings should be placed at least 24 inches below exterior finished grades to protect against seasonal freeze-thaw effects. Based on an assumed column loads of 125 kips and continuous wall loads of 5 kips per linear foot, settlement is not expected to exceed 1 inch. Building loads that generally exceed the loads stated above will require deep foundations in order to keep settlement within tolerable limits. Based on the preliminary geotechnical data, the Contractor shall consider supporting the 4-story barrack on a deep foundation system. Possible deep foundation alternatives include driven concrete piles, steel H-piles, or auger cast piles and other alternatives.

The contractor's professional geotechnical engineer should evaluate and verify the above preliminary bearing capacity and settlement values based on the final structure loads and subsurface parameters obtained from their final geotechnical investigation. The contractor's geotechnical engineer is responsible for designing an appropriate foundation system for all structures based on the final design values and the subsurface conditions encountered during the final investigation.

Slabs-on-grade may be supported on suitable natural soils or controlled structural fill and should be underlain by 6 inches of free draining granular base course (VDOT No. 57 stone or clean sand) and a vapor barrier.

SEISMIC SITE CLASSIFICATION

Based on Section 1613.5.2 of the 2006 International Building Code, the seismic site classification is "Class D". The seismic design parameters in the following table were obtained from the USGS Ground Motion Parameter application at http://earthquake.usgs.gov/research/hazmaps/design/index.php

Seismic Design Parameters		
Period, T (sec)	Maximum Considered Earthquake Ground Motion	Site Coefficient
0.2	S_S = *14.0 %g*	F_a = *1.6*
1.0	S_1 = *8.0 %g*	F_v = *2.4*

SITE PREPARATION

Foundation, slab-on-grade, and pavement subgrades shall be cleared of all organic materials, topsoil, vegetation, existing pavement, debris and other detrimental material prior to any fill or backfill placement. The subsurface exploration revealed that up to 18 inches of topsoil was encountered in borings B-2, B-3, B-6, and B-8 through B-15. Up to 2.5 ft of miscellaneous fill layer was encountered in borings B-1, B-4, B-5, and B-7. The miscellaneous fill layer should be removed and replaced with structural fill under any load bearing element and a minimum of 5-ft outside of the footprint of the proposed development; these soils are unsuitable for structure or pavement support due to the unknown nature of their placement. Many of the borings encountered an upper layer of man placed fill material which indicates the site may have been previously developed. Although the subsurface exploration did not reveal any buried structures, features such as gravel roadbeds, concrete pads, old foundation, or similar debris may exist across the site; these features may be encountered during clearing and grubbing operations. Grubbing and clearing of unsuitable materials may result in surface soil disturbance up to 3 ft, especially with regarding to the removal of root balls from large sized trees and miscellaneous fill materials.

The Offeror shall be aware that variations in the nature of subsurface conditions may be encountered in additional borings and during clearing operations and that isolated areas

of unsuitable soil such as the materials described above may exist on site; contingencies for the removal of this material should be considered during the planning and budgeting process. The Contractor should expect deeper and softer unsuitable, especially in the area of the drainage swale which passes through the site.

After unsuitable materials have been removed, exposed subgrades should be proof-rolled with a loaded dump truck or other pneumatic-tired vehicle of similar size and weight. The Contractor's geotechnical engineer and a Government representative shall be present to observe the proofroll. Any areas of soil identified as soft, loose, or of excessive moisture content shall be removed. The clay soils found in the borings at the building footprint and pavement areas are often problematic with regard to providing a firm and stable subgrade for fill or backfill placement and for bearing of footings. Portions of these soils will often exhibit pumping and rutting during proof-rolling and may be softened at foundation bearing grades. Undercutting and replacing these clay soils with structural fill will often be required and should be taken into consideration when preparing cost estimates for earthwork and site preparation. When removal of unsuitable soils is required at foundation bearing grades, the footing excavation shall be widened to at least twice the width of the original excavation.

The moist, natural, fine-grained, near-surface soils encountered on site are also susceptible to moisture changes and are subject to loss of strength during wet weather. When exposed to significant amounts of moisture, these near surface soils will become unstable for construction equipment. The construction area should be continually drained and vehicle activities should be limited during periods of heavy precipitation. Construction dewatering may be necessary during periods of heavy rainfall or if deep excavations are required for placement of new below-ground utilities. Drying and reworking of the natural soils are likely to be difficult during the wetter periods of the year; aerating and discing of subgrade soils is often necessary in order to reach acceptable moisture contents for proper compaction.

STRUCTURAL FILL AND BACKFILL

Any soils to be used as controlled structural fill or backfill within the pavement areas, the building footprint and 5 ft outside of the building footprint should classify per the Unified Soil Classification System (USCS) as SW, SP, SM, SC or combinations thereof. This soil shall also be non-expansive and free of organic matter, debris, and particles larger than 2-inches in size. For general site grading outside of pavement or building footprints, soils classified as CL, ML, MH or CH maybe used. *NOTE: soils classified as OH, OL, and PT are unsatisfactory in-situ and for any fill or backfill use.*

Fill and backfill compaction shall be achieved by sheeps-foot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Fill

or backfill soils shall be placed in maximum 12 inch loose lifts and shall be moistened or aerated as necessary to obtain dry density and moisture contents as determined by the Modified Proctor compaction test (ASTM D 1557). Compaction requirements are listed in the following table.

Structural Fill and Backfill Compaction Requirements per Modified Proctor, ASTM D 1557		
Location	Max. Dry Density *	Moisture Content
within building footprint, 5 ft outside of building footprint, beneath slabs & pavement areas	95%	within 3% of optimum
general grading in green areas	90%	within 3% of optimum

*compaction requirement may be reduced by 5% for cohesive soils (containing more than 35% passing the No. 200 sieve)

Each lift of structural fill or backfill should be tested for density and moisture content in order to confirm that compaction requirements have been met. Tests to verify compaction requirements should be performed for every 2,500 square ft of fill area, with a minimum of three tests per lift.

PAVEMENT

Traffic load data was not available at the time this report was prepared but is expected to consist primarily of two and three axle vehicles in drive lanes (passenger cars, panel vans, and delivery trucks) and two axle vehicles in parking areas (passenger cars and panel vans). California Bearing Ratio (CBR) tests based on Standard Proctor compaction (ASTM D 698) were performed on three bulk samples collected from within the upper 2 ft of borings B-11, B-12 and B-14. Test results are shown in the following table.

California Bearing Ratio Test Results per Standard Effort (ASTM D 698)		
Boring	Sample Description (classification)	CBR
B-11	Brown Silty Sandy CLAY (CL)	5.6
B-12	Brown Silty Sandy CLAY (CL)	13.6
B-14	Brown Silty Sandy CLAY (CL)	4.9

A subsurface drainage system may be required if the cohesive non-free draining soils are encountered beneath the proposed pavements. The subsurface drainage associated with pavements shall be in accordance with the Unified Facility Criteria (UFC 3-230-06A) dated 16 January 2004 or most current version. Design of all aspects of flexible and rigid pavements should be in accordance with current Army Technical Manuals or VDOT criteria.

CATHODIC PROTECTION

Cathodic protection is mandatory on buried ferrous metallic structures as described in Section 01 10 00 of the RFP. General criteria for the application and design of cathodic protection systems can be found in Unified Facilities Criteria (UFC) 3-570-02A "Cathodic Protection". Resistivity and pH of site soils was not determined during the preliminary geotechnical exploration. Consideration of soil properties with regards to cathodic protection shall be addressed in the follow-on geotechnical report.

Attached:

Appendix A

Project Site Location Map
Boring Location Map
Boring Elevation Table

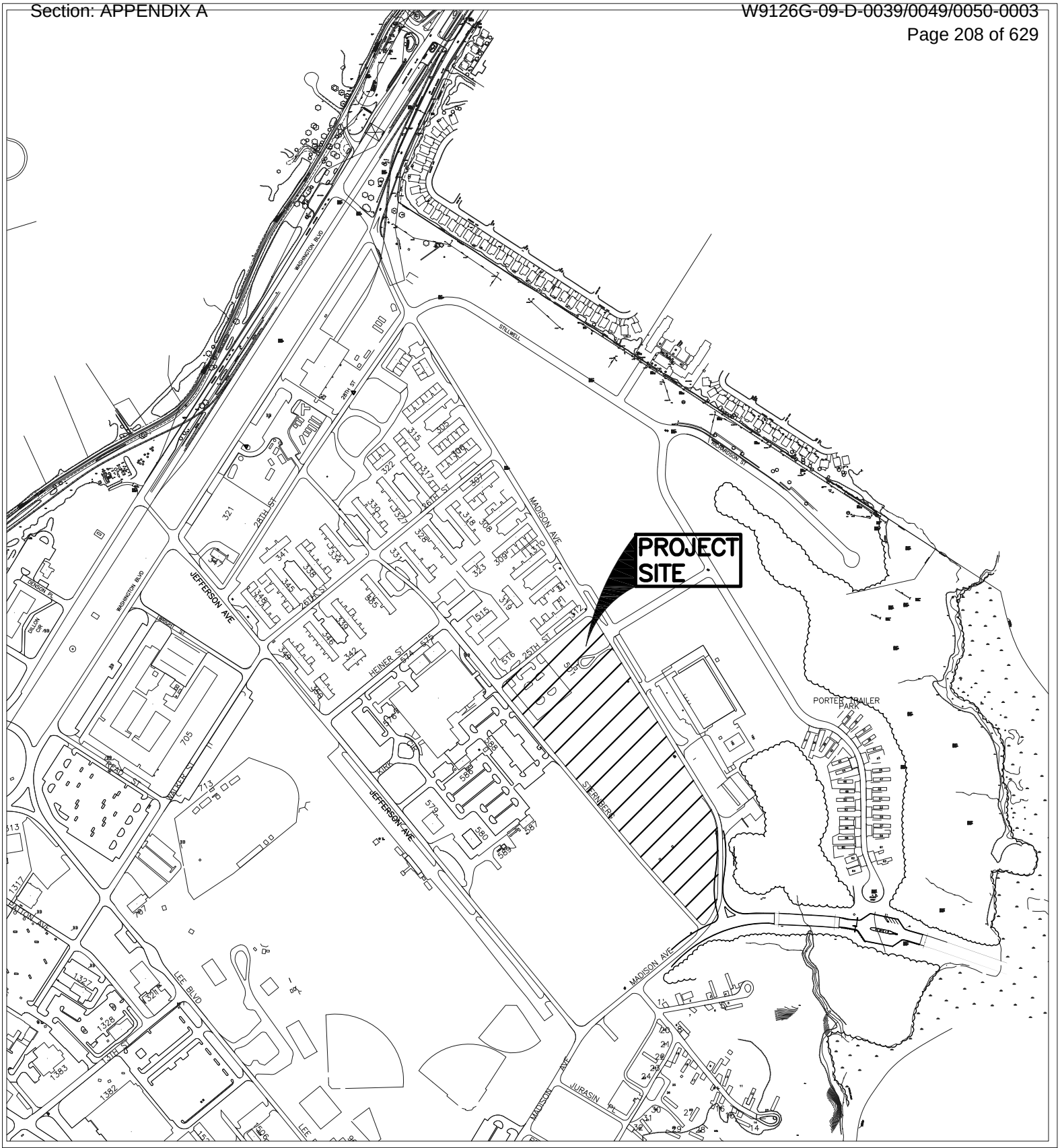
Appendix B

Engineering & Testing Services, Inc Geotechnical Services Report, February 8, 2010

- Preliminary field investigation program
- Subsurface conditions
- SPT and DMT borings logs
- Laboratory results

APPENDIX A

Project Site Location Map
Boring Location Map
Boring Elevations Table

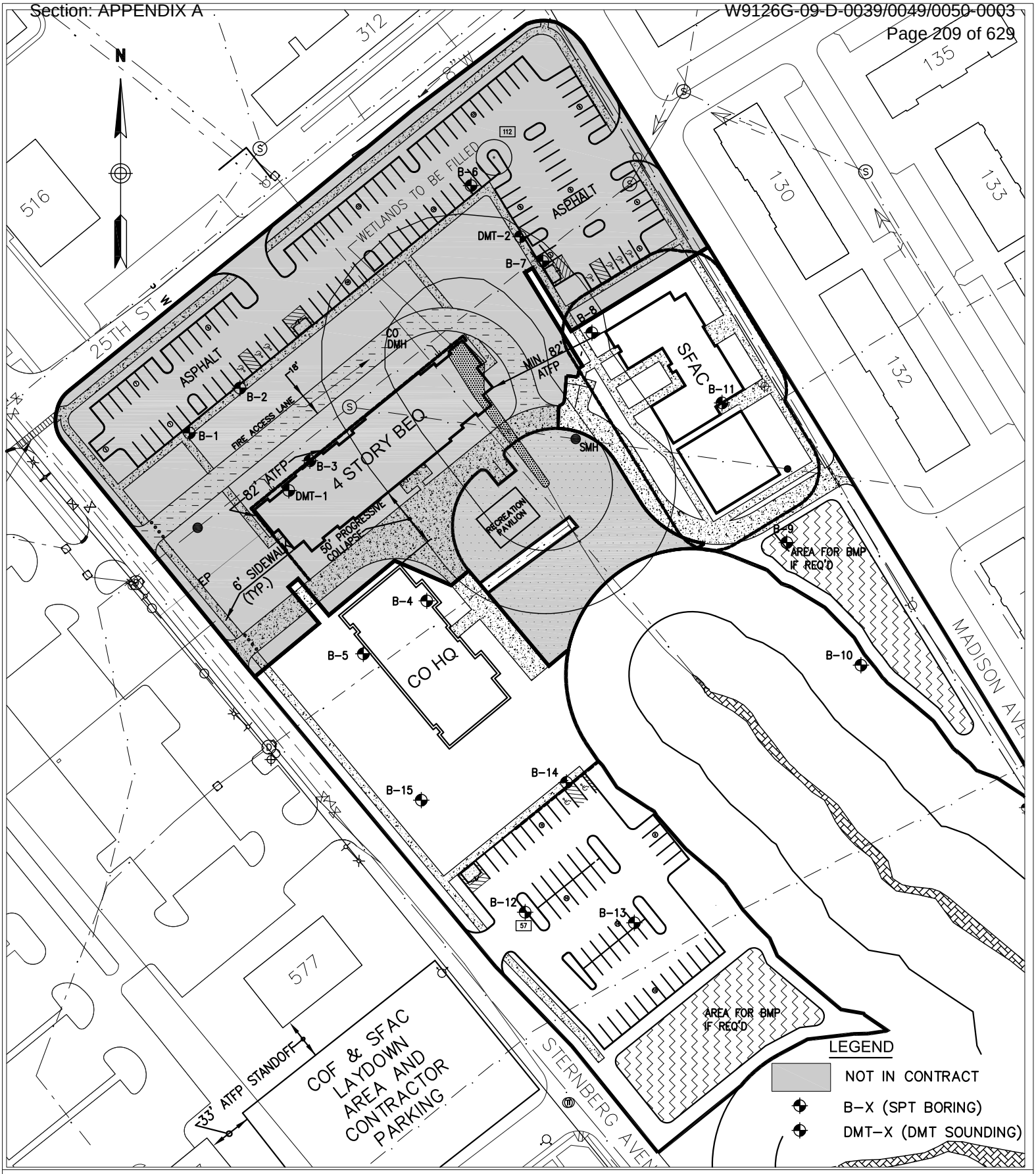


Project Site Location Map

Warrior–in–Transition Unit, Ft Eustis
Newport News, VA

NTS

Friday, October 29, 2010



Boring Location Plan

Warrior-in-Transition Unit, Ft Eustis
Newport News, VA

0 50 100 200 300

NTS

Friday, October 29, 2010

Table A – Approximate Boring Elevations

Boring ID	Approx Ground El
DMT-1	38
DMT-2	37
B-1	38
B-2	38
B-3	38
B-4	36
B-5	36
B-6	38
B-7	37
B-8	37
B-9	37
B-10	35.5
B-11	37
B-12	36.5
B-13	37
B-14	37.5
B-15	36.5

APPENDIX B

ETS Geotechnical Services Report (8 February 2010)

- Preliminary field investigation program
- Subsurface conditions
- SPT and DMT borings logs
- Laboratory results

ENGINEERING & TESTING SERVICES, INC.

February 8, 2010

To: U.S. Army Corps of Engineers
Geotechnical-Environmental Engineering Sect - Norfolk District
803 Front Street
Norfolk, Virginia 23510

Attn: Mr. H. Marcus Kim, EIT

Re: Geotechnical Engineering Services Report
Proposed Ft. Eustis - WTU Exploration – PN 071539
Ft. Eustis, Virginia
ETS Report No.: ETS-09E134-1

Dear Mr. H. Marcus Kim:

Transmitted herewith is the Geotechnical Engineering report for the referenced project. This subsurface exploration study was authorized by you in accordance with ETS proposal ETS-09P243R for the Proposed Ft. Eustis Warriors Transition Unit Exploration and Testing project.

This report contains the results of our field exploration program and laboratory testing procedures of subsurface materials at the proposed WTU building locations located at the open field and temporary facilities encompassed by Madison Avenue, 25th Street and Sternberg Avenue at the Ft. Eustis military installation. We will store the soil samples for 30 days after which time they will be discarded, unless you request otherwise.

We appreciate the opportunity to be of service to you on this project. If we can be of further assistance, such as providing our inspection services during construction, or providing engineering recommendations for foundation design and construction related activities, or if you have any questions regarding this report, please contact our office at 757-306-1040.

Respectfully Submitted,
Engineering and Testing Services, Inc.

Veldon R. Sallee, P.E.
Project Engineer
VA License No.: 41765

COMMONWEALTH OF VIRGINIA
VELDON R. SALLEE
Lic. No. 041765
2/8/2010
PROFESSIONAL ENGINEER

5226 Indian River Road • Suite 102 • Virginia Beach, VA 23464 • *phone 757.306.1040* • *fax 757.306.1042*
www.etsva.com

1.0 PURPOSE AND SCOPE OF STUDY

The purpose of these services was to provide support to the USACE-Norfolk District in conducting a preliminary geotechnical investigation for the proposed construction OF multiple WTU buildings and parking lots. Our Geotechnical Engineering services included sampling and testing of in-situ materials at proposed building locations and determination of the general subsurface soil conditions by drilling Standard Penetration Test (SPT) borings, dilatometer (DMT) soundings, and conducting laboratory testing to be used by USACE-Norfolk District for independent evaluation of the soil conditions.

2.0 SITE AND PROJECT CHARACTERISTICS

The proposed project site is situated within an open field encompassed between Madison Avenue, 25th Street and Sternberg Avenue at the Ft. Eustis Military Reservation. Temporary trailer offices and its associated parking lot currently occupy the northwest corner of the proposed site, at the vicinity of the proposed 4-story barracks building. An existing gravel parking area is also situated at the northern corner of the site near the intersection of Madison Avenue and 25th Street.

Predominantly, the project site consists of an open grass covered field with rolling topography. An existing swale, draining southeast toward the Warwick River extends approximately from 25th Street between two existing parking areas, to the southern end of the proposed site within the existing tree line. The depth of the existing swale ranges from a few inches deep at the northern end, upward to several feet deep at the southern end where existing site grades drop drastically within the tree line. Large decaying tree stumps and miscellaneous fill materials were also observed scattered throughout the project site surface areas.

From visual observations, multiple areas of the proposed site appeared previously developed. Underground utilities were also noted to be present within the vicinity of the proposed building locations. Existing site drainage is accomplished by surface water run-off via the existing swale toward Warwick River and infiltration into the ground.

Proposed developments for this project include the design and construction of a 4-story permanent barracks (48,200 SF), a 2-story Company Head Quarters building (17,350 SF) and a Soldier & Family Support Center-SFAC (7,000 SF) facility. Two parking areas, accessed from either Madison Avenue or Sternberg Avenue, will be constructed to the service these buildings.

The proposed barracks is expected to have column loads on the order of 200 kips and wall loads on the order of 12 kips-per-linear-foot (klf). The two-story Company HQ is expected to have foundation loads on the order of 100 kips and 4 klf for column and wall

loads, respectively. The SFAC is anticipated to have column and wall loads on the order of 60 kips and 2 klf, respectively. It is our understanding that the buildings will be mainly supported by load-bearing walls and columns with slab-on-grade construction.

3.0 FIELD EXPLORATION PROGRAM

In order to explore the general subsurface soil types and to aid in developing a preliminary subsurface investigation for the proposed construction, two 75 feet deep Standard Penetration Test (SPT) Borings, designated as B-1 and B-4, three 50 feet borings, designated as B-2, B-3 and B-5, five 35 feet SPT borings, designated as B-6 through B-10, and five 10 feet deep SPT borings, designated as B-11 through B-15, were drilled at strategic locations across the project site at the vicinity of the proposed building and parking improvements. The SPT borings were performed with the use of a power drill rig using mud-rotary drilling procedures. The soil samples were obtained with a Split-Spoon Sampler in general accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). The SPT samples were collected continuously from the ground surface to a 10 foot depth and at 5 foot intervals thereafter. The soil samples were obtained with a standard 2-inch outside diameter and 30-inch long split spoon sampler with each SPT. The split spoon sampler was driven 24 inches into the subsoils by a 140 pound hammer falling approximately 30 inches. The number of blows required to drive the sampler each 6-inch increment of penetration was recorded and is noted on the boring logs. The recorded SPT N-value (blows per foot) noted in this report is the sum of the second and third penetration increments.

In addition to the SPT borings, two Marchetti Dilatometer (DMT) soundings were conducted to depths of 75 feet at DMT-1 and approximately 35 feet at DMT-2. Three bulk California Bearing Ratio (CBR) samples were also collected at the proposed pavement borings, B-11 through B-15, and transported to our USACE validated laboratory for CBR testing in order to characterize the proposed parking subgrade materials.

Soil test borings and DMT soundings were located and staked in the field by others. The approximate boring locations are depicted on the Boring Location Plan included in the appendix (Appendix I) of this report. The soil boring logs, soil profiles and DMT profiles are also included in Appendix II, III and IV of this report, respectively.

4.0 LABORATORY TESTING PROCEDURES

Representative portions of all soil samples collected during the drilling operations were sealed in glass jars, labeled and transferred to our USACE validated laboratory for classification and analysis. Visual soil classifications were performed under the direction of a Geotechnical Engineer in accordance with the Unified Soil Classification System-USCS (ASTM Standards D2487 and D2488). Representative soil samples from the SPT

borings were selected and subjected to natural moisture content (ASTM D2216), Atterberg Limits (ASTM D4318) and No. 200-Sieve Analysis (ASTM D1140) testing. The purpose of these tests was to substantiate the visual soil classifications and to provide guidance for the estimation of soil design parameters. The laboratory test results are presented in the Summary of ETS Laboratory Test Results table located in the appendix (Appendix V) of this report.

In addition to the laboratory classification testing conducted on select jar samples, ETS performed California Bearing Ratio (CBR) testing on each of the bulk samples collected from pavement borings B-11, B-12 and B-14. The bulk CBR samples were transported to the ETS laboratory and subjected to natural moisture content testing (D2216), No. 200-Sieve Analysis (D1140), and moisture-density relationship testing (Standard Proctor D698). The CBR test results of bulk samples retrieved from borings B-11, B-12 and B-14 achieved an average CBR value of 8.0 (5.6, 13.6 and 4.9, respectively). The Standard Proctor maximum dry density and CBR test results are included in the appendix (Appendix VI) of this report.

5.0 SUBSURFACE SOIL CONDITIONS

The results of our field exploration program indicated the presence of approximately 4 to 18 inches of topsoil materials at the surface of the test boring locations. Approximately 1 to 2.5 feet of uncontrolled fill materials were also intermixed within the upper surface materials at borings B-1, B-4, B-5, and B-7. The fill materials predominantly consisted of gravel fill and miscellaneous debris intermixed with topsoil and sandy clayey soils. The depths of topsoil materials, uncontrolled fill, debris, or other unsuitable surficial materials may be expected to vary across the project site. Underlying the topsoil materials and fill debris, the subsurface soils consisted of alternating layers granular sandy soils (SP-SM, SM, SC-SM) overlying cohesive lean sandy clays (CL) and fat clays (CH). In general, the slightly silty sands (SP-SM), silty sands (SM) and lean sandy clay (CL) soils were encountered from existing ground surfaces to mid-boring depths, and the silty clayey sands (SC-SM) and fat clay (CH) materials were encountered from mid-boring depths to boring termination depths.

Granular materials encountered at the test borings consisted of silty sands (SM), silty clayey sands (SC-SM) and slightly silty sands (SP-SM), with varying amounts of silts and clay. The Standard Penetration Test results, N-values, recorded within these granular materials ranged from 4 to 44 blows per foot (BPF), indicating very loose to dense relative density.

Cohesive lean sandy clays (CL) and fat clays (CH) were also encountered at the test borings with substantial frequency. Standard Penetration Test results, N-values, recorded within these soil types ranged from 2 to 25 blows per foot (BPF) indicating very soft to very stiff relative consistency.

Dilatometer soundings conducted at the proposed 4-story barracks (DMT-1) and proposed 2-story HQ building (DMT-2) also indicated alternating layers of sands, silty sands, clayey silts, clays and silty clays. Data retrieved from the moisture content results, Atterberg Limits test results and DMT strength profiles (located in the appendix) indicate that the subsurface materials encountered at the DMT soundings and SPT test borings appear over-consolidated. "Over-consolidated" refers to a soil's stress history in which the in-situ soils have experienced previous overburden pressures greater than the current in-situ overburden. When loaded, over-consolidated soils are inherently less compressible than normally consolidated soils. "Normally consolidated" refers to a soil matrix in which the current overburden pressure is the maximum pressure ever exerted on the soil matrix in the history of its deposition.

6.0 GROUNDWATER OBSERVATIONS

6.1 Groundwater Level:

The groundwater level was measured at the boring locations during the drilling operations. The groundwater level at the boring locations was measured to be approximately 6 to 12 feet below the existing grades. Cave-in depths within the boring holes were observed at depths of approximately 1 to 4.5 feet below existing grades. It should be noted that the groundwater levels tend to fluctuate during periods of prolonged drought and extended rainfall. In general, high groundwater levels are normally recorded in late winter and early spring. It should be noted that groundwater conditions will vary with environmental variations, seasonal conditions and site specific topography, such as existing swales, in-place drainage systems and ground cover.

6.2 Groundwater Concerns:

It is expected that dewatering will be required for excavations, which extend below 6 to 8 feet from existing grades. Dewatering at depths below the groundwater table from existing grades may require well pointing. It is recommended that the contractor determine the actual groundwater levels at the time of construction to determine groundwater impact during construction at this project.

7.0 WARRANTY AND LIMITATIONS OF STUDY

Our professional services have been performed and our findings obtained in accordance with generally accepted Geotechnical engineering principles and practices. This warranty is in lieu of all warranties, either express or implied. ETS, Inc. is not responsible for the independent conclusions; opinions or recommendations made by others based on the field exploration program and laboratory test data presented in this report.

The details of this report were developed from the information obtained from the test borings, which only depict subsurface conditions at the specific locations, times and depth shown on the logs. Soils conditions at other locations may differ from those encountered at the test borings, and the passage of time may cause the soil conditions to change from those described in this report.

The nature and extent of variation and change in the subsurface conditions at the site may not become evident until the course of construction. Construction monitoring by the Geotechnical Engineer or by his representative is therefore considered necessary to verify the subsurface conditions and to check that the soils construction phases are conducted properly. If significant variations or changes are in evidence, if the project characteristics are altered from those discussed in this report, or if additional information becomes available, a review should be made by this office to determine if any modifications in the exploration program will be required.

The scope of our services does not include design recommendations, environmental assessment, or investigations for the possible presence of hazardous or toxic materials in the soil, groundwater or surface water within or in the general vicinity of the proposed study area. Any statements made in this report or shown on the test boring logs regarding unusual subsurface conditions, and/or composition, odor, staining, origin or other characteristics of the surface and/or subsurface materials are strictly for the information of our client and may or may not be indicative of an environmental problem. Unless complete environmental information regarding the site is already available, an environmental assessment is recommended prior to the development of this site.

APPENDICES

APPENDIX I – BORING LOCATION PLAN

APPENDIX II – SOIL BORING LOGS

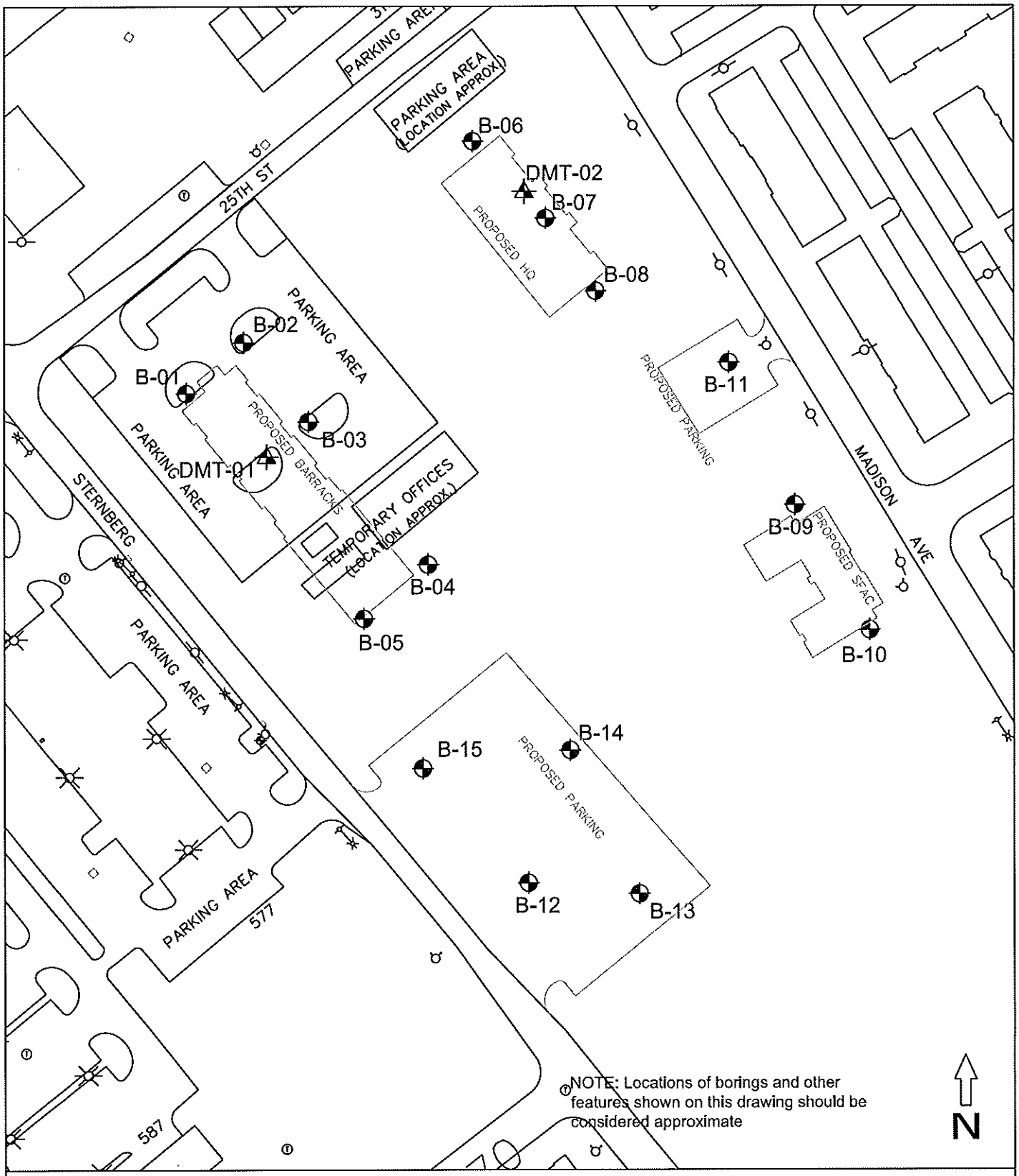
APPENDIX III – SOIL BORING PROFILES

APPENDIX IV – DMT SOUNDING PROFILES & TEST RESULTS

APPENDIX V – SUMMARY OF ETS LABORATORY TEST RESULTS

APPENDIX VI – STANDARD PROCTOR & CBR TEST RESULTS

APPENDIX I – BORING LOCATION PLAN



DMT Boring

SPT Boring

1 inch = 100 ft

0 20 100 200

Boring Location Drawing

Warrior Training Unit, Ft Eustis

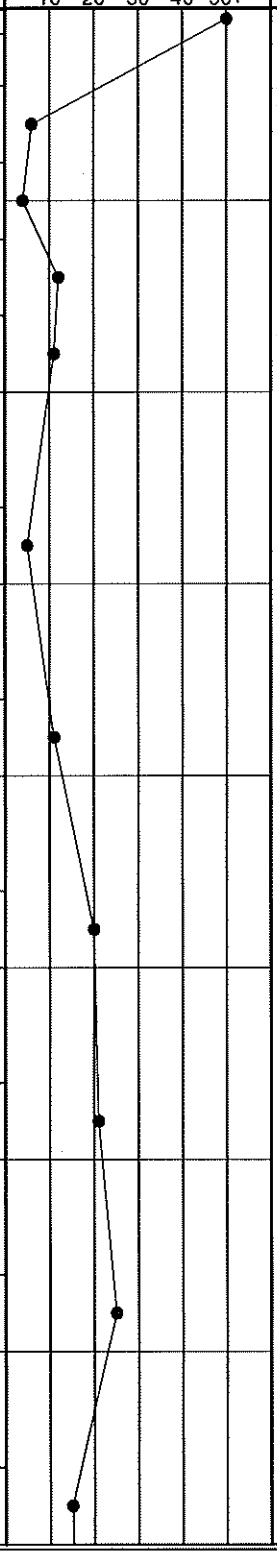
Newport News, VA

APPENDIX II – SOIL BORING LOGS

Project No. ETS-09E134		Date 05JAN2010	Sheet 1 of 2
Project FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION			
Client US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT			
Boring Location NORTHWEST CORNER OF 5-STORY BLDG		Ground Elevation	Hole No. B-1
Project Location FT EUSTIS - NEWPORT NEWS, VIRGINIA	Drill Method MUD ROTARY	Station	Depth of Hole: (Ft) 75
Name of Foreman HCEA	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft) 7.0	At Completion: (Ft)
Name of Inspector V. SALLEE, P.E.	After Hours Feet		Cave in at: (Ft) 4.5

Depth (ft.)	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Remarks
0	BROWN, MOIST, SAND & SILT (SM), WITH DEBRIS AND GRAVEL (FILL)	S-1	5 50/1"	6	
	BROWN, MOIST, FINE TO COARSE SILTY SAND (SM), TRACE GRAVEL, WITH ORGANIC MATERIAL, LOOSE	S-2	4 3 / 3 3	12	FILL TO 2.5'
5	LIGHT BROWN, WET, FINE TO MEDIUM, SILTY SAND (SM), VERY LOOSE	S-3	0 1 / 3 5	14	
	LIGHT BROWN, WET, FINE TO MEDIUM, SILTY SAND (SM), MEDIUM DENSE	S-4	5 6 / 6 10	18	
	ORANGE, WET, FAT SANDY CLAY (CH), STIFF	S-5	5 5 / 6 5	24	LL- 51 PI- 33 USCS- CH
10					
15	GREEN TO GRAY, SATURATED, FINE TO COARSE, SILTY CLAYEY SAND (SC-SM), LITTLE TO TRACE GRAVEL, WITH MARINE SHELL FRAGMENTS, VERY LOOSE TO MEDIUM DENSE	S-6	1 2 / 3 5	24	
		S-7	4 4 / 7 10	20	
20					
25		S-8	5 8 / 12 19	24	
		S-9	8 7 / 14 24	20	
30					
35	GRAY, SATURATED, FAT CLAY (CH), TRACE FINE SAND, TRACE MARINE SHELL FRAGMENTS, VERY STIFF TO STIFF	S-10	4 9 / 16 20	24	
		S-11	4 7 / 8 11	24	LL- 76 PI- 54
40					

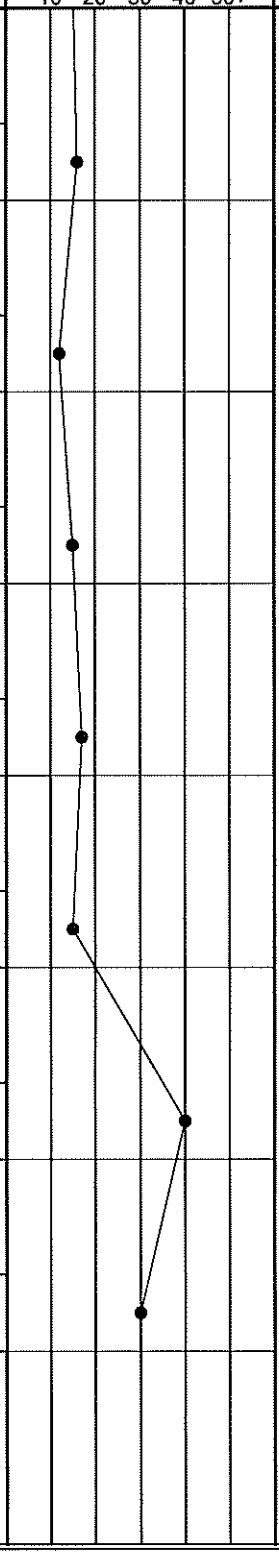
Standard Penetration Test Blows/Ft.



Project No. ETS-09E134		Date 05JAN2010	Sheet 2 of 2
Project FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION			
Client US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT			
Boring Location NORTHWEST CORNER OF 5-STORY BLDG		Ground Elevation	Hole No. B-1
Project Location FT EUSTIS - NEWPORT NEWS, VIRGINIA	Drill Method MUD ROTARY	Station	Depth of Hole: (Ft) 75
Name of Foreman HCEA	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft) 7.0	At Completion: (Ft)
Name of Inspector V. SALLEE, P.E.	After Hours Feet		Cave in at: (Ft) 4.5

Depth (ft.)	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Remarks
40					USCS- CH
		S-12	4 7 9 10	24	
45					
		S-13	5 6 6 7	24	
50	GRAY, WET, NON-PLASTIC SILT (ML/SM) AND FINE SAND, TRACE CLAY, STIFF				
	GRAY, WET, SILTY FAT CLAY (CH), LITTLE FINE SAND, WITH MARINE SHELL FRAGMENTS, STIFF	S-14	3 7 8 12	24	LL- 55 PI- 32 USCS- CH
55					
	GREEN-GRAY, SATURATED, FINE TO COARSE, CLAYEY SILTY SAND (SC-SM), WITH MARINE SHELL FRAGMENTS, MEDIUM DENSE	S-15	5 8 9 11	24	
60					
		S-16	5 6 9 16	24	
65					
	GREEN-GRAY, SATURATED, FINE TO MEDIUM, SLIGHTLY SILTY SAND (SP-SM), DENSE TO MEDIUM DENSE	S-17	5 17 23 44	24	
70					
		S-18	4 12 18 24	24	
75	BORING TERMINATED AT 75 FEET				
80					

Standard Penetration Test Blows/Ft.



ETS	Project No. ETS-09E134	Date 04JAN2010	Sheet 1 of 2
	Project FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION		
	Client US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT		
	Boring Location NORTHEAST CORNER OF 5-STORY BLDG	Ground Elevation	Hole No. B-2
Project Location FT EUSTIS - NEWPORT NEWS, VIRGINIA	Drill Method MUD ROTARY	Station	Depth of Hole: (Ft) 50
Name of Foreman HCEA	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft) 7.5	At Completion: (Ft)
Name of Inspector V. SALLEE, P.E.	After Hours Feet		Cave in at: (Ft) 2.0

Depth (ft.)	Legend	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Standard Penetration Test Blows/Ft. (10 20 30 40 50+)	Remarks
0		BROWN, MOIST, SILTY SANDY CLAY (CL), TRACE FINE GRAVEL, MEDIUM STIFF	S-1	2 3 5 8	14		18" TOPSOIL
		LIGHT BROWN, MOIST, LEAN CLAY (CL), LITTLE TO TRACE, FINE TO MEDIUM, SILTY SAND, STIFF TO VERY STIFF	S-2	3 5 7 9	18		
5			S-3	5 8 10 12	18		
		DARK BROWN, WET, FINE TO MEDIUM, SILTY SAND (SM), TRACE CLAY, MEDIUM DENSE	S-4	5 8 8 7	22		
		ORANGE, SATURATED, FINE TO MEDIUM, SILTY SAND (SM), TRACE CLAY, LOOSE	S-5	1 4 3 4	18		
10							
		GREEN, SATURATED, FINE TO COARSE, SILTY CLAYEY SAND (SC-SM), TRACE MARINE SHELL FRAGMENTS, LOOSE TO MEDIUM DENSE	S-6	3 3 4 4	24		
15							
			S-7	3 8 7 10	24		
20							
		GRAY, SATURATED, FINE TO COARSE, SILTY SAND (SM), TRACE CLAY, WITH MARINE SHELL FRAGMENTS, MEDIUM DENSE	S-8	7 7 10 17	24		
25							
			S-9	6 9 14 22	24		
30							
		GRAY, SATURATED, SILTY CLAYEY SAND (SC-SM), WITH MARINE SHELL FRAGMENTS, MEDIUM DENSE	S-10	3 4 8 13	24		
35							
40		GRAY, SATURATED, FAT CLAY (CH), TRACE FINE SILTY SAND, VERY STIFF TO STIFF	S-11	6 8 10 13	24		

Project No. ETS-09E134		Date 04JAN2010	Sheet 2 of 2
Project FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION			
Client US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT			
Boring Location NORTHEAST CORNER OF 5-STORY BLDG		Ground Elevation	Hole No. B-2
Project Location FT EUSTIS - NEWPORT NEWS, VIRGINIA	Drill Method MUD ROTARY	Station	Depth of Hole: (Ft) 50
Name of Foreman HCEA	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft) 7.5	At Completion: (Ft)
Name of Inspector V. SALLEE, P.E.	After Hours Feet		Cave in at: (Ft) 2.0

Depth (ft.)	Legend	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Standard Penetration Test Blows/Ft. 10 20 30 40 50+	Remarks
40		GRAY, SATURATED, FAT CLAY (CH), TRACE FINE SILTY SAND, VERY STIFF TO STIFF					
			S-12	4 7 9 10	24		LL- 74 PI- 52 USCS- CH
45							
			S-13	6 7 8 7	18		
50		BORING TERMINATED AT 50 FEET					
55							
60							
65							
70							
75							
80							

Project No.	Date	Sheet 1 of 2
ETS-09E134	04JAN2010	

Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION

Client: US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT

Boring Location	Ground Elevation	Hole No.
		B-3

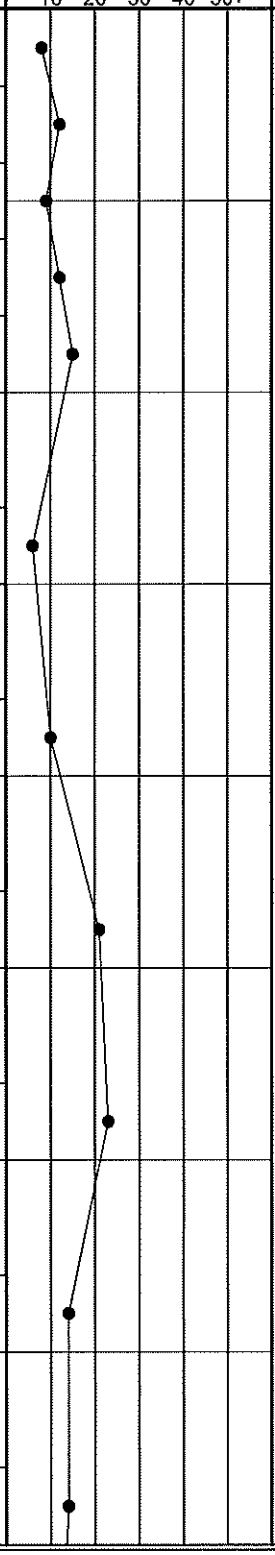
Project Location	Drill Method	Station	Depth of Hole: (Ft)
FT EUSTIS - NEWPORT NEWS, VIRGINIA	MUD ROTARY		50

Name of Foreman	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft)	At Completion: (Ft)
HCEA		7.5	

Name of Inspector	After Hours Feet	Cave in at: (Ft)
V. SALLEE, P.E.		3.5

Depth (ft.)	Legend	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Remarks
0		LIGHT BROWN, MOIST, FINE TO COARSE, SILTY SAND (SM), TRACE CLAY, TRACE FINE TO MEDIUM GRAVEL, LOOSE	S-1	2 4 4 5	16	6" TOP SOIL
		ORANGE-BROWN, WET, LEAN CLAY (CL), TRACE FINE SILTY SAND, STIFF TO MEDIUM STIFF	S-2	2 5 7 9	18	
5			S-3	3 4 5 7	22	
		LIGHT BROWN, WET, FINE TO MEDIUM, SILTY SAND (SM), TRACE CLAY, MEDIUM DENSE	S-4	4 6 6 4	20	
		LIGHT BROWN, SATURATED, FINE TO COARSE, SLIGHTLY SILTY SAND (SP-SM), MEDIUM DENSE	S-5	2 6 9 10	18	
10						
		LIGHT BROWN, WET, LEAN SANDY CLAY (CL), MEDIUM STIFF	S-6	2 2 4 6	18	LL- 47 PI- 29 USCS- CL
15						
		GREEN, SATURATED, FINE TO COARSE, SILTY SAND (SM), TRACE CLAY, WITH MARINE SHELL FRAGMENTS, LOOSE	S-7	4 5 5 5	24	
20						
		GREEN, SATURATED, FINE TO COARSE, SILTY CLAYEY SAND (SC-SM), MEDIUM DENSE	S-8	5 8 13 22	24	
25						
			S-9	9 10 13 21	24	
30						
		GREEN-GRAY, SATURATED, FAT CLAY (CH), TRACE FINE SILTY SAND, STIFF	S-10	4 5 9 16	24	LL- 63 PI- 41 USCS- CH
35						
40			S-11	3 6 8 10	24	

Standard Penetration Test Blows/Ft.



Project No.	Date	Sheet 2 of 2
ETS-09E134	04JAN2010	

Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION

Client: US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT

Boring Location	Ground Elevation	Hole No.
		B-3

Project Location	Drill Method	Station	Depth of Hole: (Ft)
FT EUSTIS - NEWPORT NEWS, VIRGINIA	MUD ROTARY		50

Name of Foreman	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft)	At Completion: (Ft)
HCEA		7.5	

Name of Inspector	After	Hours	Feet	Cave in at: (Ft)
V. SALLEE, P.E.				3.5

Depth (ft.)	Legend	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Standard Penetration Test Blows/Ft. (10 20 30 40 50+)	Remarks
40		GREEN-GRAY, SATURATED, FAT CLAY (CH), TRACE FINE SILTY SAND, STIFF					
			S-12	3 5 7 8	24		
45							
			S-13	5 7 8 8	20		
50		GRAY, SATURATED, FINE TO MEDIUM, SILTY SAND (SM), TRACE CLAY, MEDIUM DENSE					
		BORING TERMINATED AT 50 FEET					
55							
60							
65							
70							
75							
80							

Project No.	Date	Sheet 1 of 2
ETS-09E134	06JAN2010	

Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION

Client: US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT

Boring Location	Ground Elevation	Hole No.
		B-4

Project Location	Drill Method	Station	Depth of Hole: (Ft)
FT EUSTIS - NEWPORT NEWS, VIRGINIA	MUD ROTARY		75

Name of Foreman	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft)	At Completion: (Ft)
HCEA		6.0	

Name of Inspector	After	Hours	Feet	Cave in at: (Ft)
V. SALLEE, P.E.				4.25

Depth (ft.)	Legend	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Standard Penetration Test Blows/Ft. (10 20 30 40 50+)	Remarks
0		LIGHT BROWN-DARK BROWN, MOIST, FINE TO COARSE SILTY SAND (SM), TRACE FINE TO COARSE GRAVEL, WITH ORGANIC MATTER & DEBRIS (FILL), MEDIUM DENSE	S-1	4 5 11 14	14		FILL TO 20"
			S-2	2 2 5 6	16		
		LIGHT BROWN, MOIST, LEAN CLAY (CL), TRACE FINE TO MEDIUM SAND, MEDIUM STIFF	S-3	3 4 5 4	18		
5		LIGHT BROWN, SATURATED, FINE TO MEDIUM SILTY CLAYEY SAND (SC-SM), TRACE GRAVEL, LOOSE	S-4	2 3 7 30	18		
		TRACE MEDIUM GRAVEL AT 6'	S-5	2 3 3 3	24		
10		ORANGE, SATURATED, FINE TO COARSE SILTY CLAYEY SAND (SC-SM), WITH SHELL FRAGMENTS AND CALCIFIED DEPOSITS, LOOSE					
			S-6	3 5 4 4	12		
15							
20		GREEN-GRAY, SATURATED, FINE TO COARSE, SILTY CLAYEY SAND (SC-SM), WITH MARINE SHELL FRAGMENTS, MEDIUM DENSE	S-7	4 5 9 10	24		
			S-8	4 6 10 16	24		
25							
			S-9	7 6 8 11	24		
30							
35		GRAY, SATURATED, FAT CLAY (CH), TRACE FINE SILTY SAND, WITH MARINE SHELL FRAGMENTS, VERY STIFF	S-10	5 7 10 13	24		
			S-11	3 6 8 9	24		
40							

Project No.	Date	Sheet 2 of 2
ETS-09E134	06JAN2010	

Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION

Client: US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT

Boring Location	Ground Elevation	Hole No.
		B-4

Project Location	Drill Method	Station	Depth of Hole: (Ft)
FT EUSTIS - NEWPORT NEWS, VIRGINIA	MUD ROTARY		75

Name of Foreman	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft)	At Completion: (Ft)
HCEA		6.0	

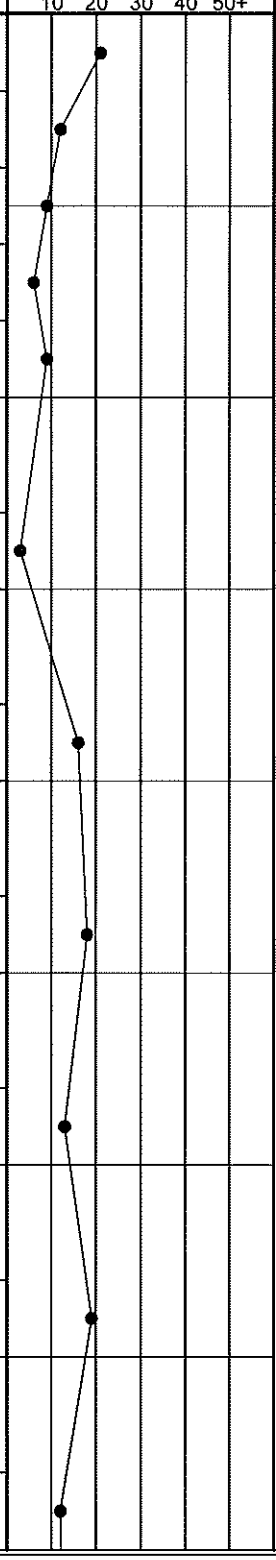
Name of Inspector	After Hours Feet	Cave in at: (Ft)
V. SALLEE, P.E.		4.25

Depth (ft.)	Legend	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Standard Penetration Test Blows/Ft. (10 20 30 40 50+)	Remarks
40		GRAY, SATURATED, FAT CLAY (CH), TRACE FINE SILTY SAND, WITH MARINE SHELL FRAGMENTS, VERY STIFF					
			S-12	4 5 6 8	24		
45							
			S-13	4 5 7 8	24		
50							
			S-14	5 7 10 11	24		
55		GREEN-GRAY, SATURATED, FINE TO COARSE, SILTY CLAYEY SAND (SC-SM), WITH MARINE SHELL FRAGMENTS, MEDIUM DENSE					
			S-15	5 7 10 11	24		
60							
			S-16	4 8 9 15	24		
65		GREEN-GRAY, SATURATED, FINE TO MEDIUM, SILTY SAND (SM), TRACE CLAY, MEDIUM DENSE					
			S-17	3 8 14 18	24		
70							
			S-18	5 7 11 15	24		
75		GREEN-GRAY, SATURATED, FINE TO COARSE, SILTY CLAYEY SAND (SC-SM), WITH MARINE SHELL FRAGMENTS, MEDIUM DENSE					
		BORING TERMINATED AT 75 FEET					
80							

Project No. ETS-09E134		Date 06JAN2010	Sheet 1 of 2
Project FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION			
Client US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT			
Boring Location		Ground Elevation	Hole No. B-5
Project Location FT EUSTIS - NEWPORT NEWS, VIRGINIA	Drill Method MUD ROTARY	Station	Depth of Hole: (Ft) 50
Name of Foreman HCEA	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft) 12	At Completion: (Ft)
Name of Inspector V. SALLEE, P.E.	After Hours Feet		Cave in at: (Ft) 1.5

Depth (ft.)	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Remarks
0	LIGHT BROWN, MOIST, SANDY CLAY (CL), WITH GRAVEL FRAGMENTS & TRACE DEBRIS (FILL TO 12"), VERY STIFF	S-1	2 13 8 9	18	FILL TO 12"
	LIGHT BROWN, MOIST, LEAN SANDY CLAY (CL), STIFF	S-2	3 5 7 11	18	
5	LIGHT BROWN, WET, FINE TO MEDIUM, SILTY SAND (SM), TRACE CLAY, LOOSE	S-3	2 5 4 7	20	
	LIGHT BROWN, WET, SILTY LEAN CLAY (CL), TRACE FINE SAND, MEDIUM STIFF	S-4	1 2 4 5	24	
		S-5	4 4 5 7	24	
10					
	ORANGE, SATURATED, SILTY CLAY (CL-ML), SOME FINE TO COARSE SAND, VERY SOFT	S-6	1 0 3 4	18	
15					
	GRAY, SATURATED, FINE TO COARSE, SILTY CLAYEY SAND (SC-SM), WITH MARINE SHELL FRAGMENTS, MEDIUM DENSE	S-7	5 7 9 15	24	
20					
		S-8	4 8 10	24	
25					
		S-9	4 6 7 11	24	
30					
		S-10	5 7 12 16	24	
35					
	GRAY, SATURATED, FAT CLAY (CH), TRACE FINE SAND, STIFF	S-11	3 5 7 10	24	
40					

Standard Penetration Test Blows/Ft.



Project No. ETS-09E134		Date 06JAN2010	Sheet 2 of 2
Project FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION			
Client US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT			
Boring Location		Ground Elevation	Hole No. B-5
Project Location FT EUSTIS - NEWPORT NEWS, VIRGINIA	Drill Method MUD ROTARY	Station	Depth of Hole: (Ft) 50
Name of Foreman HCEA	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft) 12	At Completion: (Ft)
Name of Inspector V. SALLEE, P.E.	After Hours Feet		Cave in at: (Ft) 1.5

Depth (ft.)	Legend	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Standard Penetration Test Blows/Ft. 10 20 30 40 50+	Remarks
40		GRAY, SATURATED, FAT CLAY (CH), TRACE FINE SAND, STIFF					
			S-12	7 6 7 11	24		
45							
			S-13	4 5 8 11	24		
50		BORING TERMINATED AT 50 FEET					
55							
60							
65							
70							
75							
80							

Project No.	Date	Sheet 1 of 1
ETS-09E134	06JAN2010	

Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION

Client: US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT

Boring Location	Ground Elevation	Hole No.
		B-6

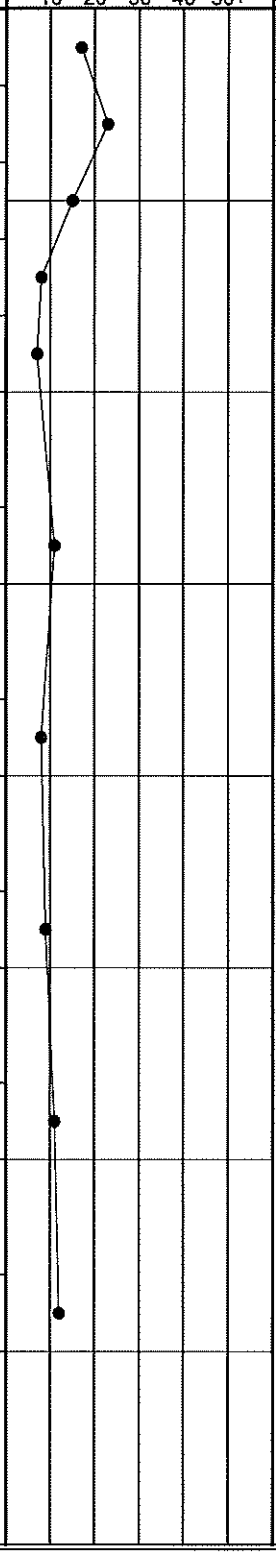
Project Location	Drill Method	Station	Depth of Hole: (Ft)
FT EUSTIS - NEWPORT NEWS, VIRGINIA	MUD ROTARY		35

Name of Foreman	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft)	At Completion: (Ft)
HCEA		8.0	8

Name of Inspector	After Hours Feet	Cave in at: (Ft)
V. SALLEE, P.E.		1.5

Depth (ft.)	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Remarks
0	GRAY, SATURATED, LEAN CLAY (CL), TRACE FINE SILTY SAND, MEDIUM DENSE	S-1	5 8 9 7	10	6" TOPSOIL LL- 27 PI- 11 USCS- CL
	LIGHT BROWN, MOIST, LEAN CLAY (CL), TRACE FINE SILTY SAND, VERY STIFF	S-2	6 9 14 14	16	
5	LIGHT BROWN, MOIST, SILTY SAND (SM), TRACE CLAY, MEDIUM DENSE	S-3	6 7 8 7	18	
	LIGHT BROWN, WET, LEAN CLAY (CL), LITTLE TO TRACE FINE SILTY SAND, MEDIUM STIFF	S-4	2 3 5 7	24	
	ORANGE, SATURATED, LEAN CLAY (CL), LITTLE TO TRACE FINE SILTY SAND, MEDIUM STIFF <LENSE OF SILTY SAND 5">	S-5	2 5 2 5	24	
10	<INTERBEDDED LENSE OF SILTY SANDS>	S-6	3 4 7 10	24	
15					
	GRAY, SATURATED, LEAN SILTY SANDY CLAY (CL), MEDIUM STIFF	S-7	3 4 4 4	24	LL- 41 PI- 21 USCS- CL
20		S-8	1 5 4 4	24	
25	DARK BROWN-GRAY, SATURATED, LEAN CLAY (CL), LITTLE FINE TO MEDIUM SILTY SAND, WITH ORGANIC MATTER, MEDIUM STIFF <LARGE ROOTS IN SPOON FROM 25 TO 28 FEET>				
	GREEN, SATURATED, FINE TO COARSE, SILTY CLAYEY SAND (SC-SM), WITH MARINE SHELL FRAGMENTS, MEDIUM DENSE	S-9	1 5 6	24	
30		S-10	4 5 7 10	24	
35	GRAY, WET, FAT CLAY (CH), TRACE FINE SILTY SAND, STIFF				
	BORING TERMINATED AT 35 FEET				
40					

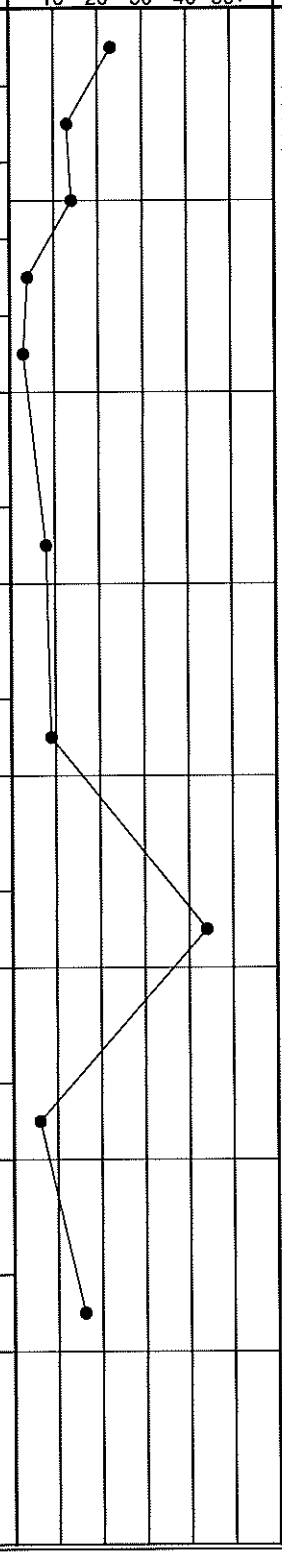
Standard Penetration Test Blows/Ft.



ETS	Project No. ETS-09E134	Date 07JAN2010	Sheet 1 of 1
	Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION		
	Client: US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT		
	Boring Location	Ground Elevation	Hole No. B-7
Project Location: FT EUSTIS - NEWPORT NEWS, VIRGINIA	Drill Method: MUD ROTARY	Station	Depth of Hole: (Ft) 35
Name of Foreman: HCEA	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft) 7.5	At Completion: (Ft) 8
Name of Inspector: V. SALLEE, P.E.	After Hours Feet		Cave in at: (Ft) 2.5

Depth (ft.)	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Remarks
0	LIGHT BROWN, MOIST, LEAN CLAY (CL), LITTLE FINE SILTY SAND, VERY STIFF, WITH GRAVEL, FILL TO 12"	S-1	3 11 12 7/14"	12	
	LIGHT BROWN, MOIST, LEAN CLAY (CL), LITTLE TO TRACE FINE SILTY SAND, STIFF	S-2	2 5 8 10	14	LL- 41 PI- 25 USCS- CL
5	LIGHT BROWN, MOIST, SILTY CLAYEY SAND (SC-SM), MEDIUM DENSE	S-3	2 6 8 8	24	
	ORANGE BROWN-GRAY, SATURATED, SILTY CLAY (CL-ML), LITTLE FINE TO MEDIUM SAND, SOFT	S-4	2 2 2 3	24	
		S-5	0 1 2 1	24	
10					
	LIGHT BROWN-GRAY, SATURATED, FINE TO COARSE, SILTY SAND (SM), TRACE CLAY, TRACE FINE GRAVEL, LOOSE	S-6	1 4 4 6	24	
15	GRAY, SATURATED, LEAN SILTY SANDY CLAY (CL), TRACE GRAVEL, MEDIUM STIFF				
		S-7	2 4 5 6	24	
20					
	LIGHT GRAY, SATURATED, FINE TO MEDIUM SILTY SAND (SM), VERY DENSE	S-8	8 17 27 31	24	
25					
	GRAY, SATURATED, FINE TO COARSE, SILTY CLAYEY SAND (SC-SM), LOOSE	S-9	2 2 4 4	24	
30					
		S-10	4 6 10 12	24	
35	GRAY, WET, FAT CLAY (CH), TRACE TO LITTLE FINE SILTY SAND, VERY STIFF				
	BORING TERMINATED AT 35 FEET				
40					

Standard Penetration Test Blows/Ft.



Project No.	Date	Sheet 1 of 1
ETS-09E134	07JAN2010	

Project	FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION
Client	US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT

Boring Location	Ground Elevation	Hole No.
		B-8

Project Location	Drill Method	Station	Depth of Hole: (Ft)
FT EUSTIS - NEWPORT NEWS, VIRGINIA	MUD ROTARY		35

Name of Foreman	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft)	At Completion: (Ft)
HCEA		7	

Name of Inspector	After	Hours	Feet	Cave in at: (Ft)
V. SALLEE, P.E.				1.75

Depth (ft.)	Legend	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Standard Penetration Test Blows/Ft. (10 20 30 40 50+)	Remarks
0		LIGHT BROWN, MOIST, SILTY LEAN CLAY (CL) , LITTLE TO TRACE FINE SAND, STIFF, TRACE ORGANIC MATTER	S-1	4 5 6 4	20		6" TOPSOIL
			S-2	5 6 8 7	18		
5		LIGHT BROWN, WET, SILTY LEAN CLAY AND FINE TO MEDIUM SAND (CL/SC), MEDIUM STIFF	S-3	3 4 4 5	24		
			S-4	1 2 2 4	24		
		GRAY, SATURATED, LEAN CLAY (CL), TRACE FINE SILTY SAND, VERY SOFT	S-5	1 1 1 3	24		LL- 31 PI- 13 USCS- CL
10							
		GRAY, SATURATED, FINE TO COARSE SILTY CLAYEY SAND (SC-SM), WITH MARINE SHELL FRAGMENTS, LOOSE TO MEDIUM DENSE	S-6	1 3 4 5	24		
15							
			S-7	3 3 5 5	24		
20							
			S-8	4 7 9 12	24		
25							
			S-9	5 7 9 11	24		
30							
			S-10	4 6 11 13	24		
35		BORING TERMINATED AT 35 FEET					
40							

ETS	Project No. ETS-09E134	Date 07JAN2010	Sheet 1 of 1
	Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION		
	Client: US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT		
	Boring Location: SEE BORING LOCATION PLAN	Ground Elevation: N/S	Hole No.: B-9
Project Location: FT EUSTIS - NEWPORT NEWS, VIRGINIA	Drill Method: MUD ROTARY	Station: N/A	Depth of Hole: (Ft) 35
Name of Foreman: HCEA	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft) 8.25	At Completion: (Ft)
Name of Inspector: V. SALLEE, P.E.	After Hours Feet		Cave in at: (Ft) 2.25

Depth (ft.)	Legend	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Standard Penetration Test Blows/Ft. (10 20 30 40 50+)	Remarks
0		LIGHT BROWN, MOIST, LEAN CLAY (CL), LITTLE TO TRACE FINE TO MEDIUM SILTY SAND, TRACE ORGANIC MATTER, STIFF	S-1	4 5 6 6	18		6" TOPSOIL
			S-2	5 7 10 10	16		
5		LIGHT BROWN, MOIST, FINE TO MEDIUM SILTY SAND (SM), TRACE CLAY, MEDIUM DENSE	S-3	3 5 6 6	20		
		ORANGE-BROWN, SATURATED, SANDY LEAN CLAY (CL), STIFF TO SOFT	S-4	3 5 6 8	22		
			S-5	1 2 3 5	20		
10							
		GRAY, SATURATED, LEAN CLAY (CL), TRACE TO LITTLE SILTY SAND, SOFT	S-6	1 1 4 6	24		
15							
		LIGHT BROWN, WET, LEAN TO FAT CLAY (CL- CH), TRACE FINE SAND, STIFF	S-7	5 7 7 4	24		
20							
			S-8	3 5 5 7	24		
25							
			S-9	4 5 7 9	24		
30							
			S-10	3 4 6 7	24		
35		GRAY, SATURATED, FINE TO COARSE SILTY CLAYEY SAND (SC-SM), WITH MARINE SHELL FRAGMENTS					
		BORING TERMINATED AT 35 FEET					
40							

Project No.	Date	Sheet 1 of 1
ETS-09E134	07JAN2010	

Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION

Client: US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT

Boring Location	Ground Elevation	Hole No.
SEE BORING LOCATION PLAN	N/S	B-10

Project Location	Drill Method	Station	Depth of Hole: (Ft)
FT EUSTIS - NEWPORT NEWS, VIRGINIA	MUD ROTARY	N/A	35

Name of Foreman	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft)	At Completion: (Ft)
HCEA		8	

Name of Inspector	After	Hours	Feet	Cave in at: (Ft)
V. SALLEE, P.E.				1.25

Depth (ft.)	Legend	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Standard Penetration Test Blows/Ft. (10 20 30 40 50+)	Remarks
0		TAN BROWN, MOIST, SILTY CLAY (CL), TRACE OF SAND, STIFF	S-1	4 5 6 8	16		6" TOPSOIL
			S-2	5 6 7 10	18		
5		TAN BROWN, MOIST, FINE TO MEDIUM, SLIGHTLY SILTY SAND (SP-SM), DENSE	S-3	4 10 11 9	20		
		TAN BROWN, MOIST, SILTY CLAY (CL), STIFF TO MEDIUM STIFF	S-4	4 6 5 6	20		
			S-5	2 3 3 4	20		LL- 46 PI- 24 USCS- CL
10							
		TAN BROWN, SATURATED, SILTY CLAY (CL), TRACE SAND, STIFF	S-6	3 4 6 5	24		
15							
		GRAY, SATURATED, SILTY CLAY (CL), STIFF TO SOFT	S-7	3 6 7 8	24		
20							
			S-8	4 5 6 7	24		
25							
			S-9	2 2 3 4	24		
30							
			S-10	2 3 4 3	24		
35		BORING TERMINATED AT 35 FEET					
40							

Project No.	Date	Sheet 1 of 1
ETS-09E134	08JAN2010	

Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION

Client: US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT

Boring Location	Ground Elevation	Hole No.
SEE BORING LOCATION PLAN	N/S	B-11

Project Location	Drill Method	Station	Depth of Hole: (Ft)
FT EUSTIS - NEWPORT NEWS, VIRGINIA	MUD ROTARY	N/A	10

Name of Foreman	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft)	At Completion: (Ft)
HCEA		7.75	

Name of Inspector	After	Hours	Feet	Cave in at: (Ft)
V. SALLEE, P.E.				1.0

Depth (ft.)	Legend	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Standard Penetration Test Blows/Ft. (10 20 30 40 50+)	Remarks
0		BROWN, MOIST, SILTY SANDY CLAY (CL), TRACE SAND, STIFF	S-1	4 5 6 7	18		10" TOPSOIL LL- 26 PI- 11 USCS- CL
		TAN, MOIST, SILTY SANDY CLAY (CL), STIFF	S-2	4 5 6 8	18		
5		TAN, MOIST TO VERY MOIST, SILTY CLAYEY SAND (SC-SM), LOOSE	S-3	2 4 5 3	24		
		TAN, VERY MOIST TO SATURATED, SILTY SANDY CLAY (CL), SOFT	S-4	2 2 3 3	14		
			S-5	1 2 3 4	18		
10		BORING TERMINATED AT 10 FEET					
15							
20							
25							
30							
35							
40							

Project No.	Date	Sheet 1 of 1
ETS-09E134	08JAN2010	

Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION

Client: US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT

Boring Location	Ground Elevation	Hole No.
SEE BORING LOCATION PLAN	N/S	B-12

Project Location	Drill Method	Station	Depth of Hole: (Ft)
FT EUSTIS - NEWPORT NEWS, VIRGINIA	MUD ROTARY	N/A	10

Name of Foreman	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft)	At Completion: (Ft)
HCEA		7.5	

Name of Inspector	After	Hours	Feet	Cave in at: (Ft)
V. SALLEE, P.E.				1.0

Depth (ft.)	Legend	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Standard Penetration Test Blows/Ft. (10 20 30 40 50+)	Remarks
0		BROWN, MOIST, SILTY SANDY CLAY (CL), STIFF	S-1	4 5 7 7	20		10" TOP SOIL
			S-2	4 6 7 9	20		
5		TAN BROWN, MOIST, SILTY SAND (SM), LOOSE	S-3	4 5 9 11	16		
		TAN BROWN, MOIST TO VERY MOIST, SILTY CLAY (CL), TRACE SAND, MEDIUM STIFF	S-4	3 5 5 9	18		
10		TAN BROWN, VERY MOIST TO SATURATED, SILTY SANDY CLAY (CL), SOFT	S-5	3 4 4 5	18		
		BORING TERMINATED AT 10 FEET					

15 20 25 30 35 40

ETS	Project No. ETS-09E134	Date 08JAN2010	Sheet 1 of 1
	Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION		
	Client: US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT		
	Boring Location: SEE BORING LOCATION PLAN	Ground Elevation: N/S	Hole No.: B-13
Project Location: FT EUSTIS - NEWPORT NEWS, VIRGINIA	Drill Method: MUD ROTARY	Station: N/A	Depth of Hole: (Ft) 10
Name of Foreman: HCEA	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft) 7.25	At Completion: (Ft)
Name of Inspector: V. SALLEE, P.E.	After Hours Feet		Cave in at: (Ft) 1.0

Depth (ft.)	Legend	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Standard Penetration Test Blows/Ft. (10 20 30 40 50+)	Remarks
0		TOPSOILS MIXED WITH ROOTS AND ORGANIC MATTER	S-1	2 4 / 3 4	4		4" TOPSOIL
		TAN BROWN, MOIST, SILTY CLAY (CL), STIFF	S-2	2 6 / 7 11	20		
5		TAN BROWN, MOIST, SANDY CLAY (CL), STIFF	S-3	4 8 / 9 14	18		
		TAN BROWN, MOIST TO VERY MOIST, SILTY SANDY FINE SAND (SP-SM), LOOSE	S-4	3 5 / 5 5	18		
		TAN BROWN, VERY MOIST TO SATURATED, SANDY CLAY (CL), LOOSE	S-5	1 3 / 3 4	18		
10		BORING TERMINATED AT 10 FEET					
15							
20							
25							
30							
35							
40							

ETS	Project No. ETS-09E134	Date	Sheet 1 of 1
	Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION		
	Client: US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT		
	Boring Location	Ground Elevation	Hole No. B-14
Project Location: FT EUSTIS - NEWPORT NEWS, VIRGINIA	Drill Method: MUD ROTARY	Station	Depth of Hole: (Ft) 10
Name of Foreman: HCEA	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft) 7.0	At Completion: (Ft)
Name of Inspector: V. SALLEE, P.E.	After Hours Feet		Cave in at: (Ft) 2.0

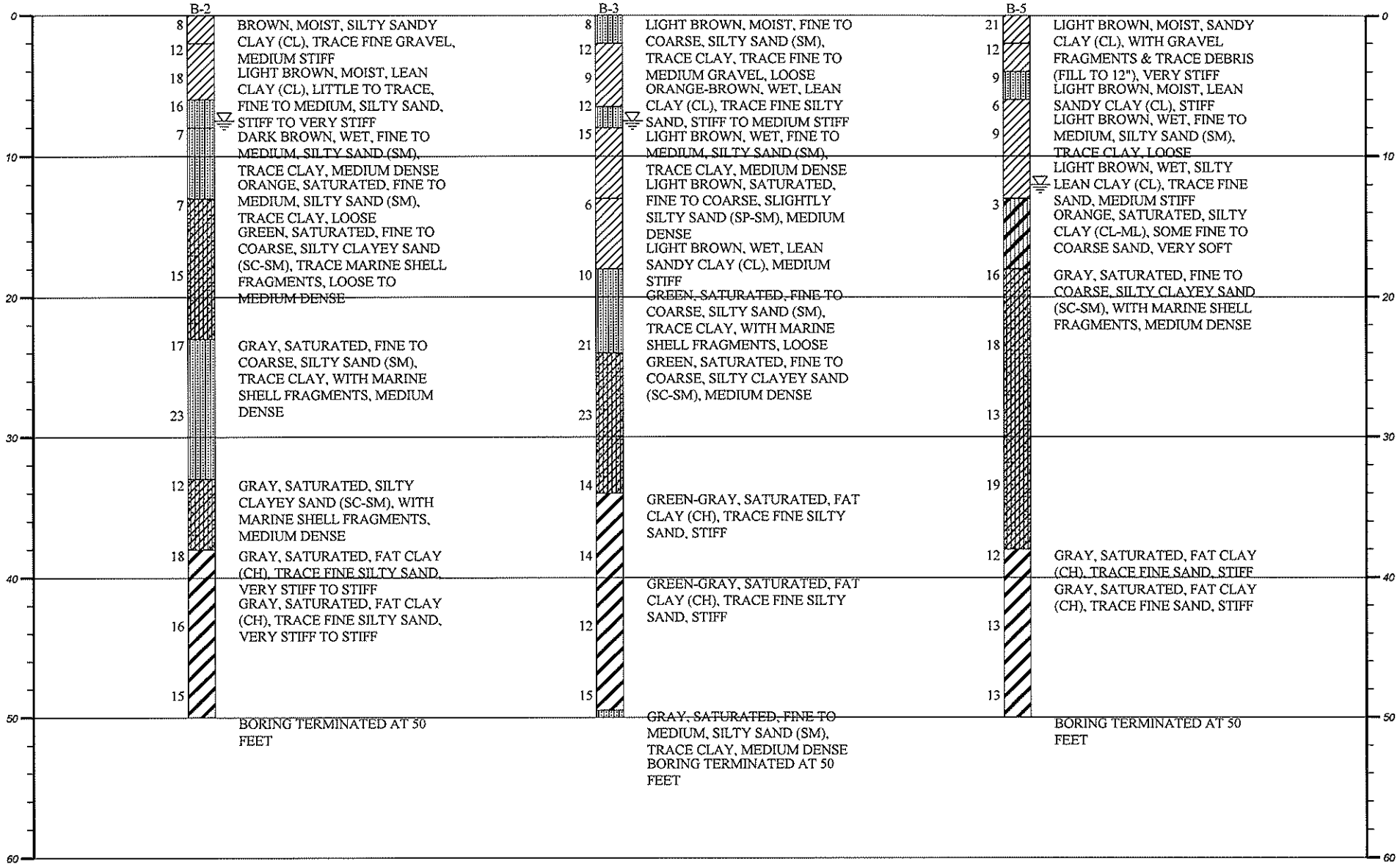
Depth (ft.)	Legend	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Standard Penetration Test Blows/Ft. (10 20 30 40 50+)	Remarks
0		BROWN, MOIST, SILTY SANDY CLAY (CL), VERY STIFF	S-1	2 6 10 15	16		6" TOPSOIL
			S-2	5 5 8 11	20		
5		LIGHT BROWN, MOIST, FINE TO MEDIUM, SILTY SAND (SM), TRACE CLAY, MEDIUM DENSE TO LOOSE	S-3	2 6 8 12	18		
			S-4	2 4 4 6	24		
			S-5	2 4 5 6	24		
10		BORING TERMINATED AT 10 FEET					
15							
20							
25							
30							
35							
40							

ETS	Project No. ETS-09E134	Date	Sheet 1 of 1
	Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION		
	Client: US ARMY CORPS OF ENGINEERS - NORFOLK DISTRICT		
	Boring Location	Ground Elevation	Hole No. B-15

Project Location: FT EUSTIS - NEWPORT NEWS, VIRGINIA	Drill Method: MUD ROTARY	Station	Depth of Hole: (Ft) 10
Name of Foreman: HCEA	Water Level Observations: (all levels noted in feet)	Noted on Rods: (Ft) 8.0	At Completion: (Ft)
Name of Inspector: V. SALLEE, P.E.	After Hours Feet		Cave in at: (Ft) 1.5

Depth (ft.)	Legend	Classification of Material (Description)	Sample No.	Blows/6"	Recovery (inches)	Standard Penetration Test Blows/Ft. (10 20 30 40 50+)	Remarks
0		LIGHT BROWN, MOIST, SILTY SAND (SM), TRACE CLAY, MEDIUM DENSE	S-1	2 5 6 6	16		4" TOPSOIL
		LIGHT BROWN, MOIST, LEAN CLAY (CL), TRACE FINE SILTY SAND, VERY STIFF	S-2	5 7 9 11	18		LL- 48 PI- 28 USCS- CL
5			S-3	2 4 7 9	24		
		LIGHT BROWN, MOIST, SILTY CLAYEY SAND (SC), MEDIUM DENSE	S-4	3 5 4 4	24		
		ORANGE-BROWN, SATURATED, LEAN SANDY CLAY (CL), MEDIUM STIFF	S-5	2 2 5 4	24		
10		BORING TERMINATED AT 10 FEET					
15							
20							
25							
30							
35							
40							

APPENDIX III – SOIL BORING PROFILES

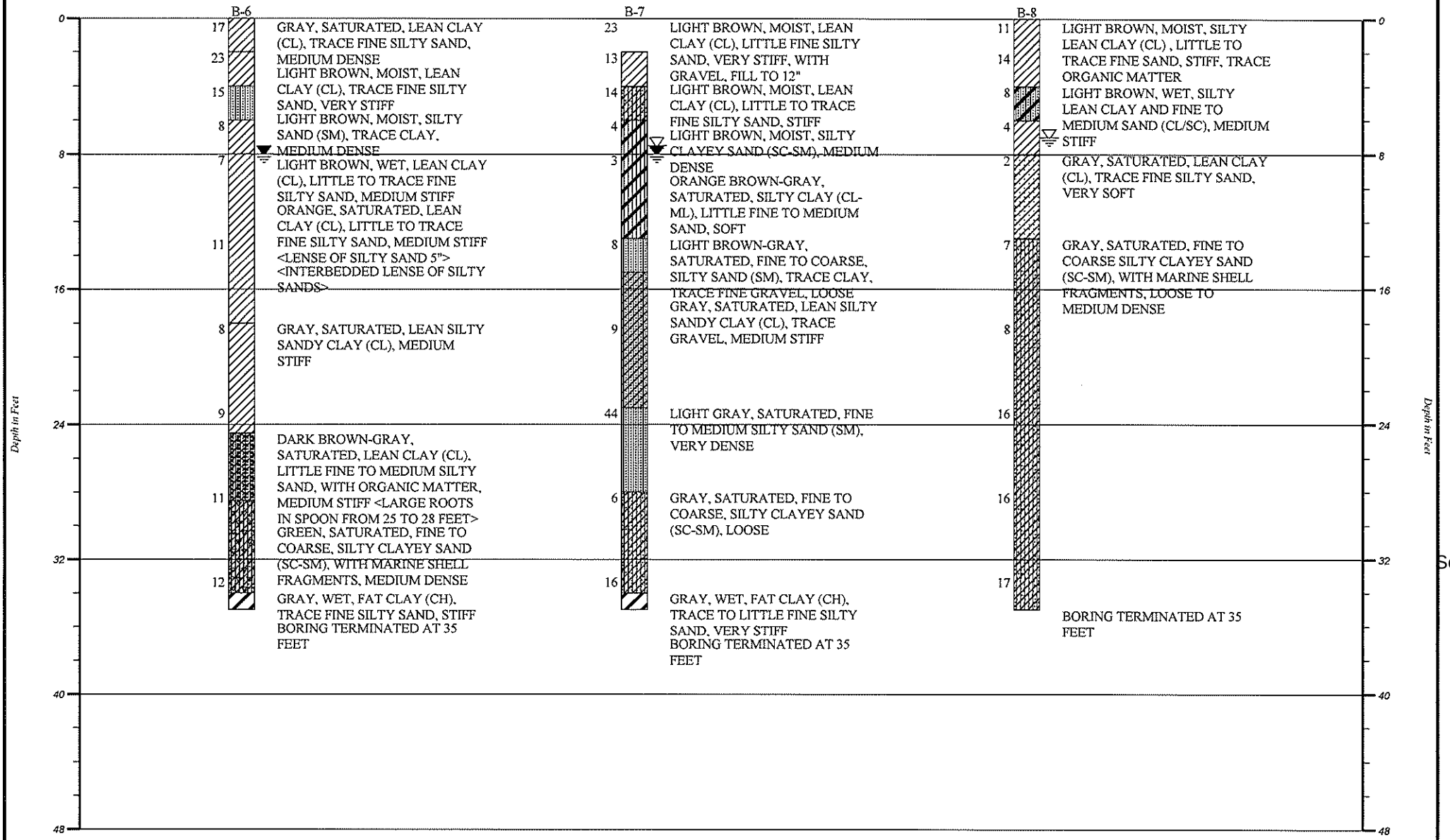


Strata symbols

- Low plasticity clay
- Silty sand
- Poorly graded clayey silty sand
- High plasticity clay
- Silty low plasticity clay

ETS

GENERALIZED SOIL PROFILE		
HORIZONTAL SCALE: / VERTICAL SCALE: 1"=10'	DRAWN BY/APPROVED BY: VS	DATE DRAWN: 2/8/2010
FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION		
PROJECT NO. ETS-09E134		FIGURE NUMBER: A-III

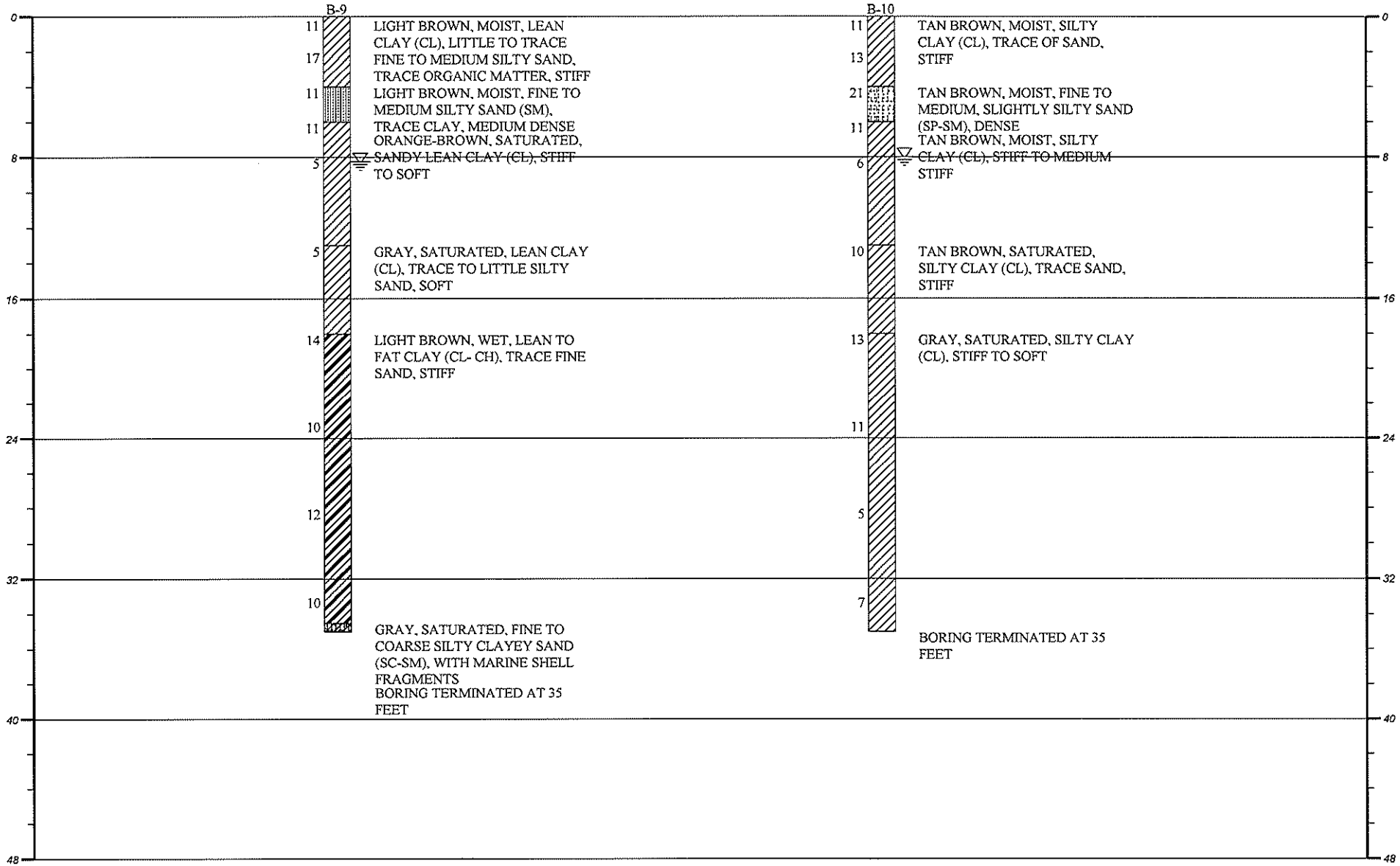


Strata symbols

- Low plasticity clay
- Silty sand
- Description not given for: "OJ0"
- Description not given for: ":ZO&"
- High plasticity clay
- Poorly graded clayey silty sand
- Silty low plasticity clay
- Description not given for: "O0"
- Silty sandy clay
- Description not given for: "OS"

ETS

GENERALIZED SOIL PROFILE		
HORIZONTAL SCALE: / VERTICAL SCALE: 1"=8'	DRAWN BY/APPROVED BY: VS	DATE DRAWN: 2/8/2010
FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION		
PROJECT NO. ETS-09E134		FIGURE NUMBER: A-III

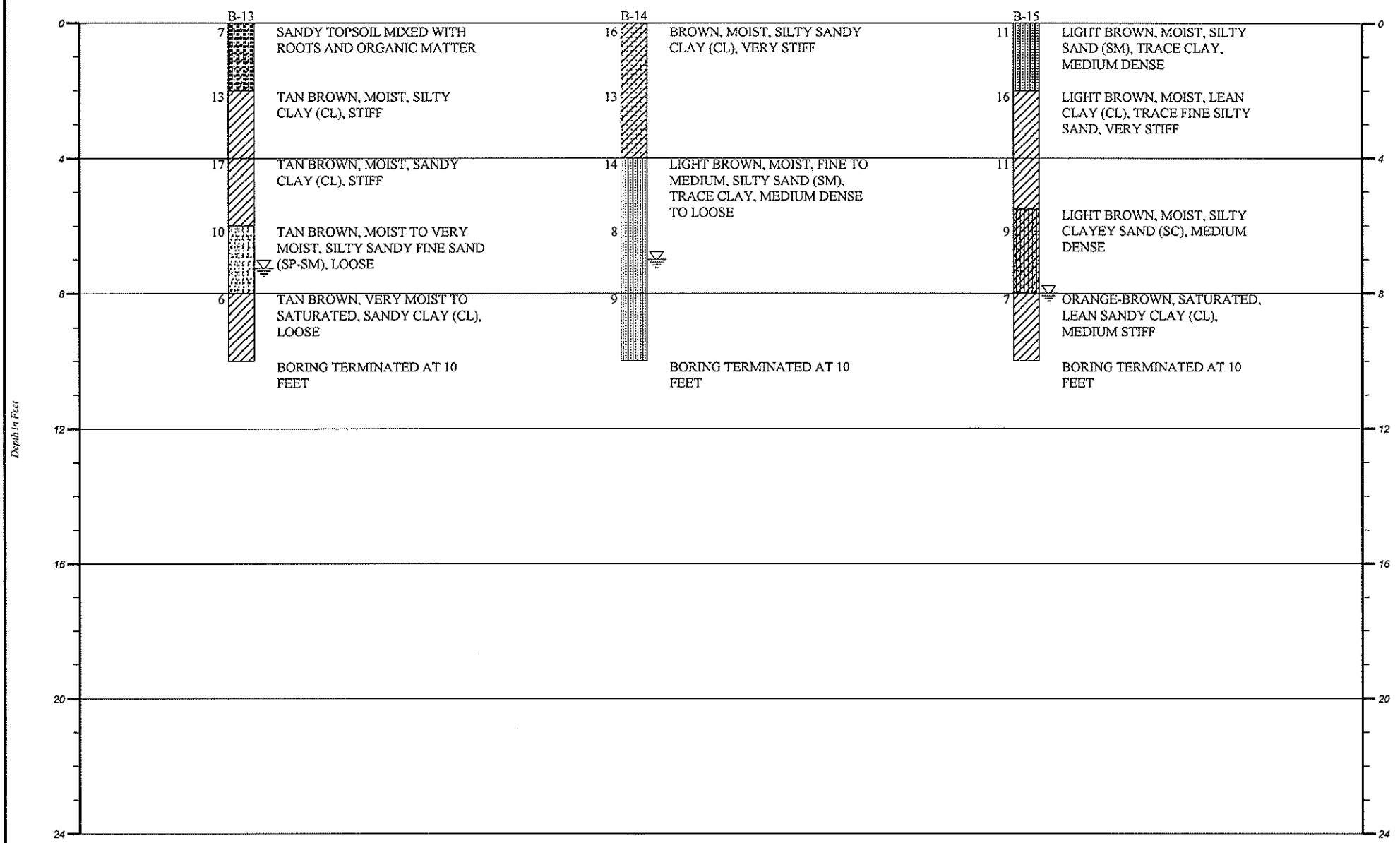


Strata symbols

- Low plasticity clay
- Silty sand
- Low-high plasticity clays
- Description not given for: ":ZO&"
- Poorly graded sand with silt

ETS

GENERALIZED SOIL PROFILE		
HORIZONTAL SCALE: VERTICAL SCALE: 1"=8'	DRAWN BY/APPROVED BY VS	DATE DRAWN 2/8/2010
FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION		
PROJECT NO. ETS-09E134		FIGURE NUMBER A-III



Strata symbols

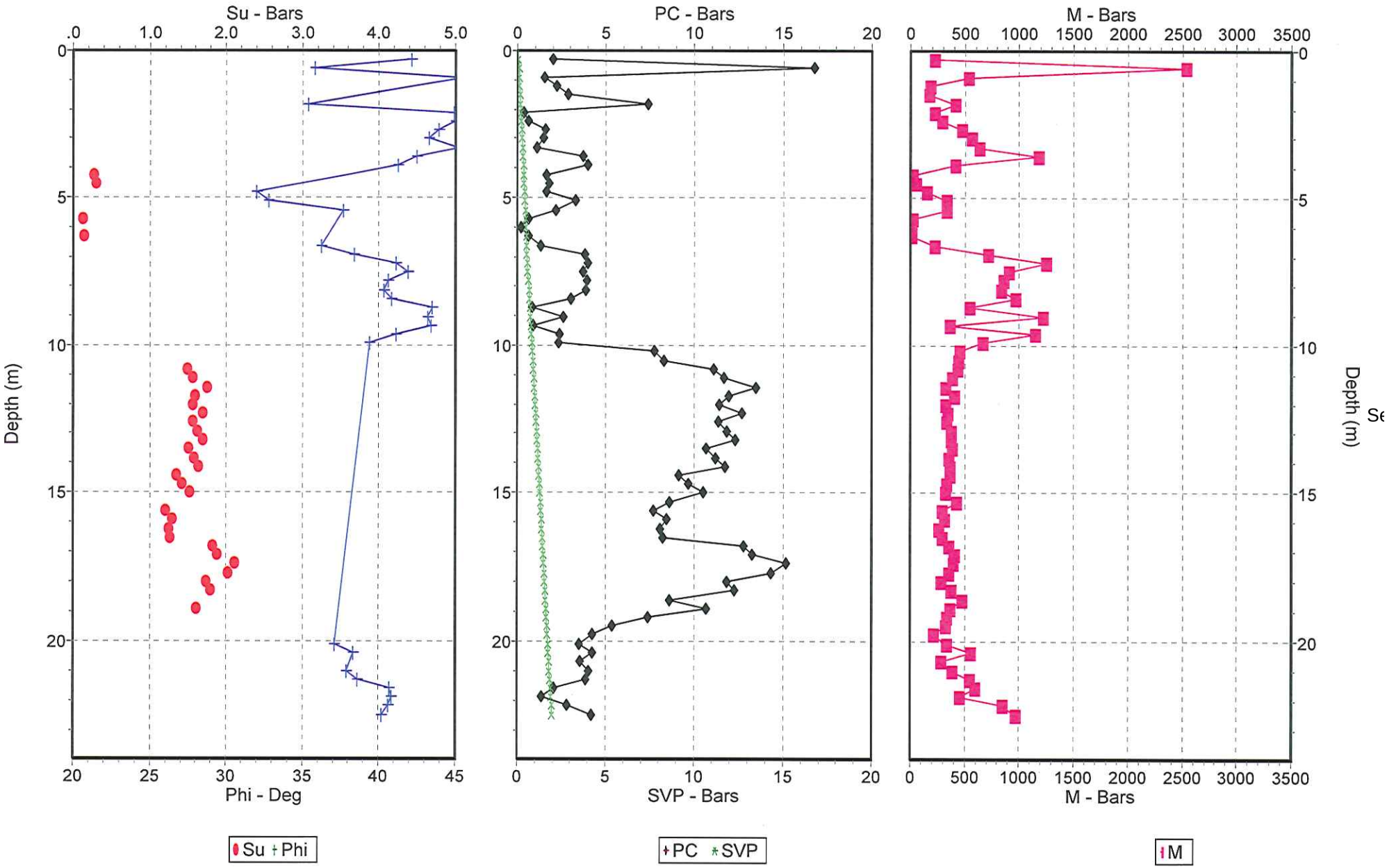
- Description not given for: "TSJR"
- Low plasticity clay
- Poorly graded sand with silt
- Description not given for: "OS"
- Silty sand
- Poorly graded clayey silty sand

ETS

GENERALIZED SOIL PROFILE		
HORIZONTAL SCALE: VERTICAL SCALE: 1"=4'	DRAWN BY/APPROVED BY VS	DATE DRAWN 2/8/2010
FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION		
PROJECT NO. ETS-09E134		FIGURE NUMBER A-III

APPENDIX IV – DMT SOUNDING PROFILES & TEST RESULTS

HILLIS - CARNES ENGINEERING ASSOCIATES, INC.
Warriors Transition Unit, Fort Eustis, VA
DMT-1



DILATOME TA LISTIN(NTERPRE (BASED O 1988 DILA ER MANU/ SNDG. NO DMT-1
HILLIS - C/ S ENGINE ASSOCIAT C. Page 1
JOB FILE: iors Transil n Unit, Forl ustis, VA FILE NO. :83-500
LOCATION 1
SNDG.BY astings/F. (cia SNDG. DA E: 01/05/10
ANAL.BY : ARCIA, P.E. ANAL. DAT E: 01/11/10

ANALYSIS ETERS: I ANGE = S ROD M. = 3.57 BL.THICK. = 13.7 MM SU FACT(1
SURF.ELE 1.2 M LC GAGE 0 = BARS FR DIA. = 4.8 BL.WIDTH = 94 MM PHI FACT(1
WATER DI 0.2 M HI GAGE 0 = BARS LIN WT. = 6.5 I/M DELTA = 0.2 BARS OCR FACT 1
SP.GR.WA 1 CAL GAGE 0 = S DELT HI = 0.5 DELTA-B = 0.2 BARS M FACTO 1
MAX SU ID 0.6 SU PTION = (MIN PHI ID = 1.2 OCR OPTI 0 K0 FACTO 1
UNIT CON NS: 1 E R = 1.019 I CM2 = 100 = 1.044 TS 14.51 PSI M = 3.2808 FT

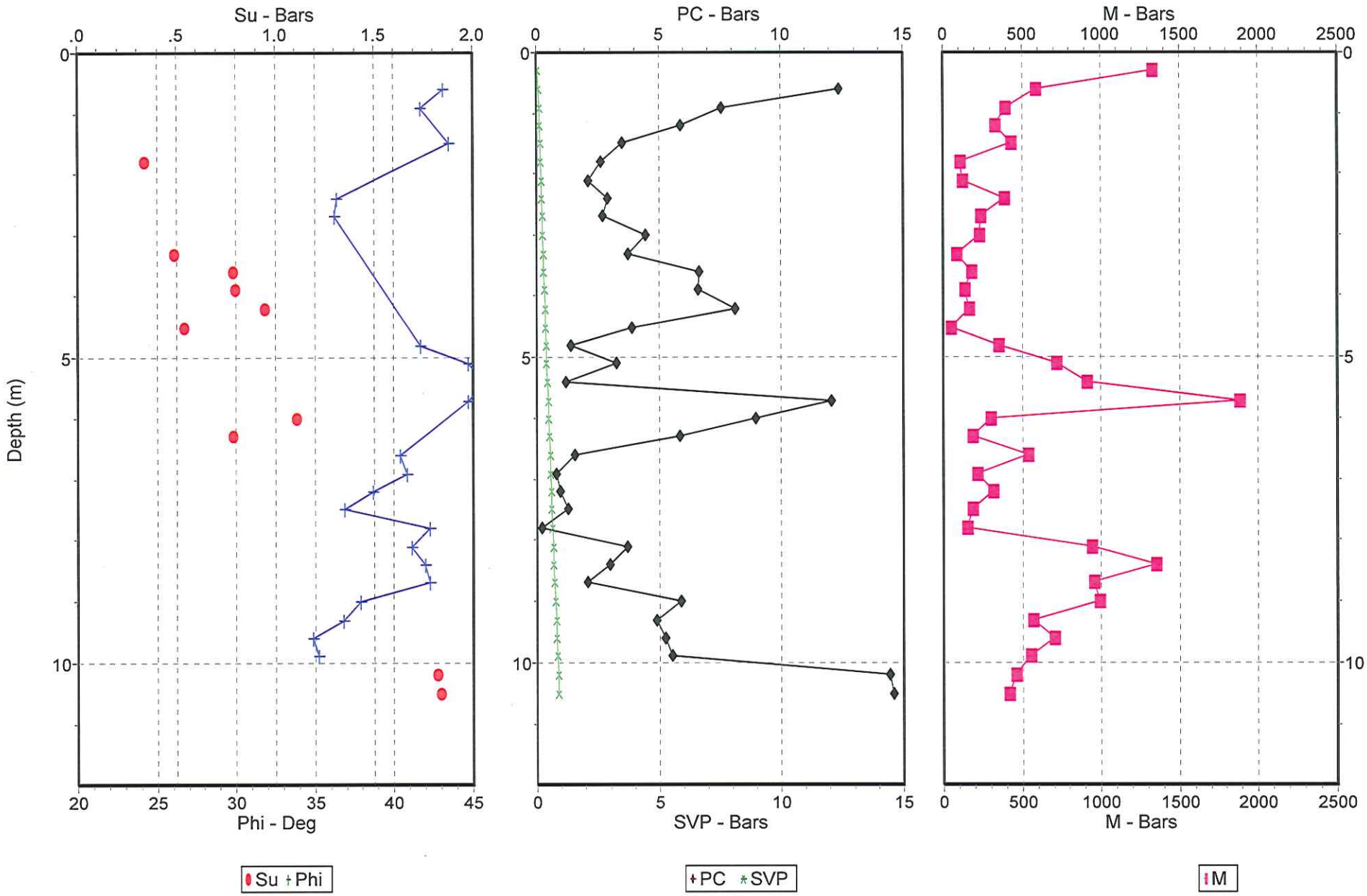
Z (M)	ELEV (M)	THRUST (KGF)	A (BAR)	B (BAR)	C (BAR)	DA (BAR)	DB (BAR)	ZMRNG (BAR)	ZMLO (BAR)	ZMHI (BAR)	ZMCAL (BAR)	P0 (BAR)	P1 (BAR)	P2 (BAR)	U0 (BAR)	GAMMA (T/M3)	SVP (BAR)	KD	ID	UD	ED (BAR)
0.3	0.9	380	1	3.4		0.2	0.2	9	0.05	0.05	0	1.05	3.15	0.15	0.01	1.7	0.057	18.25	2.02		73
0.6	0.6	600	3.95	22.8		0.2	0.2	9	0.05	0.05	0	3.18	22.55	0.15	0.039	2	0.082	38.26	6.17		672
0.9	0.3	1100	1.55	7.35		0.2	0.2	9	0.05	0.05	0	1.43	7.1	0.15	0.069	1.8	0.109	12.54	4.17		197
1.2	0	735	1.65	3.85		0.2	0.2	9	0.05	0.05	0	1.71	3.6	0.15	0.098	1.7	0.131	12.34	1.17		66
1.5	-0.3	560	2.05	4.15	0.55	0.2	0.2	9	0.05	0.05	0	2.12	3.9	0.7	0.128	1.7	0.151	13.14	0.9	0.29	62
1.8	-0.6	665	3.25	7.35	0.3	0.2	0.2	9	0.05	0.05	0	3.22	7.1	0.45	0.157	1.8	0.173	17.65	1.27	0.1	135
2.1	-0.9	1150	1.15	4.85		0.2	0.2	9	0.05	0.05	0	1.14	4.6	0.15	0.186	1.8	0.197	4.82	3.65		120
2.4	-1.2	1450	1.55	5.95		0.2	0.2	9	0.05	0.05	0	1.5	5.7	0.15	0.216	1.8	0.22	5.83	3.27		146
2.7	-1.5	1650	2.35	8.35		0.2	0.2	9	0.05	0.05	0	2.22	8.1	0.15	0.245	1.9	0.245	8.05	2.98		204
3	-1.8	1575	2.45	9.75		0.2	0.2	9	0.05	0.05	0	2.26	9.5	0.15	0.275	1.9	0.272	7.28	3.66		251
3.3	-2.1	2200	2.55	11		0.2	0.2	9	0.05	0.05	0	2.3	10.75	0.15	0.304	1.9	0.298	6.68	4.24		293
3.6	-2.4	2075	4.15	17.4		0.2	0.2	9	0.05	0.05	0	3.66	17.15	0.15	0.334	1.9	0.325	10.23	4.06		468
3.9	-2.7	1850	3.9	8.85		0.2	0.2	9	0.05	0.05	0	3.82	8.6	0.15	0.363	1.8	0.35	9.89	1.38		166
4.2	-3	375	2.2	2.85	1.2	0.2	0.2	9	0.05	0.05	0	2.34	2.6	1.35	0.393	1.5	0.369	5.27	0.13	0.49	9
4.5	-3.3	310	2.4	3.55	0.4	0.2	0.2	9	0.05	0.05	0	2.51	3.3	0.55	0.422	1.6	0.385	5.43	0.38	0.06	27
4.8	-3.6	460	2.2	5.05		0.2	0.2	9	0.05	0.05	0	2.23	4.8	0.15	0.451	1.7	0.404	4.39	1.45		89
5.1	-3.9	665	3.4	8.1	0.65	0.2	0.2	9	0.05	0.05	0	3.34	7.85	0.8	0.481	1.8	0.426	6.69	1.58	0.11	157
5.4	-4.2	1100	3.1	8.15		0.2	0.2	9	0.05	0.05	0	3.02	7.9	0.15	0.51	1.9	0.452	5.55	1.95		169
5.7	-4.5	500	1.55	2.4		0.2	0.2	9	0.05	0.05	0	1.68	2.15	0.15	0.54	1.6	0.474	2.4	0.42		16
6	-4.8	360	1.05	1.95		0.2	0.2	9	0.05	0.05	0	1.18	1.7	0.15	0.569	1.6	0.491	1.23	0.87		18
6.3	-5.1	325	1.65	2.25	0.05	0.2	0.2	9	0.05	0.05	0	1.79	2	0.2	0.599	1.5	0.507	2.35	0.18	-0.33	7
6.6	-5.4	875	2.55	6.9		0.2	0.2	9	0.05	0.05	0	2.5	6.65	0.15	0.628	1.8	0.527	3.56	2.21		144
6.9	-5.7	1650	4.85	14.2		0.2	0.2	9	0.05	0.05	0	4.55	13.95	0.15	0.658	1.9	0.552	7.06	2.41		326
7.2	-6	2550	5.65	21.2		0.2	0.2	9	0.05	0.05	0	5.04	20.95	0.15	0.687	2	0.58	7.52	3.65		552
7.5	-6.3	2945	5.55	17.2		0.2	0.2	9	0.05	0.05	0	5.14	16.95	0.15	0.716	2	0.609	7.26	2.67		410
7.8	-6.6	2530	5.6	16.8		0.2	0.2	9	0.05	0.05	0	5.21	16.55	0.15	0.746	2	0.638	6.99	2.54		393
8.1	-6.9	2500	5.65	16.8		0.2	0.2	9	0.05	0.05	0	5.26	16.55	0.15	0.775	2	0.668	6.72	2.52		392
8.4	-7.2	2600	5.35	18.8		0.2	0.2	9	0.05	0.05	0	4.85	18.55	0.15	0.805	2	0.697	5.8	3.39		475
8.7	-7.5	3150	3.65	13.6		0.2	0.2	9	0.05	0.05	0	3.32	13.35	0.15	0.834	1.9	0.725	3.43	4.03		348
9	-7.8	3900	5.85	22.8		0.2	0.2	9	0.05	0.05	0	5.17	22.55	0.15	0.864	2	0.753	5.72	4.03		603
9.3	-8.1	3300	3.65	10.6		0.2	0.2	9	0.05	0.05	0	3.47	10.35	0.15	0.893	1.9	0.781	3.3	2.67		239
9.6	-8.4	2880	5.45	22.8		0.2	0.2	9	0.05	0.05	0	4.75	22.55	0.15	0.922	2	0.809	4.73	4.65		618
9.9	-8.7	2250	4.85	15.6		0.2	0.2	9	0.05	0.05	0	4.48	15.35	0.15	0.952	1.9	0.837	4.22	3.08		377

10.2	-9	1400	8.15	14	0.15	0.2	0.2	9	0.05	0.05	0	8.03	13.75	0.3	0.981	1.95	0.864	8.15	0.81	-0.1	199
10.5	-9.3	910	8.55	14.2	1.6	0.2	0.2	9	0.05	0.05	0	8.44	13.95	1.75	1.011	1.95	0.892	8.32	0.74	0.1	191
10.8	-9.6	850	10.2	15.4	3.75	0.2	0.2	9	0.05	0.05	0	10.11	15.15	3.9	1.04	1.9	0.92	9.86	0.56	0.32	175
11.1	-9.9	830	10.6	15.2	5.25	0.2	0.2	9	0.05	0.05	0	10.54	14.95	5.4	1.07	1.9	0.946	10.01	0.47	0.46	153
11.4	-10.2	950	11.6	15.4	6.65	0.2	0.2	9	0.05	0.05	0	11.58	15.15	6.8	1.099	1.9	0.973	10.78	0.34	0.54	124
11.7	-10.5	960	11	15.8	5.8	0.2	0.2	9	0.05	0.05	0	10.93	15.55	5.95	1.129	1.9	0.999	9.81	0.47	0.49	160
12	-10.8	1000	10.8	14.8	5.6	0.2	0.2	9	0.05	0.05	0	10.77	14.55	5.75	1.158	1.9	1.026	9.37	0.39	0.48	131
12.3	-11.1	1060	11.6	15.8	6.4	0.2	0.2	9	0.05	0.05	0	11.56	15.55	6.55	1.187	1.9	1.052	9.86	0.38	0.52	138
12.6	-11.4	1320	11	15.2	5.4	0.2	0.2	9	0.05	0.05	0	10.96	14.95	5.55	1.217	1.9	1.079	9.03	0.41	0.44	138
12.9	-11.7	1290	11.4	16	6.9	0.2	0.2	9	0.05	0.05	0	11.34	15.75	7.05	1.246	1.9	1.105	9.13	0.44	0.57	153
13.2	-12	1250	11.8	16.4	4.65	0.2	0.2	9	0.05	0.05	0	11.74	16.15	4.8	1.276	1.9	1.132	9.25	0.42	0.34	153
13.5	-12.3	1400	11	16	5.75	0.2	0.2	9	0.05	0.05	0	10.92	15.75	5.9	1.305	1.9	1.158	8.3	0.5	0.48	168
13.8	-12.6	1500	11.4	16	6.8	0.2	0.2	9	0.05	0.05	0	11.34	15.75	6.95	1.335	1.9	1.185	8.45	0.44	0.56	153
14.1	-12.9	1550	11.8	16.4	5.3	0.2	0.2	9	0.05	0.05	0	11.74	16.15	5.45	1.364	1.9	1.211	8.57	0.43	0.39	153
14.4	-13.2	1650	10.4	15.4	3.7	0.2	0.2	9	0.05	0.05	0	10.32	15.15	3.85	1.394	1.9	1.238	7.21	0.54	0.28	168
14.7	-13.5	1800	10.8	15.4	6.15	0.2	0.2	9	0.05	0.05	0	10.74	15.15	6.3	1.423	1.9	1.264	7.37	0.47	0.52	153
15	-13.8	1840	11.4	15.8	7.2	0.2	0.2	9	0.05	0.05	0	11.35	15.55	7.35	1.452	1.9	1.291	7.67	0.42	0.6	146
15.3	-14.1	1900	10.4	16.4	3.95	0.2	0.2	9	0.05	0.05	0	10.27	16.15	4.1	1.482	1.95	1.318	6.67	0.67	0.3	204
15.6	-14.4	2000	9.8	14.2	4.7	0.2	0.2	9	0.05	0.05	0	9.75	13.95	4.85	1.511	1.9	1.345	6.13	0.51	0.41	146
15.9	-14.7	2160	10.4	15	5.65	0.2	0.2	9	0.05	0.05	0	10.34	14.75	5.8	1.541	1.9	1.372	6.42	0.5	0.48	153
16.2	-15	2170	10.2	14.2	4.75	0.2	0.2	9	0.05	0.05	0	10.17	13.95	4.9	1.57	1.9	1.398	6.15	0.44	0.39	131
16.5	-15.3	2240	10.4	14.8	5.15	0.2	0.2	9	0.05	0.05	0	10.35	14.55	5.3	1.6	1.9	1.425	6.14	0.48	0.42	146
16.8	-15.6	2520	13.4	18	7.75	0.2	0.2	9	0.05	0.05	0	13.34	17.75	7.9	1.629	1.9	1.451	8.07	0.38	0.54	153
17.1	-15.9	2400	13.8	19	9.15	0.2	0.2	9	0.05	0.05	0	13.71	18.75	9.3	1.658	1.9	1.478	8.16	0.42	0.63	175
17.4	-16.2	2440	15	20	9.9	0.2	0.2	9	0.05	0.05	0	14.92	19.75	10.05	1.688	1.9	1.504	8.8	0.37	0.63	168
17.7	-16.5	2500	14.6	19.2	9.6	0.2	0.2	9	0.05	0.05	0	14.54	18.95	9.75	1.717	1.9	1.531	8.38	0.34	0.63	153
18	-16.8	2600	13.2	17.2	8.35	0.2	0.2	9	0.05	0.05	0	13.17	16.95	8.5	1.747	1.9	1.557	7.34	0.33	0.59	131
18.3	-17.1	2720	13.6	18.6	8.2	0.2	0.2	9	0.05	0.05	0	13.52	18.35	8.35	1.776	1.9	1.583	7.42	0.41	0.56	168
18.6	-17.4	2650	11.4	18.4	2.75	0.2	0.2	9	0.05	0.05	0	11.22	18.15	2.9	1.806	1.95	1.611	5.84	0.74	0.12	240
18.9	-17.7	3350	12.8	18	4.65	0.2	0.2	9	0.05	0.05	0	12.71	17.75	4.8	1.835	1.9	1.638	6.64	0.46	0.27	175
19.2	-18	3100	10.6	16	1.5	0.2	0.2	9	0.05	0.05	0	10.5	15.75	1.65	1.865	1.95	1.665	5.19	0.61	-0.02	182
19.5	-18.3	3190	9.1	15	1.25	0.2	0.2	9	0.05	0.05	0	8.98	14.75	1.4	1.894	1.95	1.693	4.18	0.82	-0.07	200
19.8	-18.6	3220	8.1	12.6	0.4	0.2	0.2	9	0.05	0.05	0	8.05	12.35	0.55	1.923	1.8	1.719	3.56	0.7	-0.22	149
20.1	-18.9	3140	7.55	14.6	0.7	0.2	0.2	9	0.05	0.05	0	7.37	14.35	0.85	1.953	1.95	1.745	3.1	1.29	-0.2	242
20.4	-19.2	3950	8.85	19.2	0.8	0.2	0.2	9	0.05	0.05	0	8.5	18.95	0.95	1.982	1.95	1.773	3.68	1.6	-0.16	363
20.7	-19.5	4030	7.75	14	0.4	0.2	0.2	9	0.05	0.05	0	7.61	13.75	0.55	2.012	1.95	1.801	3.11	1.1	-0.26	213
21	-19.8	3750	8.5	16.2	0.65	0.2	0.2	9	0.05	0.05	0	8.29	15.95	0.8	2.041	1.95	1.829	3.41	1.23	-0.2	266
21.3	-20.1	4200	8.75	19.2	0.45	0.2	0.2	9	0.05	0.05	0	8.4	18.95	0.6	2.071	1.95	1.857	3.41	1.67	-0.23	366
21.6	-20.4	5100	7.35	20.4	0.4	0.2	0.2	9	0.05	0.05	0	6.87	20.15	0.55	2.1	2	1.885	2.53	2.79	-0.33	461
21.9	-20.7	4930	6.25	18.2	0.45	0.2	0.2	9	0.05	0.05	0	5.82	17.95	0.6	2.13	1.9	1.913	1.93	3.28	-0.41	421
22.2	-21	5500	8.65	25	0.85	0.2	0.2	9	0.05	0.05	0	8	24.75	1	2.159	2	1.941	3.01	2.87	-0.2	581
22.5	-21.3	5700	10.2	27.2	1.05	0.2	0.2	9	0.05	0.05	0	9.52	26.95	1.2	2.188	2	1.971	3.72	2.38	-0.13	605

K0	SU (BAR)	QD (BAR)	PHI (DEG)	SIGFF (BAR)	PHI0 (DEG)	PC (BAR)	OCR	M (BAR)	SOIL TYPE
2.24		10.1	42.1	0.1	36.8	2.04	35.8	224	SILTY SAND
4.84		10	35.8	0.13	30.3	16.77	204.4	2535	SAND
1.38		36.7	45.5	0.19	41.8	1.52	14	534	SAND
2.09						2.23	17.1	177	SILT
2.17						2.85	18.9	171	CLAYEY SILT
2.37		13.5	35.4	0.27	31.2	7.4	42.7	410	SANDY SILT
0.49		41.6	44.9	0.34	42	0.37	1.9	224	SAND
0.6		51.6	45	0.38	42.3	0.62	2.8	296	SILTY SAND
0.93		55.9	43.9	0.42	41.3	1.57	6.4	471	SILTY SAND
0.87		53.1	43.3	0.46	40.7	1.51	5.6	559	SAND
0.69		77.7	45.2	0.51	43	1.1	3.7	630	SAND
1.26		65.9	42.5	0.54	40.2	3.69	11.3	1181	SAND
1.27		56.8	41.3	0.58	39	3.96	11.3	413	SANDY SILT
1.21	0.27					1.67	4.5	17	MUD
1.23	0.3					1.83	4.7	51	SILTY CLAY
0.85		12.7	32	0.62	29.2	1.64	4.1	152	SANDY SILT
1.11		16.2	32.8	0.66	30.1	3.28	7.7	331	SANDY SILT
0.86		33.5	37.7	0.73	35.5	2.15	4.8	330	SILTY SAND
0.65	0.13					0.63	1.3	17	SILTY CLAY
0.31						0.23	0.5	15	CLAYEY SILT
0.63	0.14					0.65	1.3	7	MUD
0.66		28.3	36.2	0.84	34.1	1.35	2.6	223	SILTY SAND
1.02		48.7	38.4	0.89	36.5	3.84	7	712	SILTY SAND
0.99		81	41.1	0.96	39.5	3.97	6.8	1243	SAND
0.93		96.1	41.9	1.02	40.4	3.72	6.1	908	SILTY SAND
0.95		80	40.6	1.05	39.1	3.94	6.2	857	SILTY SAND
0.92		78.9	40.3	1.1	38.9	3.89	5.8	839	SILTY SAND
0.79		85.1	40.8	1.15	39.5	3.03	4.3	964	SAND
0.4		114.7	43.5	1.22	42.3	0.87	1.2	547	SAND
0.69		134.6	43.2	1.27	42.1	2.61	3.5	1215	SAND
0.39		120.4	43.4	1.32	42.3	0.89	1.1	361	SILTY SAND
0.65		97.6	41.1	1.34	40	2.4	3	1143	SAND
0.65		74.8	39.4	1.37	38.3	2.32	2.8	660	SILTY SAND

1.62						7.74	9	455 CLAYEY SILT
1.64						8.25	9.2	443 CLAYEY SILT
1.82	1.49					11.08	12.1	435 SILTY CLAY
1.84	1.56					11.67	12.3	383 SILTY CLAY
1.93	1.76					13.46	13.8	318 CLAY
1.82	1.6					11.94	12	398 SILTY CLAY
1.77	1.56					11.41	11.1	319 SILTY CLAY
1.82	1.7					12.67	12	344 SILTY CLAY
1.73	1.56					11.33	10.5	332 SILTY CLAY
1.74	1.62					11.81	10.7	368 SILTY CLAY
1.75	1.69					12.33	10.9	370 SILTY CLAY
1.63	1.51					10.67	9.2	387 SILTY CLAY
1.65	1.58					11.21	9.5	356 SILTY CLAY
1.67	1.64					11.72	9.7	358 SILTY CLAY
1.49	1.35					9.15	7.4	363 SILTY CLAY
1.51	1.42					9.67	7.7	335 SILTY CLAY
1.55	1.52					10.5	8.1	325 SILTY CLAY
1.42						8.62	6.5	426 CLAYEY SILT
1.34	1.2					7.71	5.7	291 SILTY CLAY
1.38	1.3					8.45	6.2	313 SILTY CLAY
1.34	1.25					8.07	5.8	263 SILTY CLAY
1.34	1.27					8.2	5.8	292 SILTY CLAY
1.61	1.83					12.79	8.8	349 SILTY CLAY
1.62	1.88					13.24	9	401 SILTY CLAY
1.7	2.11					15.17	10.1	397 SILTY CLAY
1.64	2.02					14.3	9.3	355 CLAY
1.51	1.74					11.83	7.6	286 CLAY
1.52	1.79					12.23	7.7	368 SILTY CLAY
1.3						8.58	5.3	470 CLAYEY SILT
1.41	1.61					10.65	6.5	364 SILTY CLAY
1.19						7.36	4.4	333 CLAYEY SILT
1.02						5.35	3.2	324 CLAYEY SILT
0.9						4.23	2.5	216 CLAYEY SILT
0.58		104.8	37.1	2.8	37.1	3.52	2	328 SANDY SILT
0.62		130.9	38.3	2.87	38.4	4.25	2.4	558 SANDY SILT
0.81						3.58	2	286 SILT
0.6		124.9	37.9	2.95	38	4.04	2.2	384 SANDY SILT
0.58		141.9	38.6	3.02	38.8	3.89	2.1	539 SANDY SILT
0.41		184.8	40.7	3.11	40.9	2.07	1.1	593 SILTY SAND
0.33		183.7	40.8	3.16	41	1.38	0.7	451 SILTY SAND
0.47		195.2	40.6	3.21	40.9	2.82	1.5	841 SILTY SAND
0.56		195.7	40.2	3.24	40.5	4.17	2.1	968 SILTY SAND

HILLIS - CARNES ENGINEERING ASSOCIATES, INC.
Warriors Transition Unit, Fort Eutis, VA
DMT-2



DILATOME TA LISTIN(NTERPRE (BASED O 1988 DILA ER MANU/ SNDG. NO DMT-2
HILLIS - C/ S ENGINE ASSOCIAT C. Page 1
JOB FILE: iors Transit n Unit, Forl utis, VA FILE NO. :83-500
LOCATION 2
SNDG.BY astings/F. (cia SNDG. DA E: 01/05/10
ANAL.BY : ARCIA, P.E. ANAL. DAT E: 01/11/10

ANALYSIS ETERS: ANGE = S ROD M. = 3.57 BL.THICK. = 13.7 MM SU FACT(1
SURF.ELE 1.2 M LC GAGE 0 = BARS FR DIA. = 4.8 BL.WIDTH = 94 MM PHI FACT(1
WATER DI 0.2 M HI GAGE 0 = BARS LIN WT. = 6.5 I/M DELTA = 0.18 BAF OCR FACT 1
SP.GR.WA 1 CAL GAGE 0 = S DELT HI = 0.5 DELTA-B = 0.52 BAF M FACTO 1
MAX SU IC 0.6 SU PTION = (MIN PHI ID = 1.2 OCR OPTI 0 K0 FACTO 1
UNIT CON NS: 1 E R = 1.019 I CM2 = 100 = 1.044 TS 14.51 PSI M = 3.2808 FT

Z (M)	ELEV (M)	THRUST (KGF)	A (BAR)	B (BAR)	C (BAR)	DA (BAR)	DB (BAR)	ZMRNG (BAR)	ZMLO (BAR)	ZMHI (BAR)	ZMCAL (BAR)	P0 (BAR)	P1 (BAR)	P2 (BAR)	U0 (BAR)	GAMMA (T/M3)	SVP (BAR)	KD	ID	UD	ED (BAR)	K0
0.3	0.9	1600	3.45	13		0.18	0.52	9	0.05	0.05	0	3.14	12.43	0.13	0.01	1.9	0.057	54.87	2.97		322	
0.6	0.6	1320	3.3	8.3		0.18	0.52	9	0.05	0.05	0	3.22	7.73	0.13	0.039	1.8	0.082	38.72	1.42		157	4.66
0.9	0.3	1070	2.8	6.7		0.18	0.52	9	0.05	0.05	0	2.77	6.13	0.13	0.069	1.7	0.104	25.95	1.24		117	3.18
1.2	0	1020	3.05	6.5		0.18	0.52	9	0.05	0.05	0	3.04	5.93	0.13	0.098	1.7	0.125	23.61	0.98		100	3.05
1.5	-0.3	1350	2.45	7.2		0.18	0.52	9	0.05	0.05	0	2.38	6.63	0.13	0.128	1.8	0.147	15.33	1.89		148	1.83
1.8	-0.6	920	2.05	3.85		0.18	0.52	9	0.05	0.05	0	2.13	3.28	0.13	0.157	1.7	0.169	11.65	0.59		40	2.02
2.1	-0.9	500	1.9	3.95		0.18	0.52	9	0.05	0.05	0	1.96	3.38	0.13	0.186	1.7	0.189	9.37	0.8		49	1.77
2.4	-1.2	600	2.4	7.35		0.18	0.52	9	0.05	0.05	0	2.32	6.78	0.13	0.216	1.8	0.212	9.93	2.12		155	1.42
2.7	-1.5	610	2.35	5.75		0.18	0.52	9	0.05	0.05	0	2.35	5.18	0.13	0.245	1.7	0.234	8.99	1.35		98	1.31
3	-1.8	550	3.45	6.45		0.18	0.52	9	0.05	0.05	0	3.47	5.88	0.13	0.275	1.7	0.254	12.55	0.76		84	2.11
3.3	-2.1	470	3.15	4.75	1.65	0.18	0.52	9	0.05	0.05	0	3.24	4.18	1.78	0.304	1.7	0.275	10.66	0.32	0.5	33	1.91
3.6	-2.4	800	4.65	7.1	2.55	0.18	0.52	9	0.05	0.05	0	4.69	6.53	2.68	0.334	1.8	0.297	14.68	0.42	0.54	64	2.32
3.9	-2.7	510	4.75	6.8	2.95	0.18	0.52	9	0.05	0.05	0	4.81	6.23	3.08	0.363	1.7	0.319	13.95	0.32	0.61	49	2.25
4.2	-3	560	5.55	7.8	3.25	0.18	0.52	9	0.05	0.05	0	5.6	7.23	3.38	0.393	1.8	0.341	15.27	0.31	0.57	56	2.38
4.5	-3.3	570	3.65	4.95	2.45	0.18	0.52	9	0.05	0.05	0	3.75	4.38	2.58	0.422	1.7	0.363	9.16	0.19	0.65	22	1.74
4.8	-3.6	1550	2.65	8.35	0.1	0.18	0.52	9	0.05	0.05	0	2.53	7.78	0.23	0.451	1.8	0.385	5.4	2.53	-0.11	182	0.71
5.1	-3.9	3400	4.55	13.4	0.1	0.18	0.52	9	0.05	0.05	0	4.27	12.83	0.23	0.481	1.9	0.41	9.24	2.26	-0.07	297	1.03
5.4	-4.2	3350	3.65	16.4	0.15	0.18	0.52	9	0.05	0.05	0	3.18	15.83	0.28	0.51	1.9	0.437	6.11	4.74	-0.09	439	0.58
5.7	-4.5	5800	8.95	27	0.05	0.18	0.52	9	0.05	0.05	0	8.21	26.43	0.18	0.54	2	0.465	16.51	2.37	-0.05	632	1.9
6	-4.8	2200	6.9	10.6	2.45	0.18	0.52	9	0.05	0.05	0	6.88	10.03	2.58	0.569	1.8	0.491	12.85	0.5	0.32	109	2.14
6.3	-5.1	1050	5.45	8.25	0.9	0.18	0.52	9	0.05	0.05	0	5.48	7.68	1.03	0.599	1.8	0.515	9.47	0.45	0.09	77	1.78
6.6	-5.4	1700	3.35	12.2		0.18	0.52	9	0.05	0.05	0	3.07	11.63	0.13	0.628	1.9	0.54	4.53	3.5		297	0.66
6.9	-5.7	1600	2.4	7.35	0.05	0.18	0.52	9	0.05	0.05	0	2.32	6.78	0.18	0.658	1.8	0.565	2.94	2.69	-0.29	155	0.45
7.2	-6	1250	2.55	9.45	0.1	0.18	0.52	9	0.05	0.05	0	2.37	8.88	0.23	0.687	1.8	0.588	2.86	3.87	-0.27	226	0.51
7.5	-6.3	1075	2.7	7	0.1	0.18	0.52	9	0.05	0.05	0	2.65	6.43	0.23	0.716	1.8	0.612	3.16	1.95	-0.25	131	0.59
7.8	-6.6	1850	1.7	7.3	0.05	0.18	0.52	9	0.05	0.05	0	1.59	6.73	0.18	0.746	1.8	0.636	1.32	6.13	-0.67	179	0.2
8.1	-6.9	2750	5.7	18.4		0.18	0.52	9	0.05	0.05	0	5.23	17.83	0.13	0.775	2	0.662	6.73	2.83		437	0.9
8.4	-7.2	3100	5.75	24.4	0.05	0.18	0.52	9	0.05	0.05	0	4.98	23.83	0.18	0.805	2	0.691	6.04	4.51	-0.15	654	0.78
8.7	-7.5	3050	4.95	19.6	0.1	0.18	0.52	9	0.05	0.05	0	4.38	19.03	0.23	0.834	2	0.721	4.92	4.13	-0.17	508	0.63
9	-7.8	2200	6.95	19.8		0.18	0.52	9	0.05	0.05	0	6.47	19.23	0.13	0.864	2	0.75	7.48	2.27		443	1.09
9.3	-8.1	1850	6.15	14.4		0.18	0.52	9	0.05	0.05	0	5.9	13.83	0.13	0.893	1.95	0.779	6.43	1.58		275	0.99
9.6	-8.4	1530	6.35	16.4	0.05	0.18	0.52	9	0.05	0.05	0	6.01	15.83	0.18	0.922	2	0.808	6.3	1.93	-0.15	341	1.02
9.9	-8.7	1650	6.55	14.6		0.18	0.52	9	0.05	0.05	0	6.31	14.03	0.13	0.952	1.95	0.836	6.41	1.44		268	1.03
10.2	-9	1175	11.6	17	4.15	0.18	0.52	9	0.05	0.05	0	11.5	16.43	4.28	0.981	1.9	0.864	12.17	0.47	0.31	171	2.08
10.5	-9.3	950	11.8	16.8	6.7	0.18	0.52	9	0.05	0.05	0	11.72	16.23	6.83	1.011	1.9	0.89	12.02	0.42	0.54	157	2.06

SU (BAR)	QD (BAR)	PHI (DEG)	SIGFF (BAR)	PHI0 (DEG)	PC (BAR)	OCR	M (BAR)	SOIL TYPE
							1326	SILTY SAND
	35.5	43.1	0.14	38.6	12.38	150.9	592	SANDY SILT
	28.8	41.7	0.17	37.4	7.54	72.4	397	SANDY SILT
					5.87	47	332	SILT
	42.1	43.5	0.25	40	3.51	23.9	429	SILTY SAND
0.34					2.64	15.6	106	SILTY CLAY
					2.11	11.1	120	CLAYEY SILT
	15.1	36.4	0.34	32.7	2.92	13.8	386	SILTY SAND
	15.7	36.2	0.37	32.6	2.7	11.6	236	SANDY SILT
					4.46	17.5	228	CLAYEY SILT
0.49					3.74	13.6	84	CLAY
0.79					6.65	22.4	183	SILTY CLAY
0.8					6.6	20.7	138	CLAY
0.95					8.13	23.8	164	CLAY
0.54					3.9	10.7	53	CLAY
	52.4	41.7	0.64	39.5	1.38	3.6	354	SILTY SAND
	115.8	44.7	0.7	42.8	3.26	8	721	SILTY SAND
	120.1	45.8	0.75	44.1	1.19	2.7	910	SAND
	189.1	44.7	0.79	43.1	12.04	25.9	1880	SILTY SAND
1.11					8.94	18.2	299	SILTY CLAY
0.79					5.83	11.3	187	SILTY CLAY
	57.3	40.4	0.89	38.6	1.57	2.9	538	SAND
	57.4	40.8	0.93	39.1	0.78	1.4	219	SILTY SAND
	43.8	38.7	0.96	37	0.95	1.6	319	SAND
	36	36.9	0.98	35.2	1.28	2.1	186	SILTY SAND
	71.9	42.3	1.06	41	0.18	0.3	152	SAND
	88.7	41.1	1.1	39.7	3.7	5.6	941	SILTY SAND
	103.8	42	1.15	40.7	2.97	4.3	1349	SAND
	105.2	42.3	1.21	41.1	2.07	2.9	958	SAND
	62.9	37.9	1.21	36.6	5.88	7.8	989	SILTY SAND
	52.7	36.8	1.25	35.5	4.9	6.3	571	SANDY SILT
	40.9	34.9	1.27	33.6	5.25	6.5	704	SILTY SAND
	44.3	35.2	1.32	33.9	5.55	6.6	554	SANDY SILT
1.82					14.45	16.7	460	SILTY CLAY
1.84					14.61	16.4	419	SILTY CLAY

APPENDIX V – SUMMARY OF ETS LABORATORY TEST RESULTS

Summary of Laboratory Test Data

Project Name: Ft. Eustis WTU Exploration
Project Number: ETS-09E134
Client: US Army Corps of Engineers

Sample Number	Sample Depth (ft)	Natural Moisture (%)	Percent Passing No. 200 Sieve (%)	Atterberg Limits (LL / PL / PI)	USCS Soil Classification
B-1	8-10	26.2	(NT)	51/ 18 / 33	CH
B-1	38-40	49.9	(NT)	76 / 22 / 54	CH
B-1	48-50	36.6	67.1	(NT)	ML/SM
B-1	53-55	40.1	(NT)	55 / 23 / 32	CH
B-1	63-65	25.3	20.9	(NT)	SC-SM
B-2	43-45	52.0	(NT)	74 / 22 / 52	CH
B-3	13-15	28.3	(NT)	47 / 18 / 29	CL
B-3	33-35	41.0	(NT)	63 / 22 / 41	CH
B-4	23-25	31.3	18.6	(NT)	SC-SM
B-4	58-60	23.7	26.1	(NT)	SC-SM
B-5	28-30	35.7	28.6	(NT)	SC-SM
B-6	0-2	14.4	(NT)	27 / 16 / 11	CL
B-6	18-20	20.8	(NT)	41 / 20 / 21	CL
B-6	23-25	26.0	74.3	(NT)	CL
B-6	27-28.5	32.7	54.5	(NT)	CL
B-7	2-4	21.5	(NT)	41 / 16 / 25	CL
B-7	28-30	33.4	35.7	(NT)	SC-SM
B-8	4-6	21.1	52.6	(NT)	CL/SC
B-8	8-10	34.8	(NT)	31 / 18 / 13	CL
B-8	18-20	21.4	18.2	(NT)	SC-SM
B-9	0-2	17.4	63.0	(NT)	CL
B-9	8-10	29.2	74.5	(NT)	CL
B-10	8-10	26.1	(NT)	46 / 22 / 24	CL
B-11	0-2	14.2	(NT)	26 / 15 / 11	CL
B-15	2-4	28.0	(NT)	48 / 20 / 28	CL

(NT)- not tested

APPENDIX VI – STANDARD PROCTOR & CBR TEST RESULTS

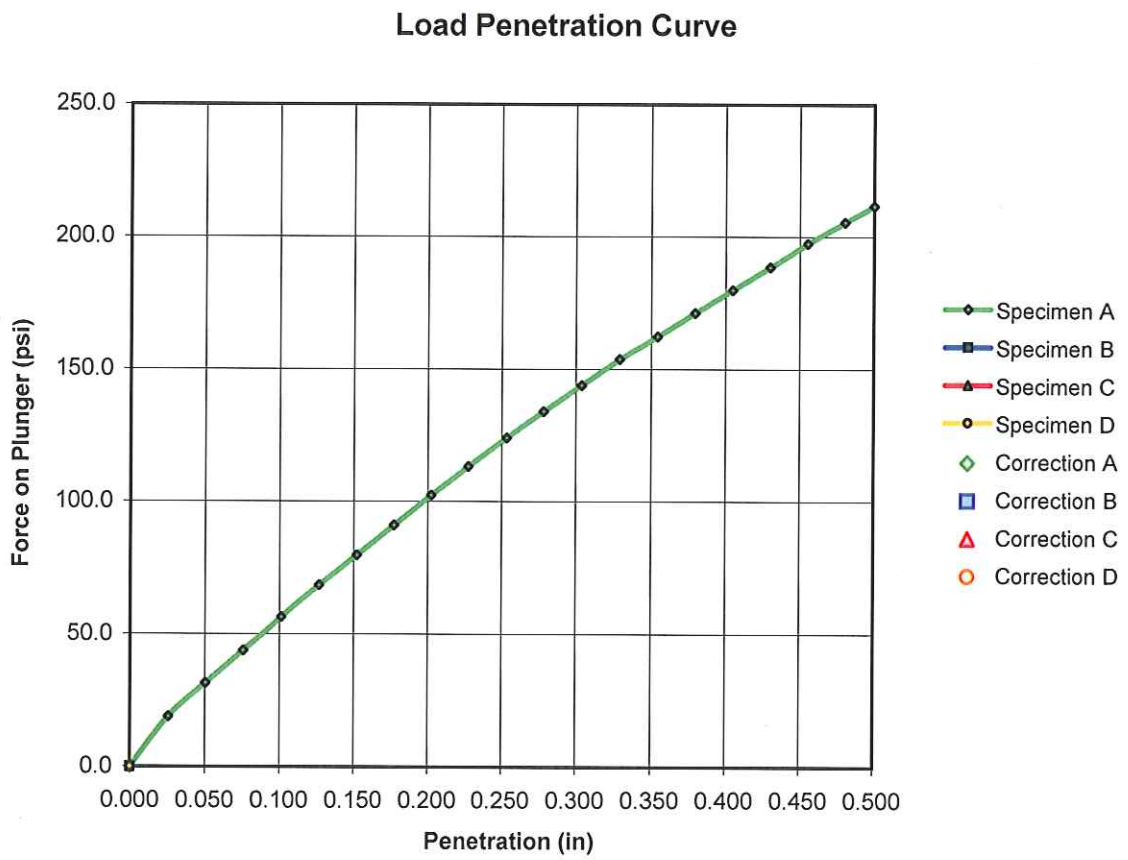
Engineering & Testing Services, Inc.

California Bearing Ratio Test Report

Tested By: ETS Soils Lab 1/21/2010

Computed By: M. Maranton 1/25/2010

Checked By: V. Sallee, P.E. 1/25/2010



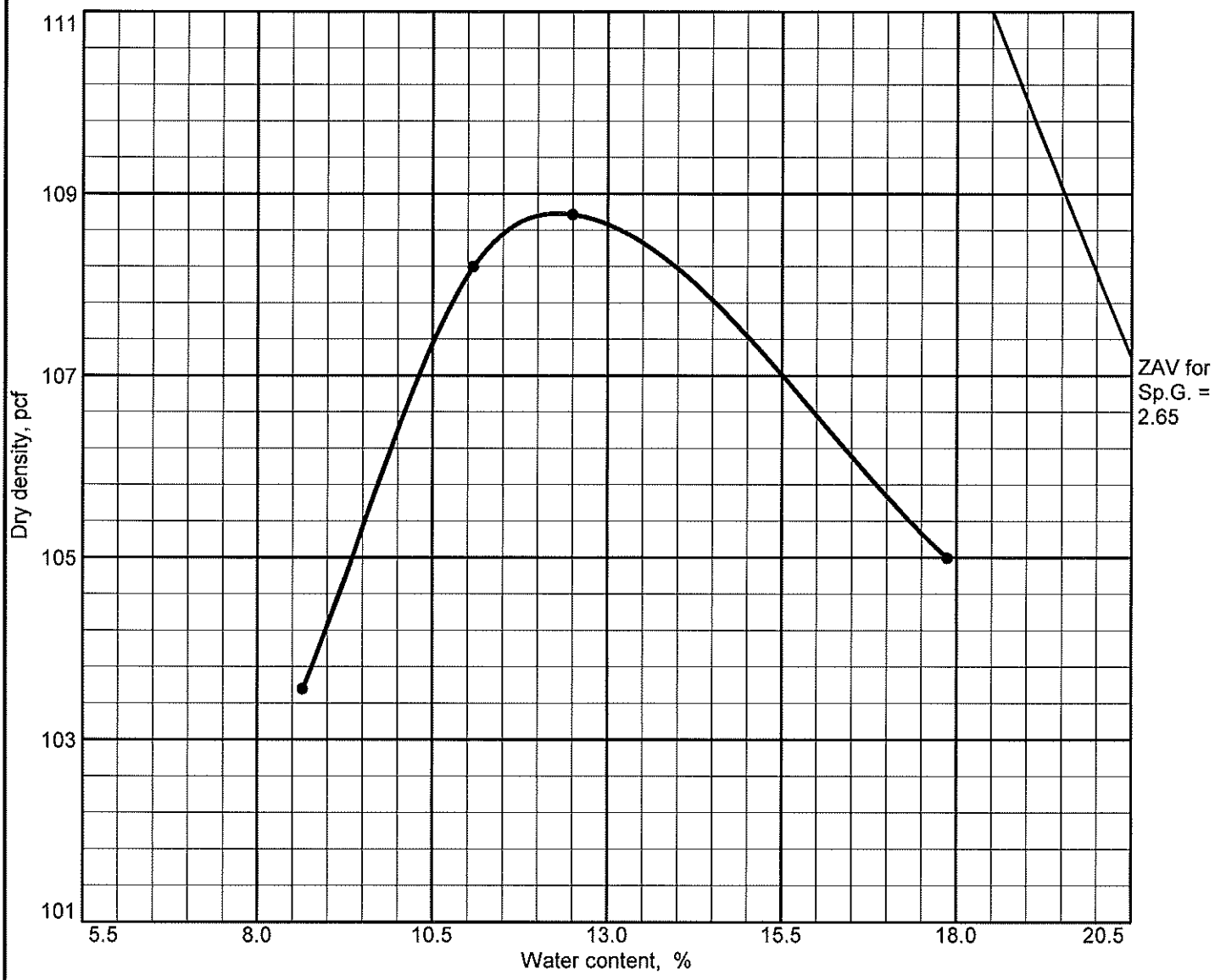
Project Information	
Project Number	ETS-09E 134
Project Name	FT. EUSTIS WARRIORS TRANSITION UNIT (TWU) EXPLORATION
Project Location	NEWPORT NEWS, VA
Test Date	1/25/2010
Client	US ARMY CORPS OF ENGINEERS - NORFOLK

Test Results

Measurements	CBR Results	Density Data	
0.1 in Pen.	5.6	Compaction Type	Standard Effort
0.2 in Pen.	6.8	Test Standard	D698 - Method A
Moisture (%)	12.1	Max Dry Density (PCF)	108.8
Dry Dens (pcf)	108.0	Optimum Moisture (%)	12.3

	Project Data	Test Variables	
Sample Depth	1-2'	Liquid Limit:	
Sample Number	CBR-11	Plastic Limit:	
Remarks	BROWN, SILTY SANDY CLAY (CL)		
	Other laboratory tests conducted in accordance with ASTM D422, D698, D1883, D2216, D2487 and D2488.		

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
0-2 FEET	CL	A-6	15.1	2.65	NT	NT	0.0	61.5

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 109 pcf Optimum moisture = 12 %	BROWN, SILTY SANDY CLAY (CL)

Project No. ETS-09E134 **Client:** US ARMY CORPS OF ENGINEERS - NORFOLK
Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION

● **Source:** **Sample No.:** CBR-11 **Elev./Depth:** 0-2 FEET

Remarks:
ESTIMATED SPECIFIC GRAVITY, Gs= 2.65

ENGINEERING AND TESTING SERVICES, INC.
Virginia Beach, VA

Plate

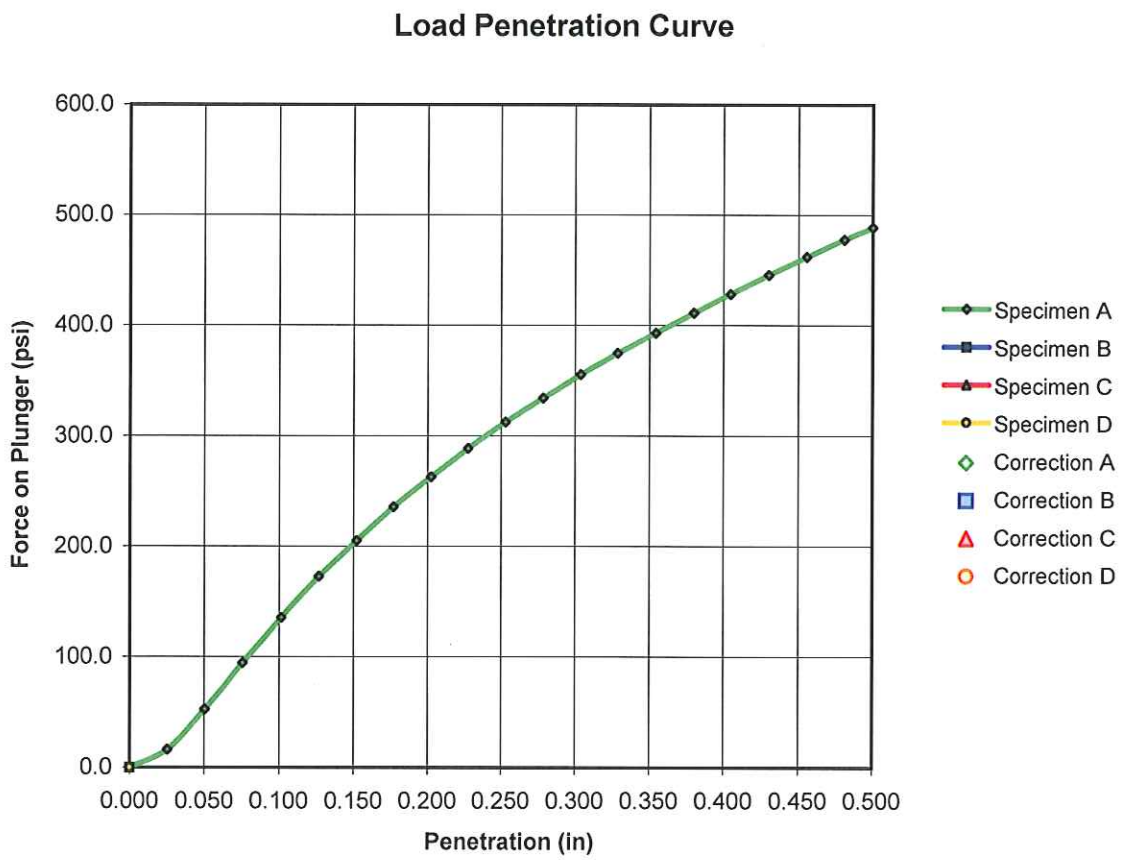
Engineering & Testing Services, Inc.

California Bearing Ratio Test Report

Tested By: ETS Soils Lab 1-25-2010

Computed By: M. Maranton 1/29/2010

Checked By: V. Sallee, P.E. 1/29/2010



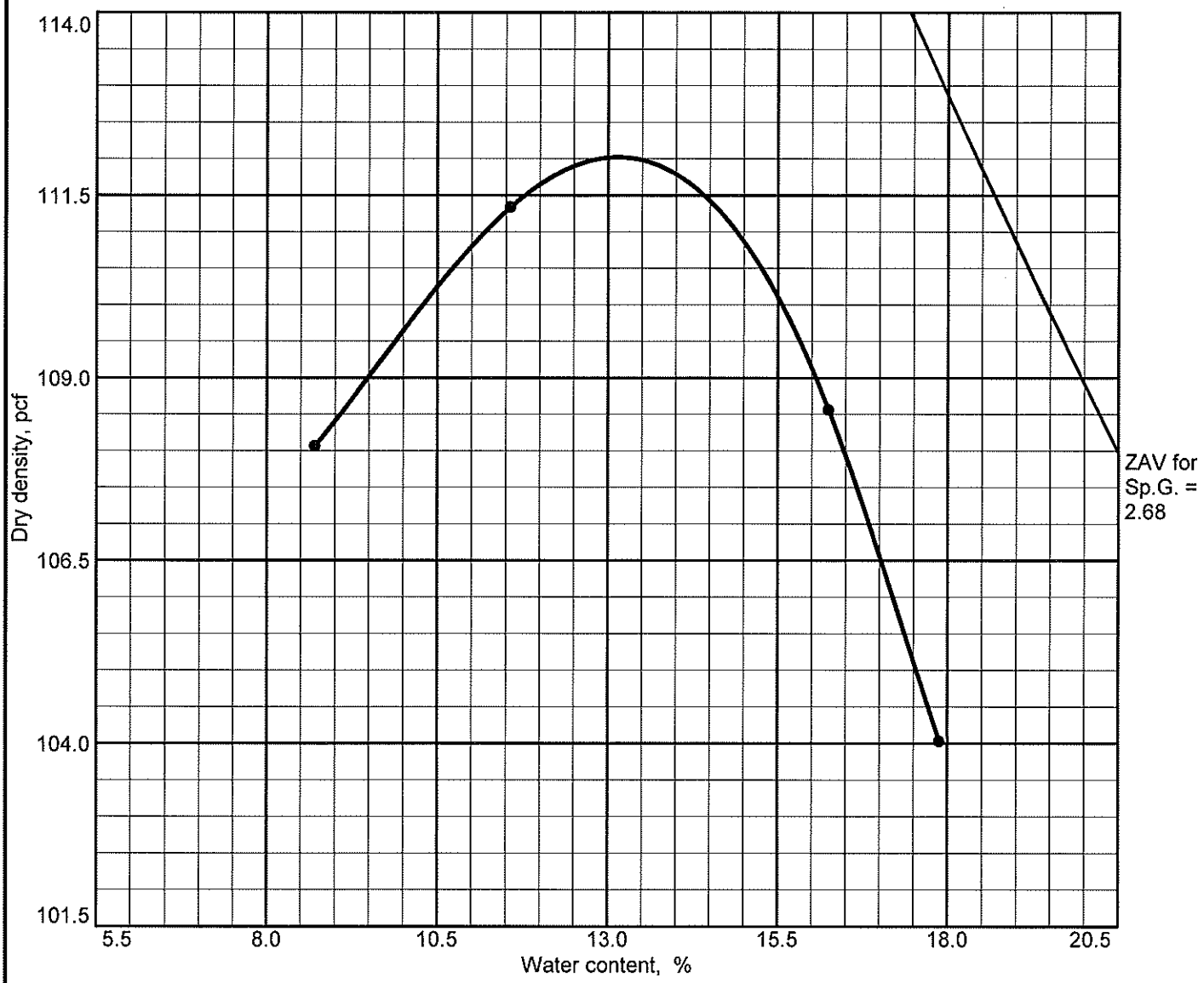
Project Information	
Project Number	ETS-09E 134
Project Name	FT. EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION
Project Location	NEWPORT NEWS, VA
Test Date	1-25-2010
Client	US ARMY CORPS OF ENGINEERS - NORFOLK

Test Results

Measurements	CBR Results	Density Data	
0.1 in Pen.	13.6	Compaction Type	Standard Effort
0.2 in Pen.	17.5	Test Standard	D698 - Method A
Moisture (%)	12.5	Max Dry Density (PCF)	112
Dry Dens (pcf)	112.6	Optimum Moisture (%)	13.1

	Project Data	Test Variables	
Sample Depth	1-2'	Liquid Limit:	
Sample Number	CBR-12	Plastic Limit:	
Remarks	BROWN, SILTY SANDY CLAY (CL)		
	Other laboratory tests conducted in accordance with ASTM D422, D698, D1883, D2216, D2487 and D2488.		

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
0-2 FEET	CL	A-6	16.3	2.68	NT	NT	0.0	71

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 112 pcf Optimum moisture = 13 %	BROWN, SILTY SANDY CLAY (CL)

Project No. ETS-09E134 **Client:** US ARMY CORPS OF ENGINEERS - NORFOLK
Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION

● **Source:** **Sample No.:** CBR-12 **Elev./Depth:** 0-2 FEET

Remarks:
ESTIMATED SPECIFIC GRAVITY, Gs= 2.68

ENGINEERING AND TESTING SERVICES, INC.
Virginia Beach, VA

Plate

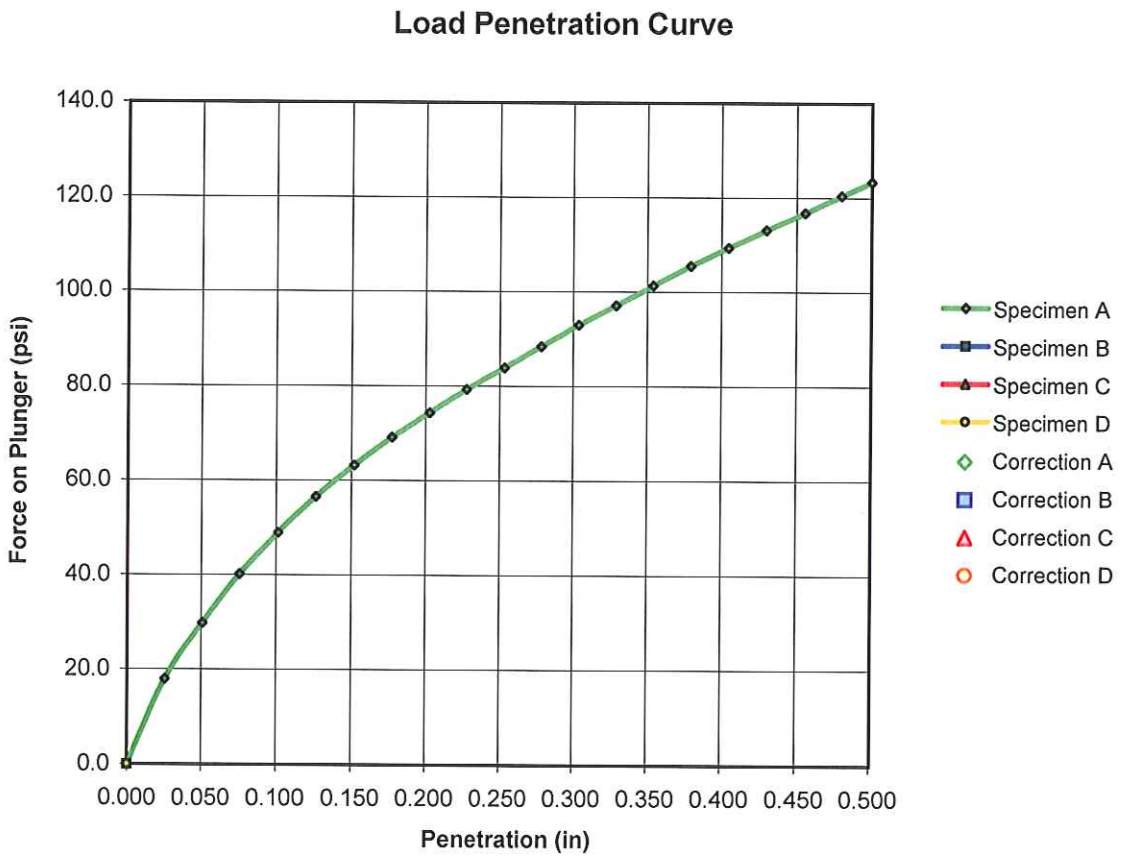
Engineering & Testing Services, Inc.

California Bearing Ratio Test Report

Tested By: ETS Soils Lab 1/21/2010

Computed By: M. Maranton 1/25/2010

Checked By: V. Sallee, P.E. 1/25/2010



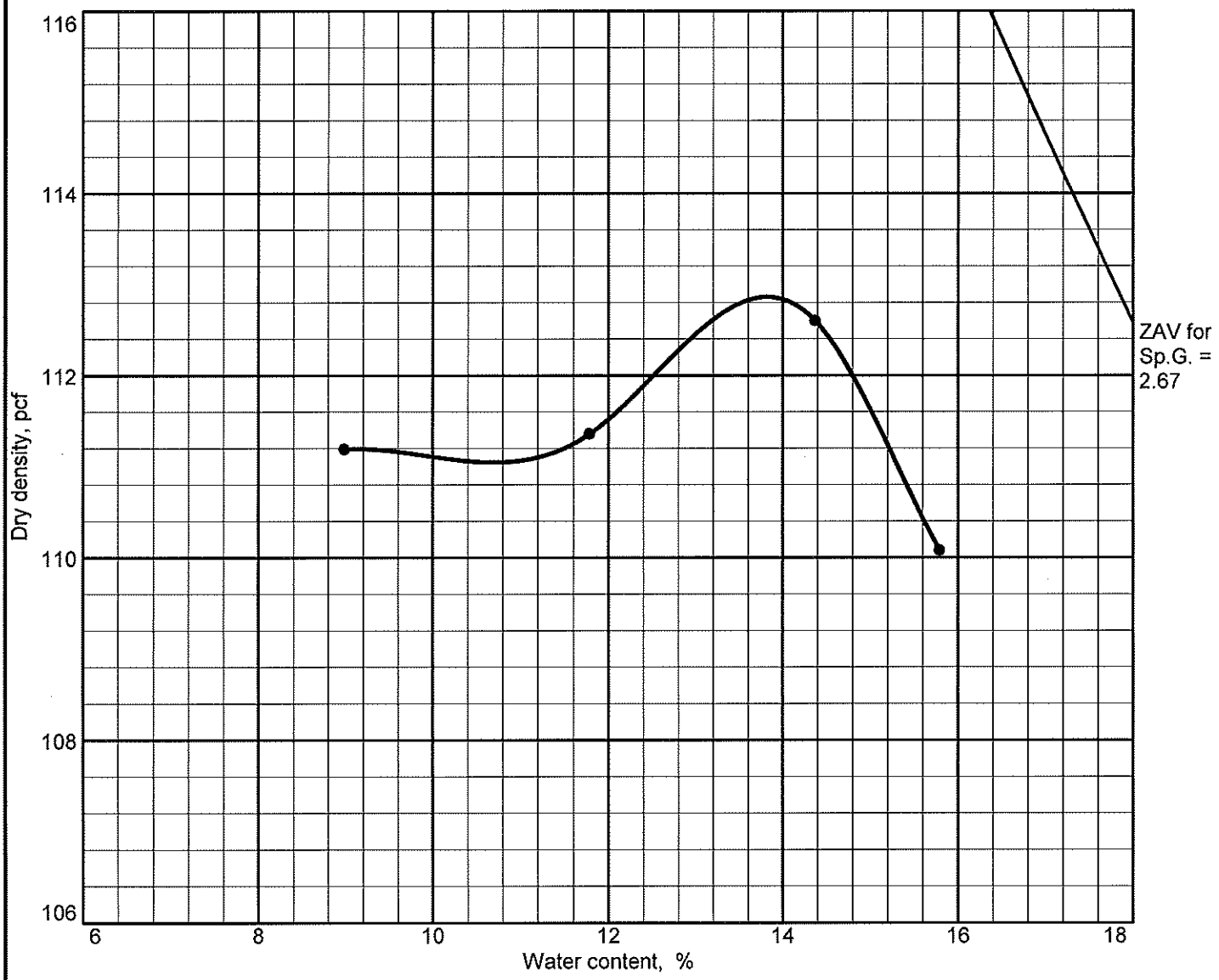
Project Information	
Project Number	ETS-09E 134
Project Name	FT. EUSTIS WARRIORS TRANSITION UNIT (TWU) EXPLORATION
Project Location	NEWPORT NEWS, VA
Test Date	1/25/2010
Client	US ARMY CORPS OF ENGINEERS - NORFOLK

Test Results

Measurements	CBR Results	Density Data	
0.1 in Pen.	4.9	Compaction Type	Standard Effort
0.2 in Pen.	5.0	Test Standard	D698 - Method A
Moisture (%)	13.0	Max Dry Density (PCF)	112.9
Dry Dens (pcf)	114.2	Optimum Moisture (%)	13.8

	Project Data	Test Variables	
Sample Depth	1-2'	Liquid Limit:	
Sample Number	CBR-14	Plastic Limit:	
Remarks	BROWN, SILTY SANDY CLAY (CL)		
	Other laboratory tests conducted in accordance with ASTM D422, D698, D1883, D2216, D2487 and D2488.		

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
0-2 FEET	CL	A-6	16.1	2.67	NT	NT	0.0	62.4

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 113 pcf Optimum moisture = 14 %	BROWN, SILTY SANDY CLAY (CL)

Project No. ETS-09E134 **Client:** US ARMY CORPS OF ENGINEERS - NORFOLK
Project: FT EUSTIS WARRIORS TRANSITION UNIT (WTU) EXPLORATION

● **Source:** **Sample No.:** CBR-14 **Elev./Depth:** 0-2 FEET

Remarks:
ESTIMATED SPECIFIC GRAVITY, Gs= 2.67

ENGINEERING AND TESTING SERVICES, INC.
Virginia Beach, VA

Plate

Appendix B
List of Drawings

Not Used

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Appendix C
Utility Connections

Electrical Service: Dominion Virginia Power (DVP)
POC- Mr. Steve Buell (757-434-6195)

Water Service: Old Dominion Utility Service (ODUS)
POC-Ms. Julie Ball (757-431-2966)

Sanitary Sewer System: Old Dominion Utility Service (ODUS)
POC-Ms. Julie Ball (757-431-2966)

Natural Gas: Virginia Natural Gas (VNG)
POC-Mr. Heath Deaver (757-455-5361)

Communication Service: Ft Eustis Directorate of Information Management (DOIM)
POC-MsMr. Bob Beil (757-878-1133)

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Old Dominion
UTILITY SERVICES, INC.
A Subsidary of American States Utility Services, Inc.

NOT TO SCALE

FT. EUSTIS-Warriors In Transit Complex

Old Dominion
Utility Services, Inc.
A Subsidiary of American States Utility Services, Inc.

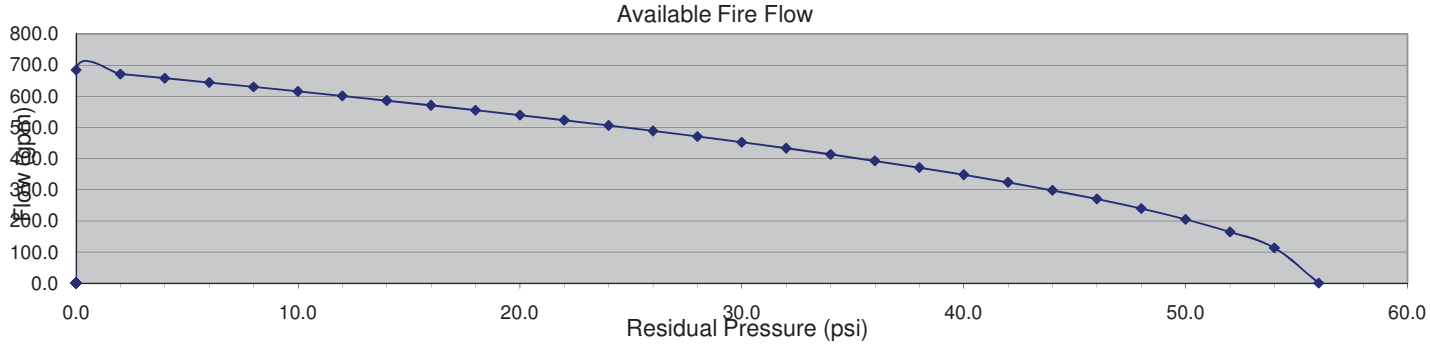
FIRE HYDRANT FIRE FLOW TEST

Date 05/04/09 Time 10:00 Weather Cloudy

Flusher / Tester Prism CE Temperature 65 °F / °C

Flow Hydrant 112
Diameter 2.5 inches
Coefficient 0.77
Pitot 12 psi
Flow at Residual Pressure **497** gpm
Mins/flowed 2 Water Used **133** cubic feet

Gage (test) Hydrant 114
Static 56 psi
Residual 25 psi
Flow available at 20psi residual **539** gpm



Pitot Chart						Flow Available at Residual Pressure			
psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	56	0	0	684
2	203	29	773	56	1074	54	113	-	-
3	249	30	786	57	1084	52	165	-	-
4	287	31	799	58	1093	50	205	-	-
5	321	32	812	59	1103	48	239	-	-
6	352	33	825	60	1112	46	270	-	-
7	380	34	837	61	1121	44	298	-	-
8	406	35	849	62	1130	42	324	-	-
9	431	36	861	63	1139	40	348	-	-
10	454	37	873	64	1148	38	371	-	-
11	476	38	885	65	1157	36	392	-	-
12	497	39	897	66	1166	34	413	-	-
13	518	40	908	67	1175	32	433	-	-
14	537	41	919	68	1184	30	452	-	-
15	556	42	930	69	1192	28	471	-	-
16	574	43	941	70	1201	26	489	-	-
17	592	44	952	71	1210	24	506	-	-
18	609	45	963	72	1218	22	523	-	-
19	626	46	974	73	1227	20	539	-	-
20	642	47	984	74	1235	18	555	-	-
21	658	48	995	75	1243	16	571	-	-
22	673	49	1005	76	1251	14	586	-	-
23	688	50	1015	77	1260	12	601	-	-
24	703	51	1025	78	1268	10	615	-	-
25	718	52	1035	79	1276	8	630	-	-
26	732	53	1045	80	1284	6	644	-	-
27	746	54	1055	81	1292	4	658	-	-
28	760	55	1065	82	1300	2	671	-	-

Old Dominion
Utility Services, Inc.
A Subsidiary of American States Utility Services, Inc.

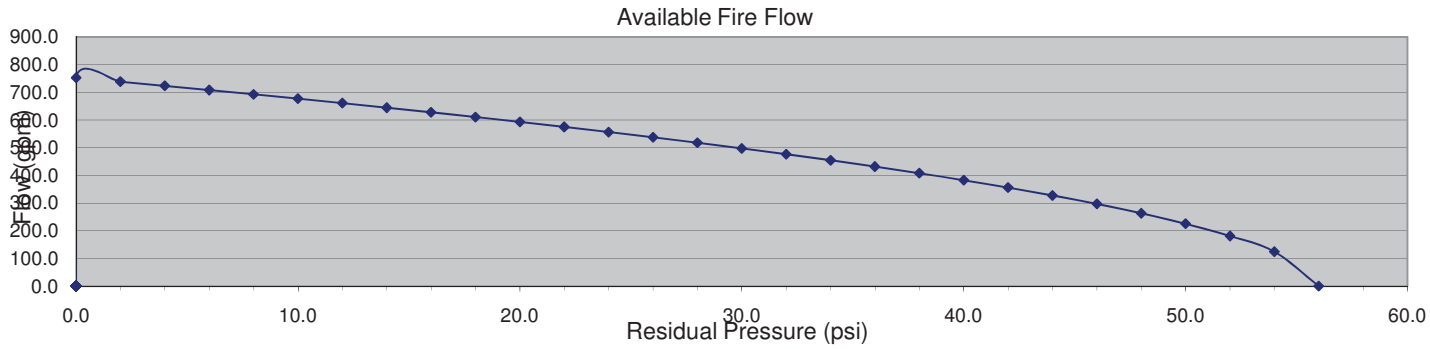
FIRE HYDRANT FIRE FLOW TEST

Date 05/04/09 Time 9:40 Weather Cloudy

Flusher / Tester Prism CE Temperature 65 °F / °C

Flow Hydrant 117
Diameter 2.5 inches
Coefficient 0.77
Pitot 12 psi
Flow at Residual Pressure **497** gpm
Mins/flowed 2 Water Used **133** cubic feet

Gage (test) Hydrant 114
Static 56 psi
Residual 30 psi
Flow available at 20psi residual **593** gpm



Pitot Chart						Flow Available at Residual Pressure			
psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	56	0	0	753
2	203	29	773	56	1074	54	124	-	-
3	249	30	786	57	1084	52	181	-	-
4	287	31	799	58	1093	50	225	-	-
5	321	32	812	59	1103	48	263	-	-
6	352	33	825	60	1112	46	297	-	-
7	380	34	837	61	1121	44	328	-	-
8	406	35	849	62	1130	42	356	-	-
9	431	36	861	63	1139	40	383	-	-
10	454	37	873	64	1148	38	408	-	-
11	476	38	885	65	1157	36	432	-	-
12	497	39	897	66	1166	34	454	-	-
13	518	40	908	67	1175	32	476	-	-
14	537	41	919	68	1184	30	497	-	-
15	556	42	930	69	1192	28	518	-	-
16	574	43	941	70	1201	26	537	-	-
17	592	44	952	71	1210	24	556	-	-
18	609	45	963	72	1218	22	575	-	-
19	626	46	974	73	1227	20	593	-	-
20	642	47	984	74	1235	18	610	-	-
21	658	48	995	75	1243	16	628	-	-
22	673	49	1005	76	1251	14	644	-	-
23	688	50	1015	77	1260	12	661	-	-
24	703	51	1025	78	1268	10	677	-	-
25	718	52	1035	79	1276	8	692	-	-
26	732	53	1045	80	1284	6	708	-	-
27	746	54	1055	81	1292	4	723	-	-
28	760	55	1065	82	1300	2	738	-	-

Old Dominion
Utility Services, Inc.
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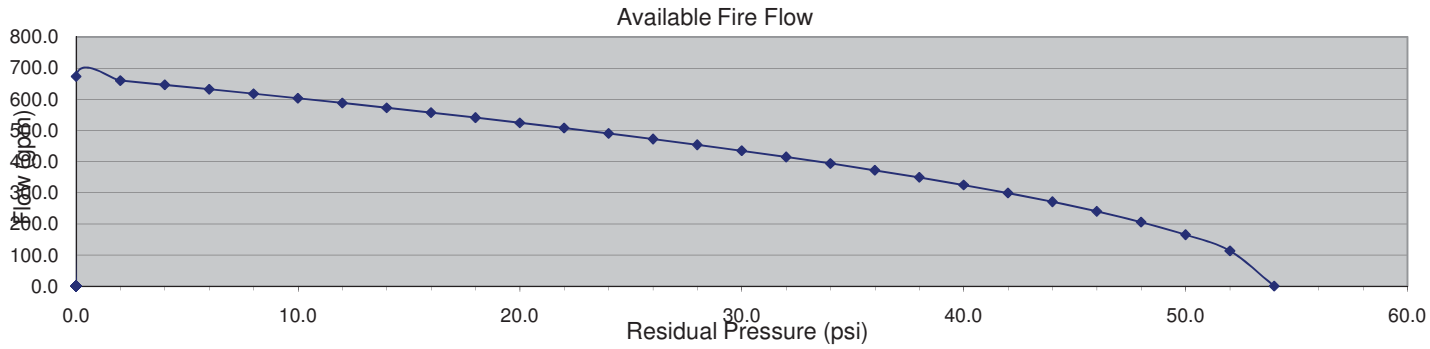
FIRE HYDRANT FIRE FLOW TEST

Date 05/04/09 Time 11:35 Weather Clear

Flusher / Tester Prism CE Temperature 75 °F / °C

Flow Hydrant 309
Diameter 2.5 inches
Coefficient 0.77
Pitot 10 psi
Flow at Residual Pressure **454** gpm
Mins/flowed 2 Water Used **121** cubic feet

Gage (test) Hydrant 310
Static 54 psi
Residual 28 psi
Flow available at 20psi residual **525** gpm



Pitot Chart						Flow Available at Residual Pressure			
psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	54	0	-	#VALUE!
2	203	29	773	56	1074	52	114	-	-
3	249	30	786	57	1084	50	165	-	-
4	287	31	799	58	1093	48	206	-	-
5	321	32	812	59	1103	46	240	-	-
6	352	33	825	60	1112	44	271	-	-
7	380	34	837	61	1121	42	299	-	-
8	406	35	849	62	1130	40	325	-	-
9	431	36	861	63	1139	38	349	-	-
10	454	37	873	64	1148	36	372	-	-
11	476	38	885	65	1157	34	394	-	-
12	497	39	897	66	1166	32	415	-	-
13	518	40	908	67	1175	30	435	-	-
14	537	41	919	68	1184	28	454	-	-
15	556	42	930	69	1192	26	473	-	-
16	574	43	941	70	1201	24	490	-	-
17	592	44	952	71	1210	22	508	-	-
18	609	45	963	72	1218	20	525	-	-
19	626	46	974	73	1227	18	541	-	-
20	642	47	984	74	1235	16	557	-	-
21	658	48	995	75	1243	14	573	-	-
22	673	49	1005	76	1251	12	588	-	-
23	688	50	1015	77	1260	10	603	-	-
24	703	51	1025	78	1268	8	618	-	-
25	718	52	1035	79	1276	6	632	-	-
26	732	53	1045	80	1284	4	646	-	-
27	746	54	1055	81	1292	2	660	-	-
28	760	55	1065	82	1300	0	674	-	-

Old Dominion
Utility Services, Inc.
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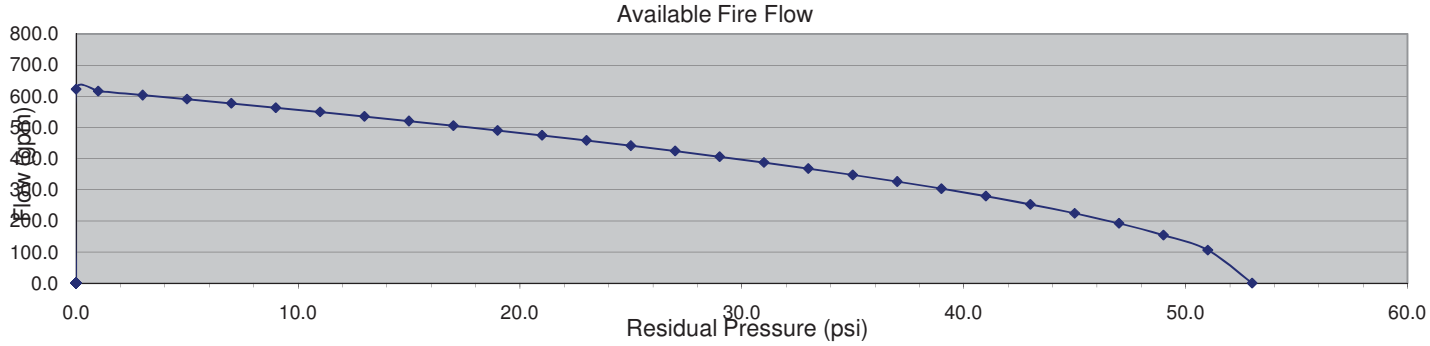
FIRE HYDRANT FIRE FLOW TEST

Date 05/04/09 Time 11:15 Weather Clear

Flusher / Tester Prism CE Temperature 75 °F / °C

Flow Hydrant 310
Diameter 2.5 inches
Coefficient 0.77
Pitot 8 psi
Flow at Residual Pressure **406** gpm
Mins/flowed 2 Water Used **109** cubic feet

Gage (test) Hydrant 309
Static 53 psi
Residual 29 psi
Flow available at 20psi residual **482** gpm



Pitot Chart						Flow Available at Residual Pressure			
psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	53	0	-	#VALUE!
2	203	29	773	56	1074	51	106	-	-
3	249	30	786	57	1084	49	154	-	-
4	287	31	799	58	1093	47	192	-	-
5	321	32	812	59	1103	45	224	-	-
6	352	33	825	60	1112	43	253	-	-
7	380	34	837	61	1121	41	279	-	-
8	406	35	849	62	1130	39	304	-	-
9	431	36	861	63	1139	37	326	-	-
10	454	37	873	64	1148	35	348	-	-
11	476	38	885	65	1157	33	368	-	-
12	497	39	897	66	1166	31	387	-	-
13	518	40	908	67	1175	29	406	-	-
14	537	41	919	68	1184	27	424	-	-
15	556	42	930	69	1192	25	441	-	-
16	574	43	941	70	1201	23	458	-	-
17	592	44	952	71	1210	21	474	-	-
18	609	45	963	72	1218	19	490	-	-
19	626	46	974	73	1227	17	505	-	-
20	642	47	984	74	1235	15	520	-	-
21	658	48	995	75	1243	13	535	-	-
22	673	49	1005	76	1251	11	549	-	-
23	688	50	1015	77	1260	9	563	-	-
24	703	51	1025	78	1268	7	577	-	-
25	718	52	1035	79	1276	5	590	-	-
26	732	53	1045	80	1284	3	604	-	-
27	746	54	1055	81	1292	1	616	-	-
28	760	55	1065	82	1300	0	623	-	-

Old Dominion
Utility Services, Inc.
A Subsidiary of American States Utility Services, Inc.

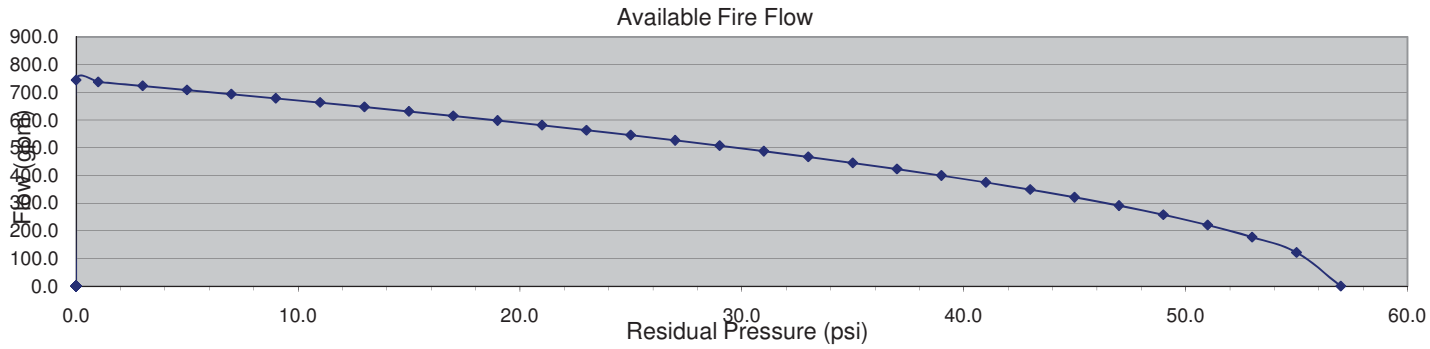
FIRE HYDRANT FIRE FLOW TEST

Date 05/01/09 Time 3:15 Weather Clear

Flusher / Tester Prism CE Temperature 80 °F / °C

Flow Hydrant 322
Diameter 2.5 inches
Coefficient 0.77
Pitot 12 psi
Flow at Residual Pressure **497** gpm
Mins/flowed 2 Water Used **133** cubic feet

Gage (test) Hydrant 502
Static 57 psi
Residual 30 psi
Flow available at 20psi residual **590** gpm



Pitot Chart						Flow Available at Residual Pressure			
psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	57	0	1	737
2	203	29	773	56	1074	55	122	0	744
3	249	30	786	57	1084	53	177	-	-
4	287	31	799	58	1093	51	221	-	-
5	321	32	812	59	1103	49	258	-	-
6	352	33	825	60	1112	47	291	-	-
7	380	34	837	61	1121	45	321	-	-
8	406	35	849	62	1130	43	349	-	-
9	431	36	861	63	1139	41	375	-	-
10	454	37	873	64	1148	39	400	-	-
11	476	38	885	65	1157	37	423	-	-
12	497	39	897	66	1166	35	445	-	-
13	518	40	908	67	1175	33	467	-	-
14	537	41	919	68	1184	31	487	-	-
15	556	42	930	69	1192	29	507	-	-
16	574	43	941	70	1201	27	526	-	-
17	592	44	952	71	1210	25	545	-	-
18	609	45	963	72	1218	23	563	-	-
19	626	46	974	73	1227	21	581	-	-
20	642	47	984	74	1235	19	598	-	-
21	658	48	995	75	1243	17	615	-	-
22	673	49	1005	76	1251	15	631	-	-
23	688	50	1015	77	1260	13	647	-	-
24	703	51	1025	78	1268	11	663	-	-
25	718	52	1035	79	1276	9	678	-	-
26	732	53	1045	80	1284	7	694	-	-
27	746	54	1055	81	1292	5	708	-	-
28	760	55	1065	82	1300	3	723	-	-

Old Dominion
Utility Services, Inc.
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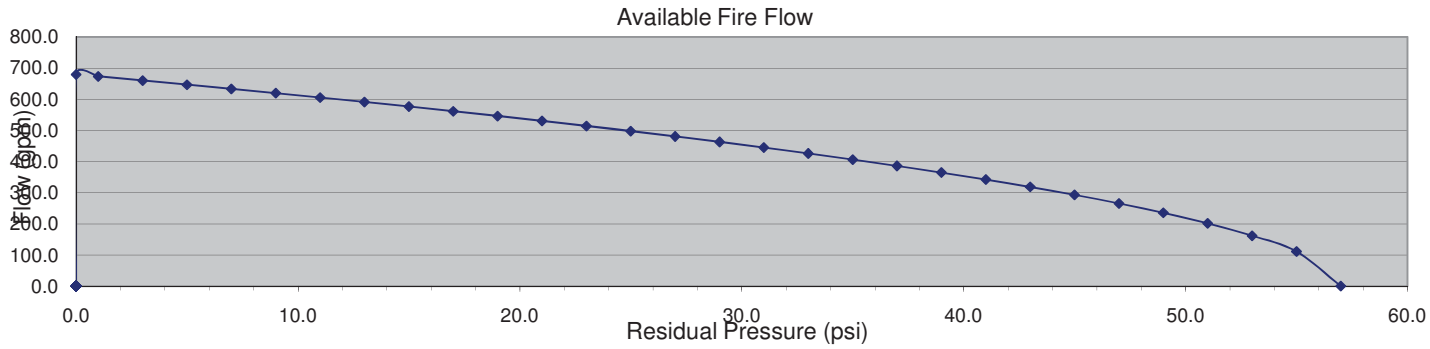
FIRE HYDRANT FIRE FLOW TEST

Date 05/01/09 Time 3:00 Weather Clear

Flusher / Tester Prism CE Temperature 80 °F / °C

Flow Hydrant 324
Diameter 2.5 inches
Coefficient 0.77
Pitot 10 psi
Flow at Residual Pressure **454** gpm
Mins/flowed 2 Water Used **121** cubic feet

Gage (test) Hydrant 502
Static 57 psi
Residual 30 psi
Flow available at 20psi residual **538** gpm



Pitot Chart						Flow Available at Residual Pressure			
psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	57	0	1	673
2	203	29	773	56	1074	55	111	0	680
3	249	30	786	57	1084	53	162	-	-
4	287	31	799	58	1093	51	202	-	-
5	321	32	812	59	1103	49	235	-	-
6	352	33	825	60	1112	47	266	-	-
7	380	34	837	61	1121	45	293	-	-
8	406	35	849	62	1130	43	318	-	-
9	431	36	861	63	1139	41	342	-	-
10	454	37	873	64	1148	39	365	-	-
11	476	38	885	65	1157	37	386	-	-
12	497	39	897	66	1166	35	406	-	-
13	518	40	908	67	1175	33	426	-	-
14	537	41	919	68	1184	31	445	-	-
15	556	42	930	69	1192	29	463	-	-
16	574	43	941	70	1201	27	481	-	-
17	592	44	952	71	1210	25	498	-	-
18	609	45	963	72	1218	23	514	-	-
19	626	46	974	73	1227	21	530	-	-
20	642	47	984	74	1235	19	546	-	-
21	658	48	995	75	1243	17	561	-	-
22	673	49	1005	76	1251	15	576	-	-
23	688	50	1015	77	1260	13	591	-	-
24	703	51	1025	78	1268	11	605	-	-
25	718	52	1035	79	1276	9	619	-	-
26	732	53	1045	80	1284	7	633	-	-
27	746	54	1055	81	1292	5	647	-	-
28	760	55	1065	82	1300	3	660	-	-

Old Dominion
Utility Services, Inc.
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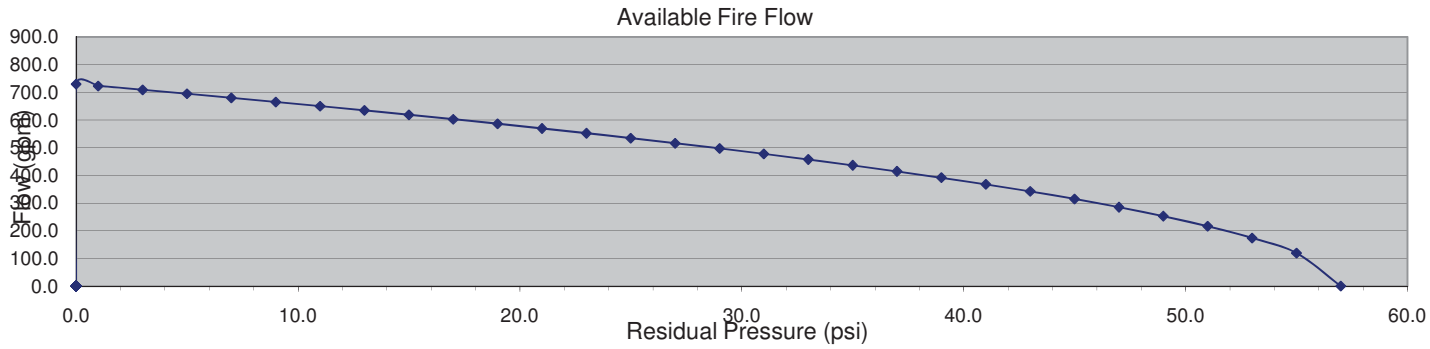
FIRE HYDRANT FIRE FLOW TEST

Date 05/01/09 Time 3:20 Weather Clear

Flusher / Tester Prism CE Temperature 80 °F / °C

Flow Hydrant 501
Diameter 2.5 inches
Coefficient 0.77
Pitot 12 psi
Flow at Residual Pressure **497** gpm
Mins/flowed 2 Water Used **133** cubic feet

Gage (test) Hydrant 502
Static 57 psi
Residual 29 psi
Flow available at 20psi residual **578** gpm



Pitot Chart						Flow Available at Residual Pressure			
psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	57	0	1	723
2	203	29	773	56	1074	55	120	0	730
3	249	30	786	57	1084	53	174	-	-
4	287	31	799	58	1093	51	216	-	-
5	321	32	812	59	1103	49	253	-	-
6	352	33	825	60	1112	47	285	-	-
7	380	34	837	61	1121	45	315	-	-
8	406	35	849	62	1130	43	342	-	-
9	431	36	861	63	1139	41	368	-	-
10	454	37	873	64	1148	39	392	-	-
11	476	38	885	65	1157	37	415	-	-
12	497	39	897	66	1166	35	437	-	-
13	518	40	908	67	1175	33	458	-	-
14	537	41	919	68	1184	31	478	-	-
15	556	42	930	69	1192	29	497	-	-
16	574	43	941	70	1201	27	516	-	-
17	592	44	952	71	1210	25	534	-	-
18	609	45	963	72	1218	23	552	-	-
19	626	46	974	73	1227	21	570	-	-
20	642	47	984	74	1235	19	586	-	-
21	658	48	995	75	1243	17	603	-	-
22	673	49	1005	76	1251	15	619	-	-
23	688	50	1015	77	1260	13	635	-	-
24	703	51	1025	78	1268	11	650	-	-
25	718	52	1035	79	1276	9	665	-	-
26	732	53	1045	80	1284	7	680	-	-
27	746	54	1055	81	1292	5	695	-	-
28	760	55	1065	82	1300	3	709	-	-

Old Dominion
Utility Services, Inc.
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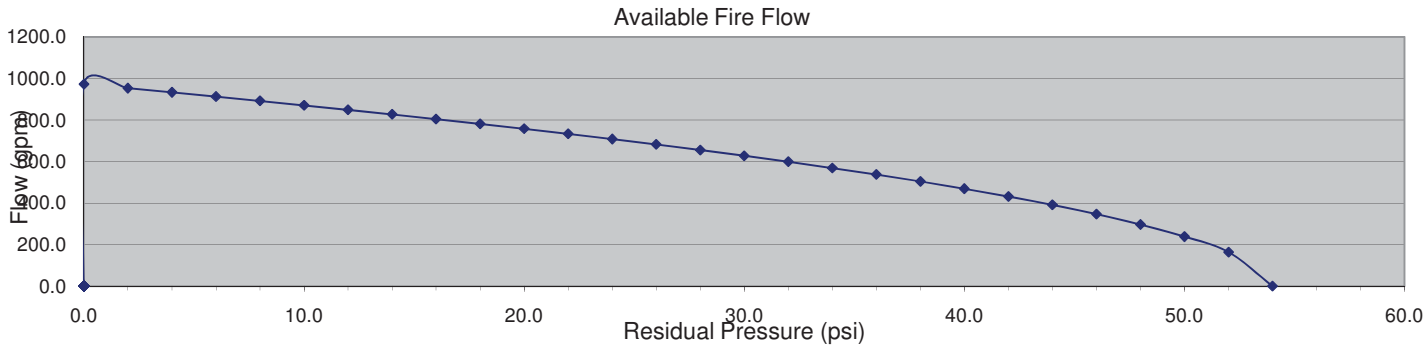
FIRE HYDRANT FIRE FLOW TEST

Date 06/25/09 Time 11:45 Weather Sunny

Flusher / Tester Prism CE Temperature 85 °F / °C

Flow Hydrant 502A
Diameter 2.5 inches
Coefficient 0.77
Pitot 20 psi
Flow at Residual Pressure **642** gpm
Mins/flowed 2 Water Used **172** cubic feet

Gage (test) Hydrant 503
Static 54 psi
Residual 29 psi
Flow available at 20psi residual **758** gpm



Pitot Chart						Flow Available at Residual Pressure			
psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	54	0	-	#VALUE!
2	203	29	773	56	1074	52	164	-	-
3	249	30	786	57	1084	50	239	-	-
4	287	31	799	58	1093	48	297	-	-
5	321	32	812	59	1103	46	347	-	-
6	352	33	825	60	1112	44	391	-	-
7	380	34	837	61	1121	42	432	-	-
8	406	35	849	62	1130	40	469	-	-
9	431	36	861	63	1139	38	505	-	-
10	454	37	873	64	1148	36	538	-	-
11	476	38	885	65	1157	34	569	-	-
12	497	39	897	66	1166	32	599	-	-
13	518	40	908	67	1175	30	628	-	-
14	537	41	919	68	1184	28	656	-	-
15	556	42	930	69	1192	26	683	-	-
16	574	43	941	70	1201	24	708	-	-
17	592	44	952	71	1210	22	734	-	-
18	609	45	963	72	1218	20	758	-	-
19	626	46	974	73	1227	18	782	-	-
20	642	47	984	74	1235	16	805	-	-
21	658	48	995	75	1243	14	827	-	-
22	673	49	1005	76	1251	12	850	-	-
23	688	50	1015	77	1260	10	871	-	-
24	703	51	1025	78	1268	8	892	-	-
25	718	52	1035	79	1276	6	913	-	-
26	732	53	1045	80	1284	4	933	-	-
27	746	54	1055	81	1292	2	953	-	-
28	760	55	1065	82	1300	0	973	-	-

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Utility Services, Inc.
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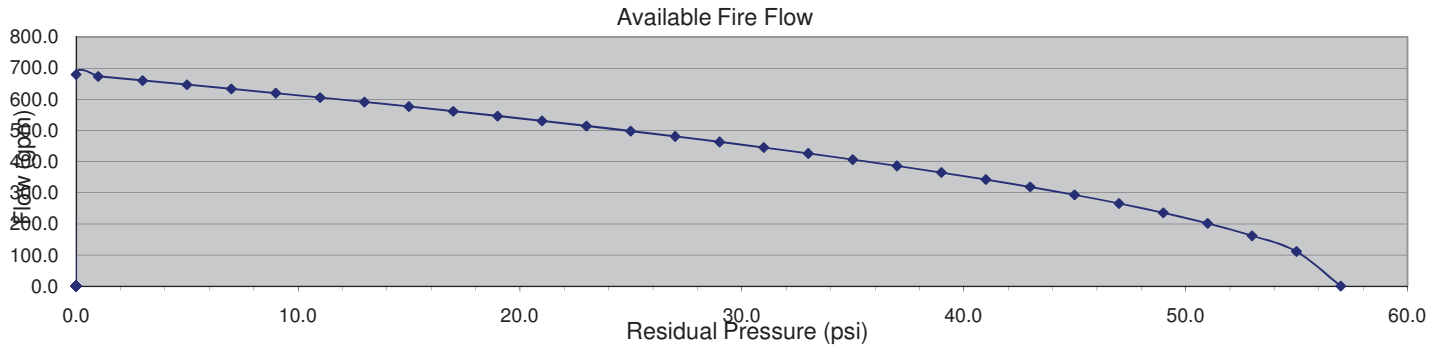
FIRE HYDRANT FIRE FLOW TEST

Date 05/01/09 Time 3:45 Weather Clear

Flusher / Tester Prism CE Temperature 80 °F / °C

Flow Hydrant 502
Diameter 2.5 inches
Coefficient 0.77
Pitot 10 psi
Flow at Residual Pressure **454** gpm
Mins/flowed 2 Water Used **121** cubic feet

Gage (test) Hydrant 324
Static 57 psi
Residual 30 psi
Flow available at 20psi residual **538** gpm



Pitot Chart						Flow Available at Residual Pressure			
psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	57	0	1	673
2	203	29	773	56	1074	55	111	0	680
3	249	30	786	57	1084	53	162	-	-
4	287	31	799	58	1093	51	202	-	-
5	321	32	812	59	1103	49	235	-	-
6	352	33	825	60	1112	47	266	-	-
7	380	34	837	61	1121	45	293	-	-
8	406	35	849	62	1130	43	318	-	-
9	431	36	861	63	1139	41	342	-	-
10	454	37	873	64	1148	39	365	-	-
11	476	38	885	65	1157	37	386	-	-
12	497	39	897	66	1166	35	406	-	-
13	518	40	908	67	1175	33	426	-	-
14	537	41	919	68	1184	31	445	-	-
15	556	42	930	69	1192	29	463	-	-
16	574	43	941	70	1201	27	481	-	-
17	592	44	952	71	1210	25	498	-	-
18	609	45	963	72	1218	23	514	-	-
19	626	46	974	73	1227	21	530	-	-
20	642	47	984	74	1235	19	546	-	-
21	658	48	995	75	1243	17	561	-	-
22	673	49	1005	76	1251	15	576	-	-
23	688	50	1015	77	1260	13	591	-	-
24	703	51	1025	78	1268	11	605	-	-
25	718	52	1035	79	1276	9	619	-	-
26	732	53	1045	80	1284	7	633	-	-
27	746	54	1055	81	1292	5	647	-	-
28	760	55	1065	82	1300	3	660	-	-

Old Dominion
Utility Services, Inc.
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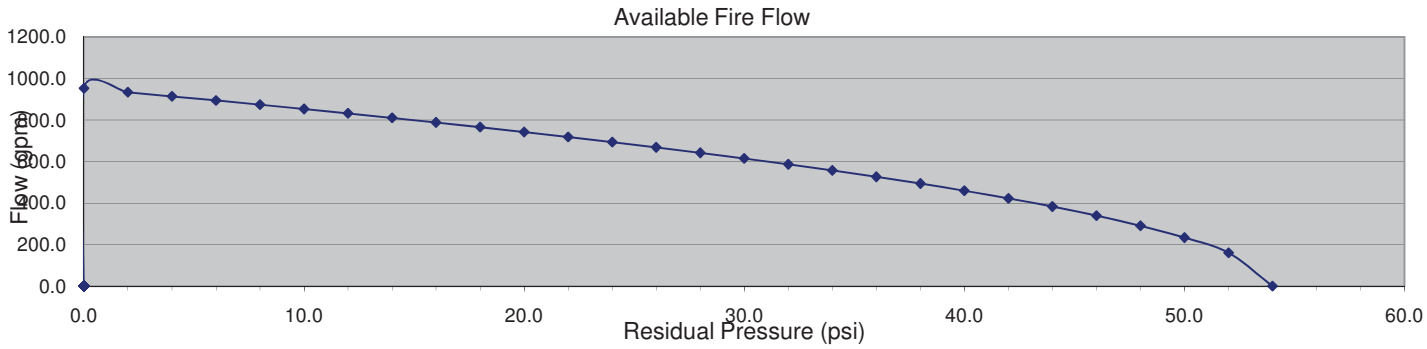
FIRE HYDRANT FIRE FLOW TEST

Date 06/25/09 Time 11:30 Weather Sunny

Flusher / Tester Prism CE Temperature 85 °F / °C

Flow Hydrant 503
Diameter 2.5 inches
Coefficient 0.77
Pitot 20 psi
Flow at Residual Pressure **642** gpm
Mins/flowed 2 Water Used **172** cubic feet

Gage (test) Hydrant 508
Static 54 psi
Residual 28 psi
Flow available at 20psi residual **742** gpm



Pitot Chart						Flow Available at Residual Pressure			
psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	54	0	-	#VALUE!
2	203	29	773	56	1074	52	161	-	-
3	249	30	786	57	1084	50	234	-	-
4	287	31	799	58	1093	48	291	-	-
5	321	32	812	59	1103	46	340	-	-
6	352	33	825	60	1112	44	383	-	-
7	380	34	837	61	1121	42	423	-	-
8	406	35	849	62	1130	40	460	-	-
9	431	36	861	63	1139	38	494	-	-
10	454	37	873	64	1148	36	526	-	-
11	476	38	885	65	1157	34	557	-	-
12	497	39	897	66	1166	32	587	-	-
13	518	40	908	67	1175	30	615	-	-
14	537	41	919	68	1184	28	642	-	-
15	556	42	930	69	1192	26	668	-	-
16	574	43	941	70	1201	24	694	-	-
17	592	44	952	71	1210	22	718	-	-
18	609	45	963	72	1218	20	742	-	-
19	626	46	974	73	1227	18	765	-	-
20	642	47	984	74	1235	16	788	-	-
21	658	48	995	75	1243	14	810	-	-
22	673	49	1005	76	1251	12	832	-	-
23	688	50	1015	77	1260	10	853	-	-
24	703	51	1025	78	1268	8	874	-	-
25	718	52	1035	79	1276	6	894	-	-
26	732	53	1045	80	1284	4	914	-	-
27	746	54	1055	81	1292	2	933	-	-
28	760	55	1065	82	1300	0	953	-	-

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FIRE HYDRANT FIRE FLOW TEST

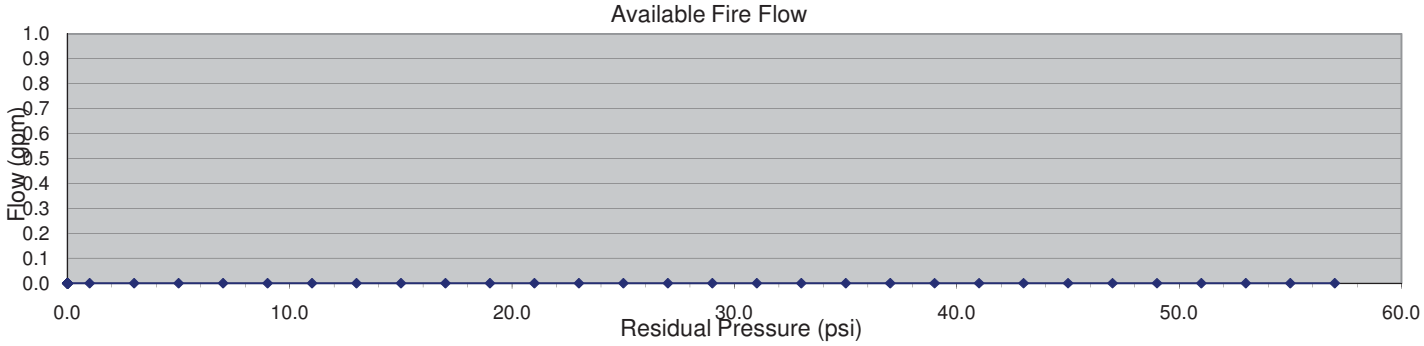
Date 05/01/09 Time 3:10 Weather Clear

Flusher / Tester Prism CE Temperature 80 °F / °C

Flow Hydrant 504
Diameter 2.5 inches
Coefficient 0.77
Pitot 0 psi
Flow at Residual Pressure gpm
Mins/flowed 2 Water Used #VALUE! cubic feet

Gage (test) Hydrant 502
Static 57 psi
Residual 52 psi

Flow available at 20psi residual #VALUE! gpm



Pitot Chart						Flow Available at Residual Pressure			
psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	57	#VALUE!	1	#VALUE!
2	203	29	773	56	1074	55	#VALUE!	0	#VALUE!
3	249	30	786	57	1084	53	#VALUE!	-	-
4	287	31	799	58	1093	51	#VALUE!	-	-
5	321	32	812	59	1103	49	#VALUE!	-	-
6	352	33	825	60	1112	47	#VALUE!	-	-
7	380	34	837	61	1121	45	#VALUE!	-	-
8	406	35	849	62	1130	43	#VALUE!	-	-
9	431	36	861	63	1139	41	#VALUE!	-	-
10	454	37	873	64	1148	39	#VALUE!	-	-
11	476	38	885	65	1157	37	#VALUE!	-	-
12	497	39	897	66	1166	35	#VALUE!	-	-
13	518	40	908	67	1175	33	#VALUE!	-	-
14	537	41	919	68	1184	31	#VALUE!	-	-
15	556	42	930	69	1192	29	#VALUE!	-	-
16	574	43	941	70	1201	27	#VALUE!	-	-
17	592	44	952	71	1210	25	#VALUE!	-	-
18	609	45	963	72	1218	23	#VALUE!	-	-
19	626	46	974	73	1227	21	#VALUE!	-	-
20	642	47	984	74	1235	19	#VALUE!	-	-
21	658	48	995	75	1243	17	#VALUE!	-	-
22	673	49	1005	76	1251	15	#VALUE!	-	-
23	688	50	1015	77	1260	13	#VALUE!	-	-
24	703	51	1025	78	1268	11	#VALUE!	-	-
25	718	52	1035	79	1276	9	#VALUE!	-	-
26	732	53	1045	80	1284	7	#VALUE!	-	-
27	746	54	1055	81	1292	5	#VALUE!	-	-
28	760	55	1065	82	1300	3	#VALUE!	-	-

Old Dominion
Utility Services, Inc.
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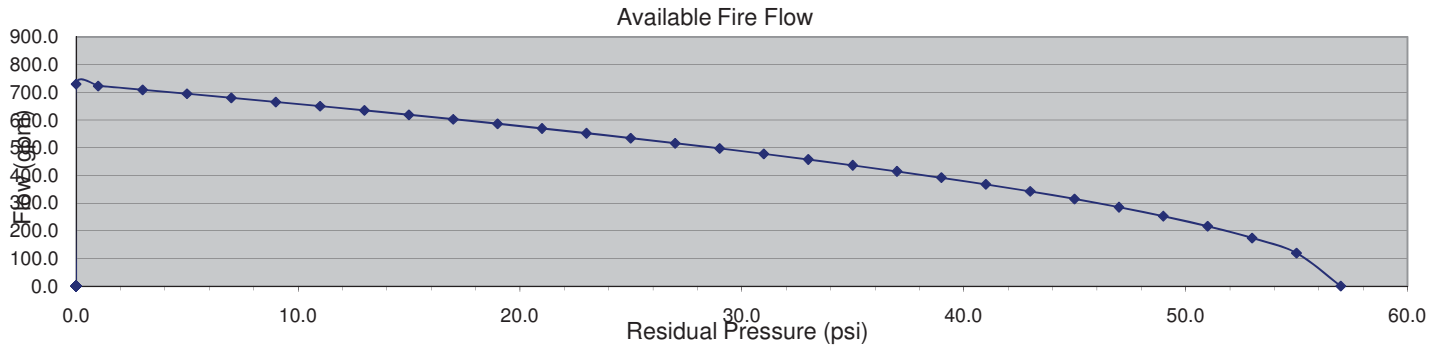
FIRE HYDRANT FIRE FLOW TEST

Date 05/01/09 Time 3:30 Weather Clear

Flusher / Tester Prism CE Temperature 80 °F / °C

Flow Hydrant 508
Diameter 2.5 inches
Coefficient 0.77
Pitot 12 psi
Flow at Residual Pressure **497** gpm
Mins/flowed 2 Water Used **133** cubic feet

Gage (test) Hydrant 502
Static 57 psi
Residual 29 psi
Flow available at 20psi residual **578** gpm



Pitot Chart						Flow Available at Residual Pressure			
psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	57	0	1	723
2	203	29	773	56	1074	55	120	0	730
3	249	30	786	57	1084	53	174	-	-
4	287	31	799	58	1093	51	216	-	-
5	321	32	812	59	1103	49	253	-	-
6	352	33	825	60	1112	47	285	-	-
7	380	34	837	61	1121	45	315	-	-
8	406	35	849	62	1130	43	342	-	-
9	431	36	861	63	1139	41	368	-	-
10	454	37	873	64	1148	39	392	-	-
11	476	38	885	65	1157	37	415	-	-
12	497	39	897	66	1166	35	437	-	-
13	518	40	908	67	1175	33	458	-	-
14	537	41	919	68	1184	31	478	-	-
15	556	42	930	69	1192	29	497	-	-
16	574	43	941	70	1201	27	516	-	-
17	592	44	952	71	1210	25	534	-	-
18	609	45	963	72	1218	23	552	-	-
19	626	46	974	73	1227	21	570	-	-
20	642	47	984	74	1235	19	586	-	-
21	658	48	995	75	1243	17	603	-	-
22	673	49	1005	76	1251	15	619	-	-
23	688	50	1015	77	1260	13	635	-	-
24	703	51	1025	78	1268	11	650	-	-
25	718	52	1035	79	1276	9	665	-	-
26	732	53	1045	80	1284	7	680	-	-
27	746	54	1055	81	1292	5	695	-	-
28	760	55	1065	82	1300	3	709	-	-

Old Dominion
Utility Services, Inc.
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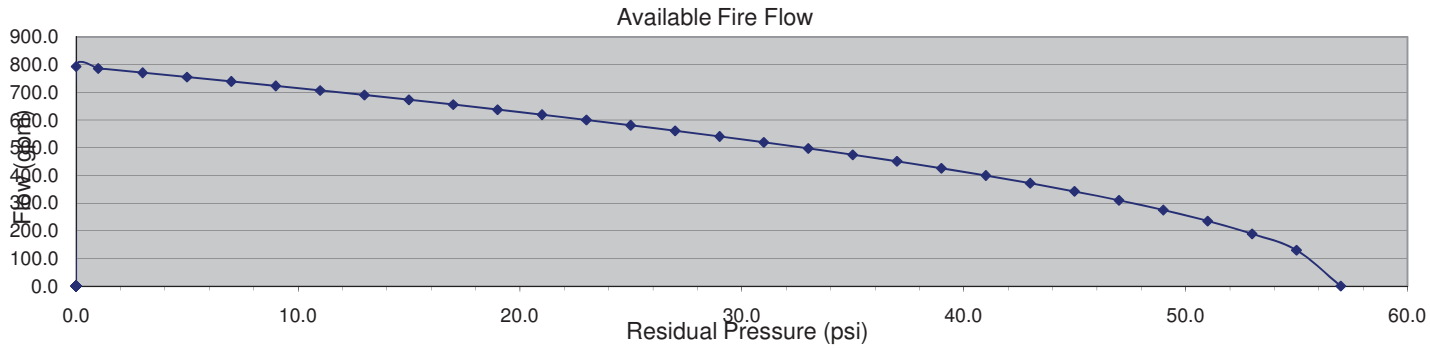
FIRE HYDRANT FIRE FLOW TEST

Date 05/01/09 Time 3:25 Weather Clear

Flusher / Tester Prism CE Temperature 80 °F / °C

Flow Hydrant 509
Diameter 2.5 inches
Coefficient 0.77
Pitot 12 psi
Flow at Residual Pressure **497** gpm
Mins/flowed 2 Water Used **133** cubic feet

Gage (test) Hydrant 502
Static 57 psi
Residual 33 psi
Flow available at 20psi residual **628** gpm



Pitot Chart						Flow Available at Residual Pressure			
psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	57	0	1	786
2	203	29	773	56	1074	55	130	0	793
3	249	30	786	57	1084	53	189	-	-
4	287	31	799	58	1093	51	235	-	-
5	321	32	812	59	1103	49	275	-	-
6	352	33	825	60	1112	47	310	-	-
7	380	34	837	61	1121	45	342	-	-
8	406	35	849	62	1130	43	372	-	-
9	431	36	861	63	1139	41	400	-	-
10	454	37	873	64	1148	39	426	-	-
11	476	38	885	65	1157	37	451	-	-
12	497	39	897	66	1166	35	474	-	-
13	518	40	908	67	1175	33	497	-	-
14	537	41	919	68	1184	31	519	-	-
15	556	42	930	69	1192	29	540	-	-
16	574	43	941	70	1201	27	561	-	-
17	592	44	952	71	1210	25	581	-	-
18	609	45	963	72	1218	23	600	-	-
19	626	46	974	73	1227	21	619	-	-
20	642	47	984	74	1235	19	637	-	-
21	658	48	995	75	1243	17	655	-	-
22	673	49	1005	76	1251	15	673	-	-
23	688	50	1015	77	1260	13	690	-	-
24	703	51	1025	78	1268	11	707	-	-
25	718	52	1035	79	1276	9	723	-	-
26	732	53	1045	80	1284	7	739	-	-
27	746	54	1055	81	1292	5	755	-	-
28	760	55	1065	82	1300	3	771	-	-

Old Dominion
Utility Services, Inc.
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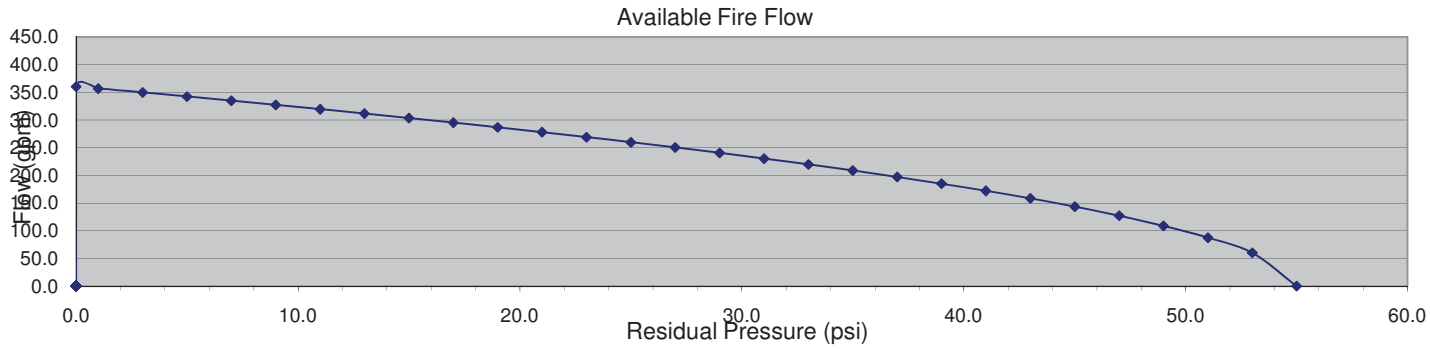
FIRE HYDRANT FIRE FLOW TEST

Date 05/04/09 Time 8:40 Weather Cloudy

Flusher / Tester Prism CE Temperature 65 °F / °C

Flow Hydrant 527
Diameter 2.5 inches
Coefficient 0.77
Pitot 1 psi
Flow at Residual Pressure **144** gpm
Mins/flowed 2 Water Used **38** cubic feet

Gage (test) Hydrant 510
Static 55 psi
Residual 45 psi
Flow available at 20psi residual **282** gpm



Pitot Chart						Flow Available at Residual Pressure			
psi	gpm	psi	gpm	psi	gpm	psi	gpm	psi	gpm
1	144	28	760	55	1065	55	0	0	360
2	203	29	773	56	1074	53	60	-	-
3	249	30	786	57	1084	51	88	-	-
4	287	31	799	58	1093	49	109	-	-
5	321	32	812	59	1103	47	127	-	-
6	352	33	825	60	1112	45	144	-	-
7	380	34	837	61	1121	43	158	-	-
8	406	35	849	62	1130	41	172	-	-
9	431	36	861	63	1139	39	185	-	-
10	454	37	873	64	1148	37	197	-	-
11	476	38	885	65	1157	35	209	-	-
12	497	39	897	66	1166	33	220	-	-
13	518	40	908	67	1175	31	230	-	-
14	537	41	919	68	1184	29	240	-	-
15	556	42	930	69	1192	27	250	-	-
16	574	43	941	70	1201	25	260	-	-
17	592	44	952	71	1210	23	269	-	-
18	609	45	963	72	1218	21	278	-	-
19	626	46	974	73	1227	19	287	-	-
20	642	47	984	74	1235	17	295	-	-
21	658	48	995	75	1243	15	303	-	-
22	673	49	1005	76	1251	13	312	-	-
23	688	50	1015	77	1260	11	320	-	-
24	703	51	1025	78	1268	9	327	-	-
25	718	52	1035	79	1276	7	335	-	-
26	732	53	1045	80	1284	5	342	-	-
27	746	54	1055	81	1292	3	350	-	-
28	760	55	1065	82	1300	1	357	-	-

Appendix E
Enviornmental Information

Not Used

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APPENDIX F
AESTHETIC CONSIDERATIONS

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Project site location is adjacent to installation medical Center which is comprised of red brick veneer, stucco bands and brown metal flashing and trim on the older portions of the building.

Newer portions of the Medical Center continue the red brick veneer and utilize a forest green metal flashings and standing seam metal roofing.

Predominant for the newer buildings in the vicinity, red brick veneer and green standing seam metal roofs are the norm for the more commercial type buildings.

Also adjacent to the site is installation Family housing. This is comprised of older and newer structures. The older style housing employs red brick veneer, vertical T-1-11 siding and low slope asphalt shingle roof.

The more recent Family Housing is more in the Virginia Colonial style as opposed to the post modern style of the older housing. This employs horizontal lapped siding, double hung windows and high pitch asphalt roofs with dormers.

Appendix G
GIS Data

Not Used

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APPENDIX H
EXTERIOR SIGNAGE

Mounting Heights

Sign heights must be consistent. Use a uniform 6'6" ht. and dimension to top of signboard for all type A signs. Use 5'0" or 3'0" ht. for types B1 through B10. Refer to preceeding pages for complete mounting height information.

In general, the size and height should be minimized, wherever possible, to reduce visual clutter.

Choose a sign sized as small as possible which will adequately do the job. Choose the 3'0" mounting height for type B signs whenever this will satisfy the message requirements.

Important!
Organize the information on the sign to be brief, clear, and concise.

Key:

● Permitted

▲ Not Permitted

○ Message Permitted on Secondary Sign Board Only

Type of Sign (D.C.6.1):	Type of Message Required: Identification	Directional	Directory	Informational	Mandatory/Prohibitory	Motivational
A1 Shields	●	▲	▲	▲	▲	▲
A2	●	○	▲	○	▲	▲
A3	●	▲	▲	▲	▲	▲
A4	●	○	○	○	▲	▲
A5	●	○	○	○	▲	▲
A6	●	○	○	▲	▲	▲
A7	●	○	○	▲	▲	▲
B1 Rectangular	▲	▲	▲	●	●	●
B2	▲	▲	●	▲	▲	▲
B3	▲	▲	○	●	▲	○
B4	▲	●	●	▲	▲	▲
B5	▲	●	●	▲	▲	▲
B6	▲	▲	▲	●	●	●
B7	▲	▲	●	●	●	●
B8	●	▲	▲	●	●	●
B9	▲	▲	●	●	▲	●
B10	▲	▲	▲	●	●	●
C1 Monumental	●	▲	▲	▲	▲	▲
C2	●	▲	▲	▲	▲	▲

Note:
Identification signs are those that state the name of the building or facility at that location. *Directional signs* point the way to a destination with an arrow. *Directory signs* are those that list a series of destinations within a building or in an area of the post, and may serve as secondary information to an identification sign. *Informational signs* convey other general messages such as schedules, policies or regulations. *Mandatory signs* carry imperative regulatory messages such as warnings and restrictions. *Motivational signs* are those that carry inspirational slogans to support training and morale.

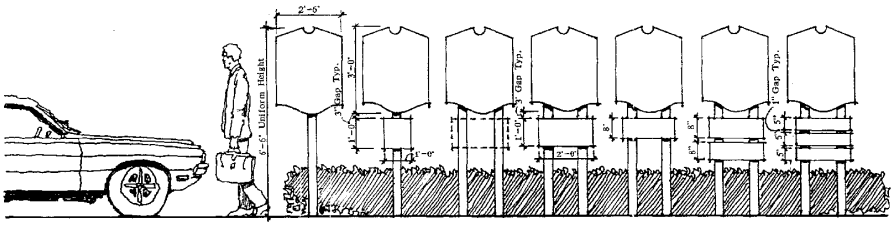
Sign Types and Dimensions

Recommendations for selecting sign types and panel sizes:
The illustrations demonstrate most choices and combinations necessary to accommodate any message requirement. Wherever possible, limit choices to those included on these pages so that signage throughout the post will be coordinated.

Certain sign sizes and shapes must be visually associated with specific categories of information. Message types must, therefore, be restricted to a limited set of sign size/shape options.

Type A signs are to be to be used primarily for identification signs at the location of the facility identified. No directional arrows are permitted on these signs. Secondary signboards may be used beneath the "colonial" board to carry directional and directory type information. Type A signs are to be used *sparingly*. Do not locate within 100 ft. of one another.

Type B are to be used in lieu of a type A sign whenever the smaller format can adequately satisfy the message requirement. Use type B8 for identification of minor facilities to avoid overuse of the type A signs. Type B signs are to be generally associated with directional, directory, informational, mandatory and motivational messages.



Type A Signs

Single Supports

A1. Shield Only.

A2 Shield plus small secondary sign.

Double Supports

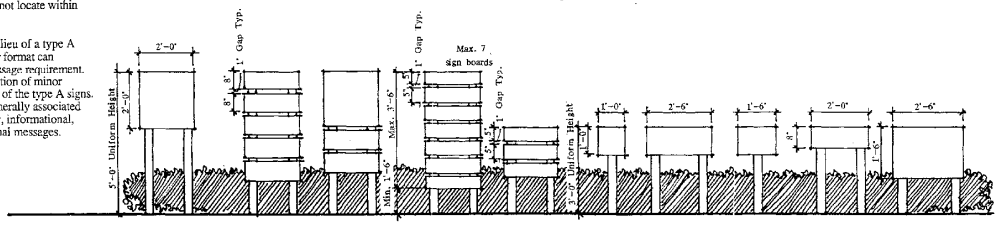
A3. Shield with allowance for future secondary sign.

A4. Shield with 12" secondary sign.

A5.

A6.

A7.



Type B Signs

B1. Single large panel.

B2. Series of medium size panels for changeable messages.

B3. Combination.

B4. Directory or directional series, 4 to 7 panels.

B5. Directory or Directonal 3 panels.

B6. Small single square panel.

B7. Medium size panel.

B8. Medium size panel.

B9. Medium size panel.

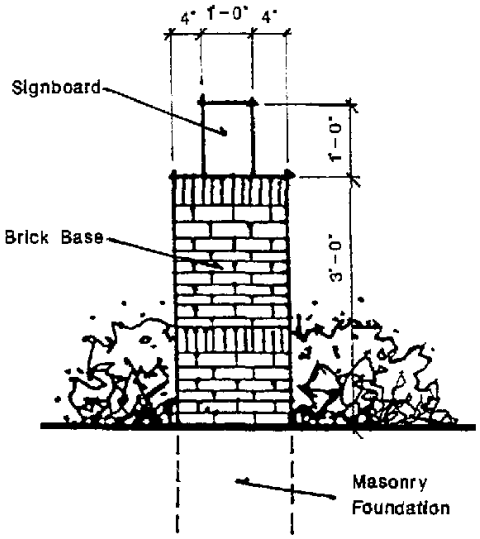
B10. Large single panel.

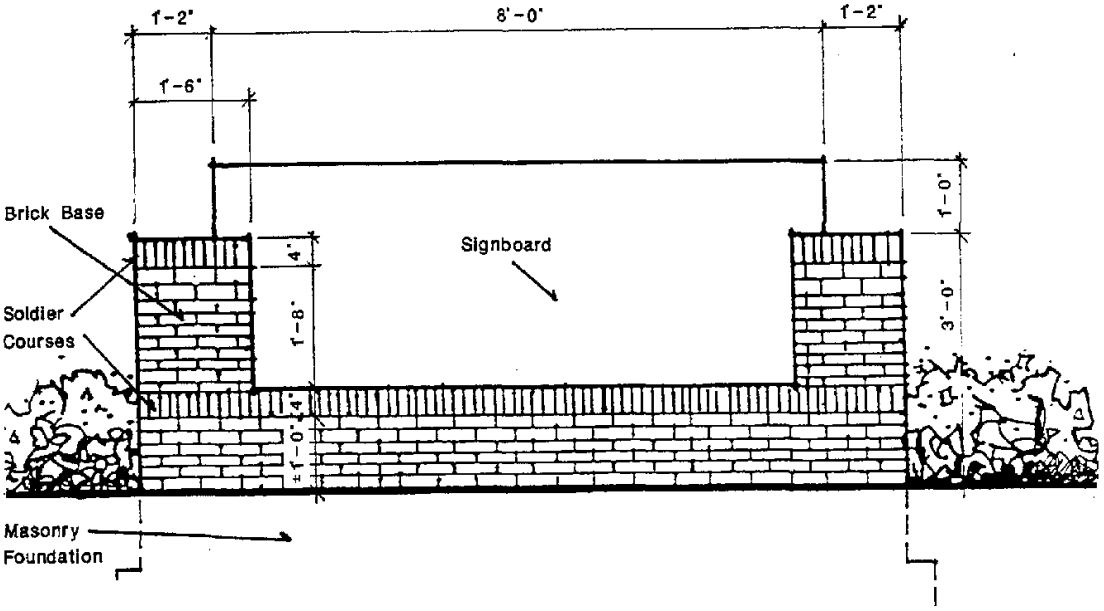
Materials and Fabrication
Type C; Monumental

Signboard to be aluminum sheet metal (0.125), built as a box with internal framing/bracing as required for strength. Top, sides, and edges are to be weather-proof with weep holes provided at the bottom for release of condensation moisture. Finish to baked enamel type paint (See DC 6.4.2).

Raised Lettering to be pinned onto aluminum or baked acrylic signboard and to be of cast or sheet aluminum (0.25" min.). Face of letter is to stand uniformly 1" in front of face of signboard. 1" deep cast letters are recommended. All pin connectors, spacers, etc. are to be of aluminum to avoid galvanic corrosion.

Base to be built securely on a masonry/reinforced concrete foundation as required for local soil conditions. Face brick to be of standard brick dimensions (no jumbo brick or concrete block to be used).





ACCEPTABLE PLANTINGS

For the Community Services and Family Housing visual zones

Ground Cover

Ajuga Reptans	Ajuga
Euonymous Radicans Coloratus	Wintercreeper
Hedera Helix	English Ivy
Juniper Species	Juniper
Liriope Spicata	Lilyturf
Pachysandra Terminalis	Japanese Spurge
Vinca Minor	Periwinkle

Shrubs

Ligustrum Tucidum	Ligustrum
Ligustrum Obtusifoium	Regal Privet
Mahonia Bealei	Letherleaf Mahonia
Myrica Cerifera	Southern Waxmyrtle
Pieris Japonica	Japanese Pieris
Pinus Mugo	Mugo Pine
Rhododendron Species	Rhododendron
Syringa Vulgaris	Common Purple Lilac
Taxus Cuspidata	Japanese Yew
Viburnum Species	Viburnum
Abelia Grandiflora	Glossy Abelia
Azalea Species	Azalea
Cornus Stolonifera	Yellowtwig Dogwood
Cotoneaster Species	Cotoneaster
Euonymous Alatus	Winged Euonymous
Forsythia “Arnold” Dwarf	Dwarf Forsythia
Ilex Crenata Species	Japanese Holly
Ilex cornuta “Bbufordi”	Buford Holly
Ilex Glabra	Inkberry
Ilex Verticillata	Winterberry
Ilex Vomitoria Nana	Dwarf Yaupon Holly
Juniper Species	Juniper

Ornanmental Trees

Prunus Serrulata Kwanzan	Kwanzan Cherry
Pyrus Calleryana “Bradford”	Bradford Pear
Amelanchier Canadensis	Downy Shadblow
Cercis Canadensis	American Redbud
Chionathos Virginicus	White Fringetree

Cornus Kousa	Kousa Dogwood
Crataegus Phaenopyrum	Washington Hawthorn
Lagerstroemia Indica	Crapemyrtle
Malus Species	Flowering Crabapples
Magnolia Grandiflora	Southern Magnolia
Magnolia Soulangeana	Saucer Magnolia
Magnolia Stellata	Star Magnolia
Magnolia Virginiana	Sweet Bay Magnolia
Oxydendrum Arboreum	Sourwood

Trees

Acer Ginnala	Amur Maple
Acer Palmatum	Japanese Maple
Acer Platanoides	Norway Maple
Acer Rubrum	Red Maple
Carpinus Caroliniana	American Hornbeam
Celitis Occidentalis	Hackberry
Cercidiphyllum Japonicum	Katsura Tree
Fagus Grandfolia	American Beech
Fraxinus Pennsylvanica	Green Ash
Gleditsia Triacanthos	Honey Locust
Liquidambar Styraciflua	Sweetgum
Nyssa Sylvatica	Sour Gum
Platanus Acerifolia	London Planetree
Quercus Acutissima	Sawtooth Oak
Quercus Borealis	Northern Red Oak
Quercus Coccinea	Scarlet Oak
Quercus “darlingtonia”	Darlington Oak
Quercus Palustris	Pin Oak
Quercus Phellos	Willow Oak
Quercus Virginiana	Live Oak
Sophora Japonica	Japanese Scholartree
Taxodium Distichum	Bald Cypress
Till Cordata	Little Leaf Linden
Zelkova Serrata	Japanese Zelkova

Evergreen Trees

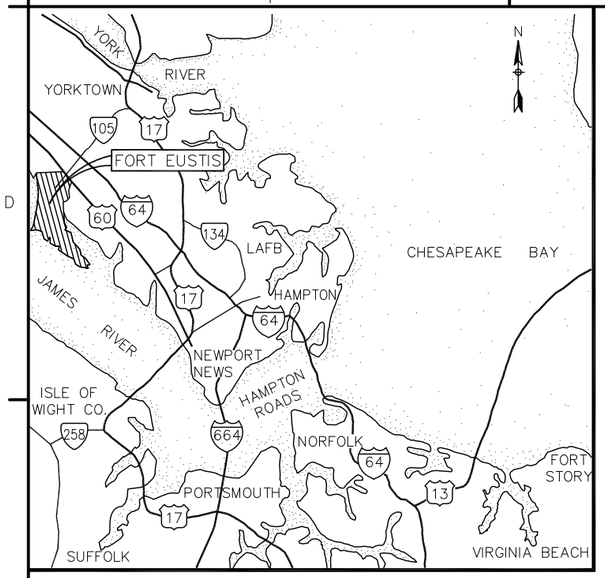
Ilex Opaca	American Holly
Juniperus Virginiana	Eastern Redcedar
Picea Abies	Norway Spruce
Pinus Strobus	White Pine
Pinus Taeda	Loblolly Pine
Pinus Thunbergii	Japanese Black Pine

Appendix J
Drawings

Existing Conditions Survey

Site Plan

Floor Plan

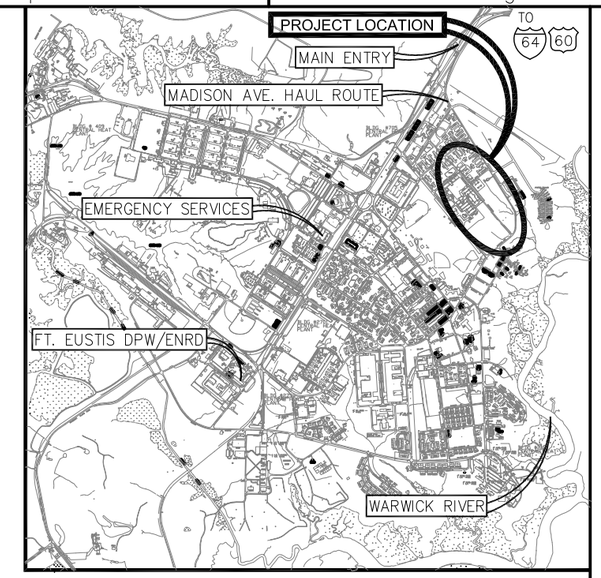


Vicinity Map
Fort Eustis, Virginia
NOT TO SCALE

Fort Eustis
WARRIOR IN TRANSITION COMPLEX PN 071539 SFAC/CO HQ
Fort Eustis, Virginia

Index of Drawings

SHT. NO.	DESCRIPTION
T-001	TITLE SHEET
SU-100	EXISTING CONDITIONS SURVEY
SU-101	EXISTING CONDITIONS SURVEY
SU-102	EXISTING CONDITIONS SURVEY
C-100	SFAC/CO HQ EXISTING CONDITIONS SURVEY KEY PLAN
C-101	SFAC/CO HQ DEMOLITION PLAN
C-102	SFAC/CO HQ SITE LAYOUT PLAN
C-103	SFAC/CO HQ UTILITY PLAN



Location Map
Fort Eustis, Virginia
NOT TO SCALE

CIVIL LEGEND

35	NEW GRADE	5	EXISTING CONTOUR	QP	DEC. TREE		EXISTING TREE
15"SD	STORM DRAIN	15" RCP SD	EXISTING STORM DRAIN	LC	EVERGREEN TREE		
W	NEW WATER LINE	8" W	EXISTING WATER LINE	1-3	STORM DRAINAGE STRUCTURE NO.		
S	NEW SANITARY LINE	SAN	EXISTING SANITARY LINE	[WR-5]	SIGN DESIGNATION (MUTCD)		
	STORM DRAINAGE		EXISTING STORM DRAINAGE		NEW SIGN		EXISTING SIGN
SDMH	STORM MANHOLE		EXISTING STORM MANHOLE		RIPRAP		
SANMH	SANITARY MANHOLE		EXISTING SANITARY MANHOLE		NEW ASPHALT PAVEMENT		EXISTING ASPHALT PAVEMENT
	NEW FIRE HYDRANT		EXISTING FIRE HYDRANT		NEW CONCRETE		EXISTING CONCRETE
	BORING LOCATION						

US Army Corps of Engineers
Norfolk District

NO.	DATE	DESCRIPTION	BY	APP

DESIGNED: GAP
DRAWN: SAB/GAP
PROJECT NO. 071539
DATE: 28-MAY-10
SCALE: AS SHOWN
SUBMITTED: XXXXXX
NORFOLK DISTRICT FILE NO. XXXXXXX-
DRAWING NO. XXX-XX-XX
SPECIFICATION NO.
Last worked on:
File name:
Plot scale: 1:1

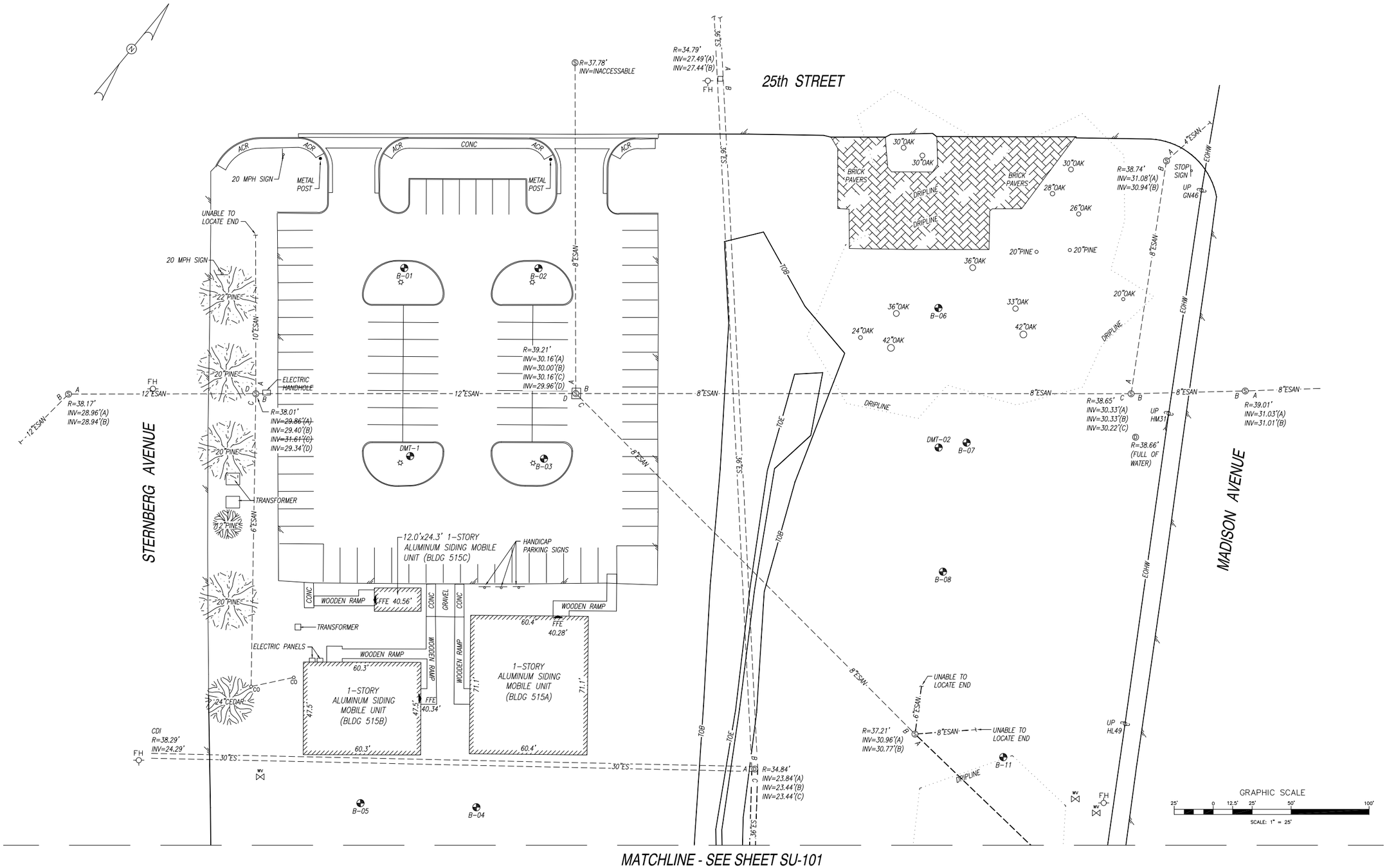
NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

FINAL SUBMITTAL
MAY 28, 2010

WARRIOR IN TRANSITION COMPLEX
FT. EUSTIS VIRGINIA
PN 071539

TITLE SHEET

SHEET REFERENCE NUMBER
T-001
SHEET XXX OF XXX



US Army Corps of Engineers
Norfolk District

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SPECIFICATION NO. XXXX
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QUALITY CHECKED: XXXXXX
PROJECT NO. 071539
DRAWING NO. XXX-XX-XX
Last worked on:
File name:

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NORFOLK, VIRGINIA

FINAL SUBMITTAL
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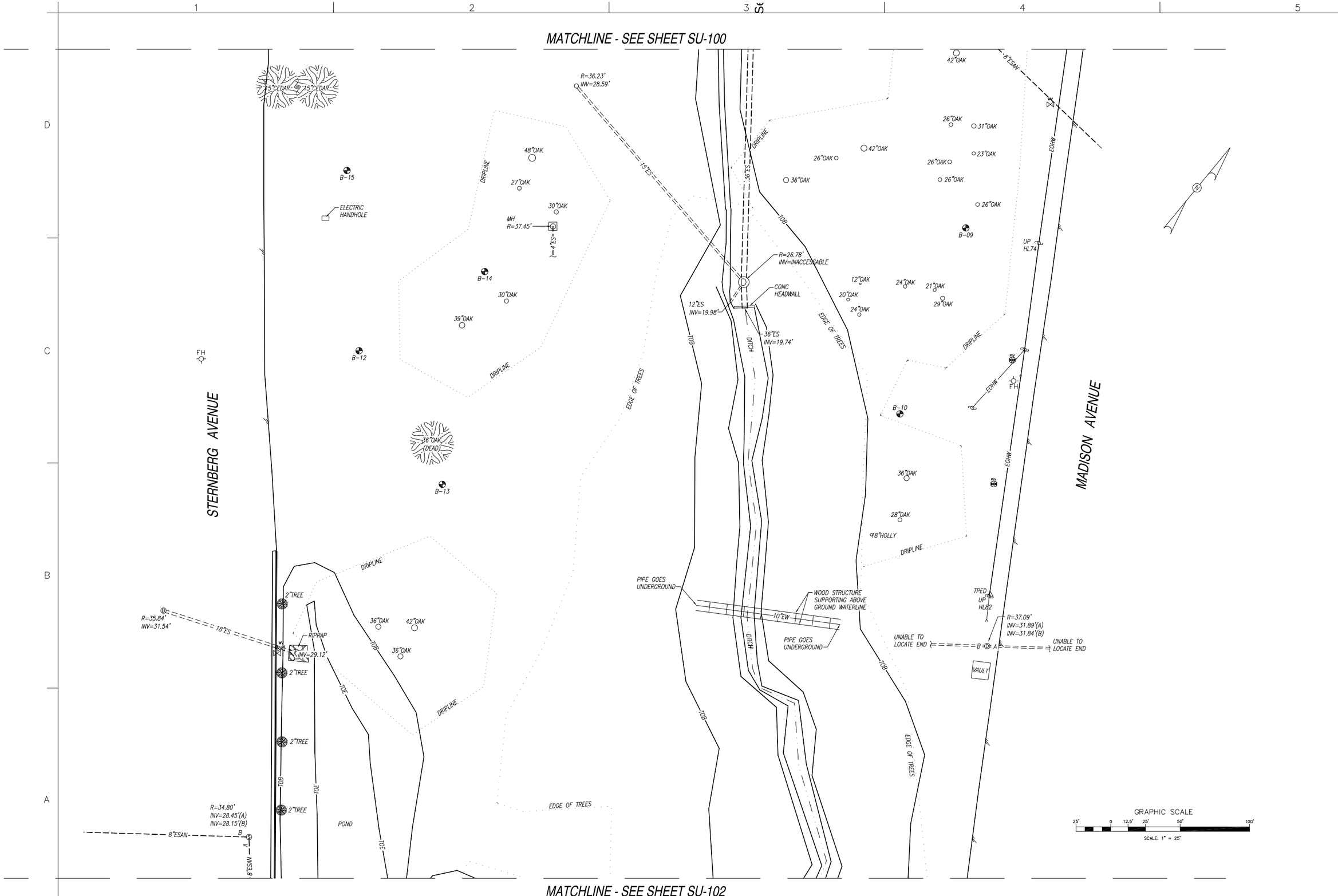
WARRIOR IN TRANSITION COMPLEX
FT. EUSTIS VIRGINIA
PN 071539

EXISTING CONDITIONS SURVEY

SHEET REFERENCE NUMBER
SU-100
SHEET XXX OF XXX



US Army Corps of Engineers
Norfolk District

MARK	DATE	DESCRIPTION	BY	APP.

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SPECIFICATION NO.
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File name:
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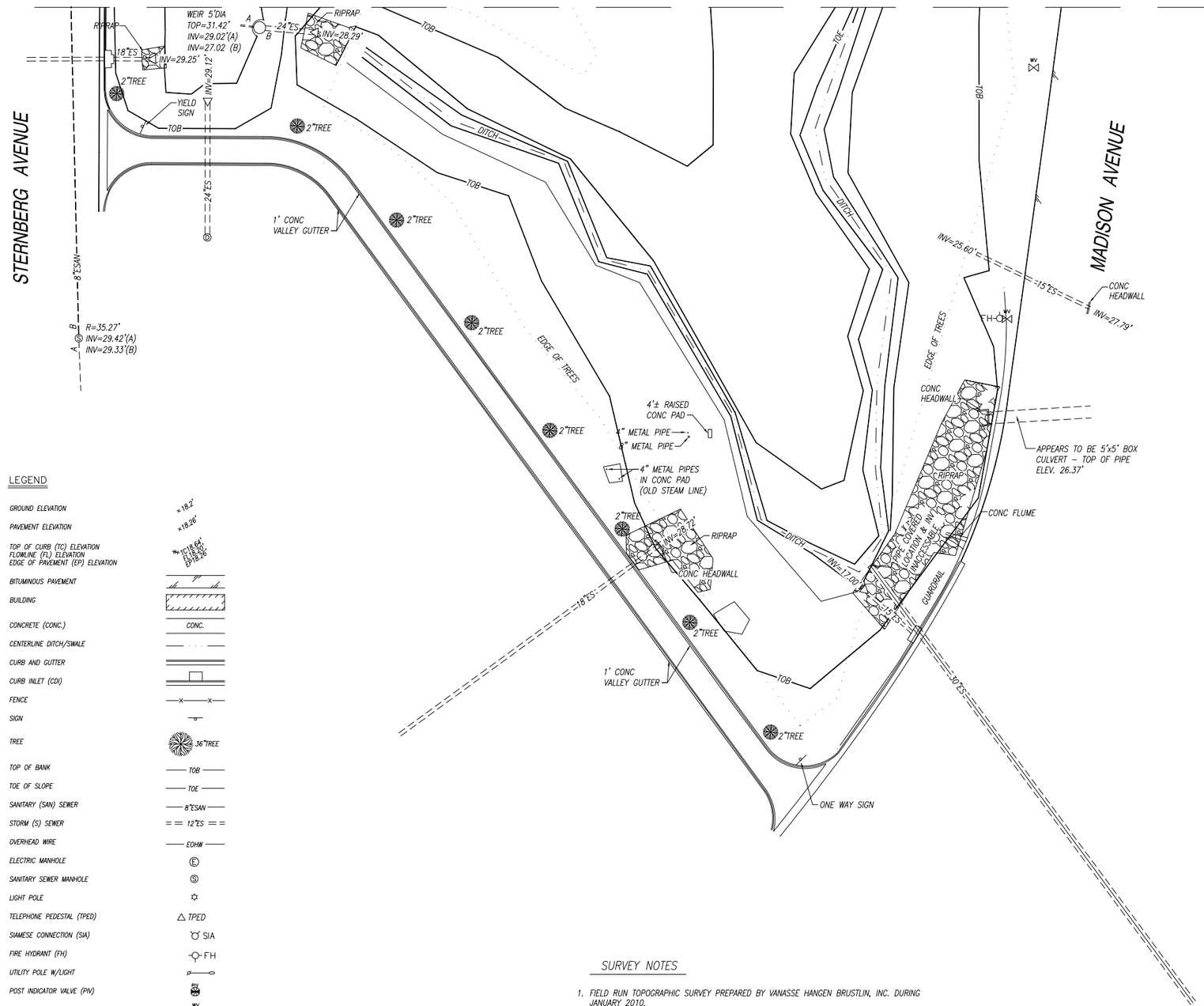
FT. EUSTIS VIRGINIA
PN 071539

EXISTING CONDITIONS SURVEY

SHEET REFERENCE NUMBER
SU-101
SHEET XXX OF XXX

MATCHLINE - SEE SHEET SU-101



LEGEND

GROUND ELEVATION	×18.2'
PAVEMENT ELEVATION	×18.26'
TOP OF CURB (TC) ELEVATION FLOWLINE (FL) ELEVATION EDGE OF PAVEMENT (EP) ELEVATION	TC18.64' FL18.32' EP18.26'
BITUMINOUS PAVEMENT	
BUILDING	
CONCRETE (CONC.)	CONC.
CENTERLINE DITCH/SWALE	
CURB AND GUTTER	
CURB INLET (CDI)	
FENCE	—x—x—
SIGN	
TREE	36"TREE
TOP OF BANK	TOB
TOE OF SLOPE	TOE
SANITARY (SAN) SEWER	8"ESAN
STORM (S) SEWER	12"ES
OVERHEAD WIRE	EOHW
ELECTRIC MANHOLE	E
SANITARY SEWER MANHOLE	S
LIGHT POLE	
TELEPHONE PEDESTAL (TPED)	TPED
SIAMESE CONNECTION (SIA)	SIA
FIRE HYDRANT (FH)	FH
UTILITY POLE W/LIGHT	
POST INDICATOR VALVE (PIV)	PIV
WATER VALVE	WV
ACCESSABLE CURB RAMP	ACR
INVERT	INV.

SURVEY NOTES

1. FIELD RUN TOPOGRAPHIC SURVEY PREPARED BY VANASSE HANGEN BRUSTLIN, INC. DURING JANUARY 2010.
2. THE EXISTENCE, SIZE AND/OR LOCATION OF UTILITIES ARE NOT GUARANTEED BY THIS SURVEY. UTILITIES SHOWN ARE BASED ON ABOVE GROUND STRUCTURES AND AVAILABLE UTILITY PLANS. THE CONTRACTOR SHALL FIELD VERIFY THE LOCATION OF ALL UTILITIES PRIOR TO CONSTRUCTION.
3. VERTICAL DATUM IS BASED ON NORTH AMERICAN VERTICAL DATUM OF 1929 (1972 ADJUSTMENT) AND BASED ON BENCHMARKS RECOVERED FROM A SURVEY PROVIDED BY THE CORP OF ENGINEERS ENTITLED "TOPOGRAPHIC SURVEY OF FORT EUSTIS BARRACKS PAHSE 4 PREPARED ON JANUARY 19, 2004 BY PRECISION MEASUREMENTS, INC.
4. HORIZONTAL DATUM IS VIRGINIA STATE GRID – SOUTH ZONE NAD83 (CORS 2007) BASED ON CORS STATION LOYX IN WILLIAMSBURG, VIRGINIA.

GRAPHIC SCALE

25' 0 12.5' 25' 50' 100'

SCALE: 1" = 25'

US Army Corps of Engineers
Norfolk District

MARK	DATE	DESCRIPTION	BY	APP.

DESIGNED: GAP
DRAWN: SAB/GAP
PROJECT NO. 071539
DRAWING NO. XXX-XX-XX
Last worked on:
File name:

CHECKED: GAP
SUBMITTED: XXXXXX
NORFOLK DISTRICT FILE NO. XXXXXXX-
SPECIFICATION NO.
Plot scale: 1:1

DATE: 28-MAY-10
SCALE: AS SHOWN

NORFOLK DISTRICT
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NORFOLK, VIRGINIA

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MAY 28, 2010

WARRIOR IN TRANSITION COMPLEX
FT. EUSTIS VIRGINIA
PN 071539

EXISTING CONDITIONS SURVEY

SHEET REFERENCE NUMBER
SU-102
SHEET XXX OF XXX

US Army Corps of Engineers
Norfolk District

MARK	DATE	DESCRIPTION	BY	APP

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DRAWN: SAB/GAP
CHECKED: GAP
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DRAWING NO. XXX–XX–XX
SPECIFICATION NO.
Last worked on:
File name:
Plot scale: 1:1

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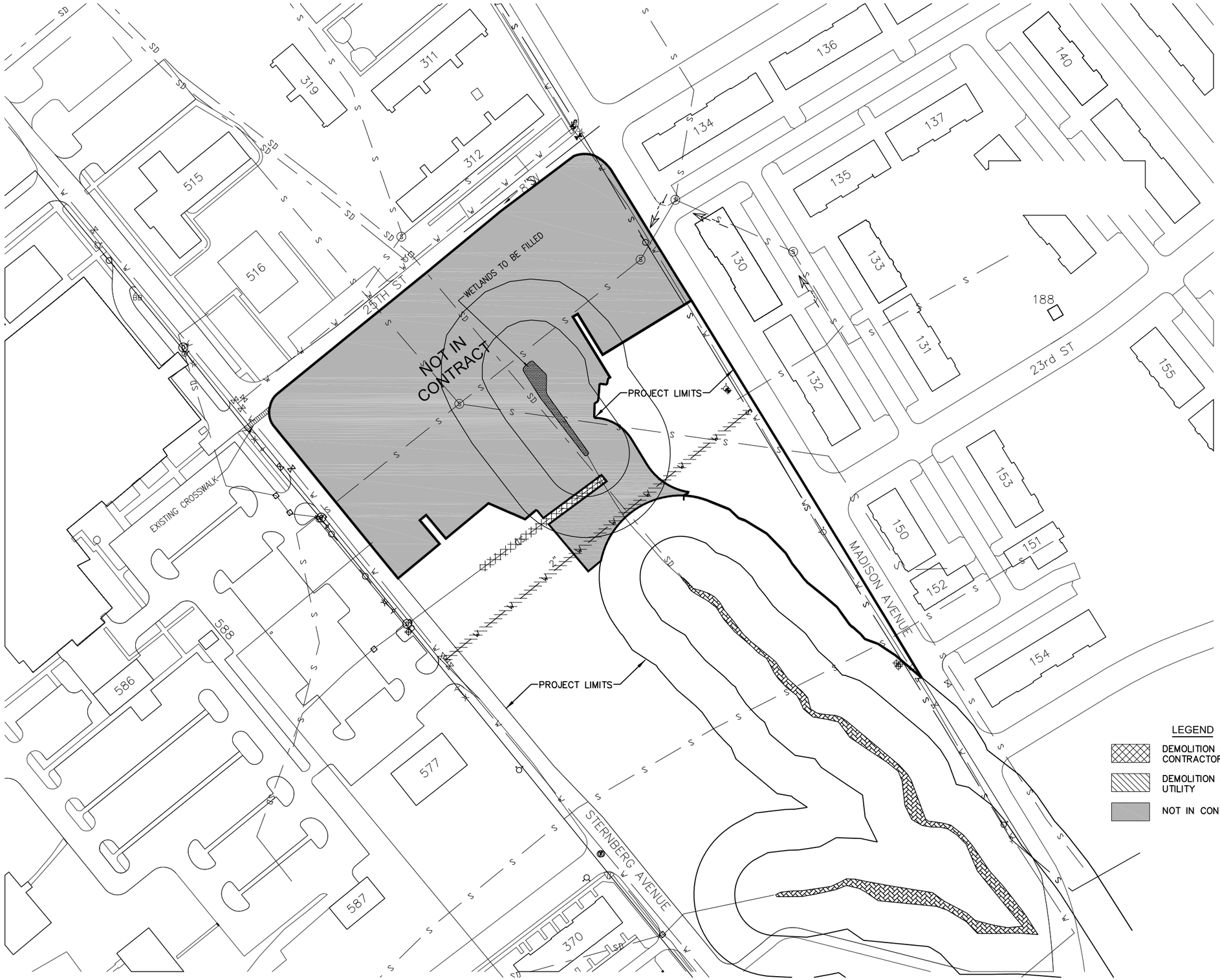
PN 071539

SFAC/CO HQ EXISTING CONDITIONS SURVEY KEY PLAN

SHEET REFERENCE NUMBER
C-100
SHEET XXX OF XXX



LEGEND

- DEMOLITION BY BARRACKS CONTRACTOR
- DEMOLITION BY PRIVATIZED UTILITY
- NOT IN CONTRACT

N

NOTE: THIS SITE LIES OUTSIDE THE 100 YR FLODD ELEVATION.

HALFSIZE

60′ 30′ 0 60′

1″ = 60′

FULLSIZE

30′ 15′ 0 30′

1″ = 30′

US Army Corps of Engineers
Norfolk District

MARK	DATE	DESCRIPTION	BY	APP

DESIGNED: GAP
DRAWN: SAB/GAP
CHECKED: GAP
SUBMITTED: XXXXXX
DATE: 28-MAY-10
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DRAWING NO. XXX–XX–XX
SPECIFICATION NO.
Last worked on:
File name:
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NORFOLK DISTRICT
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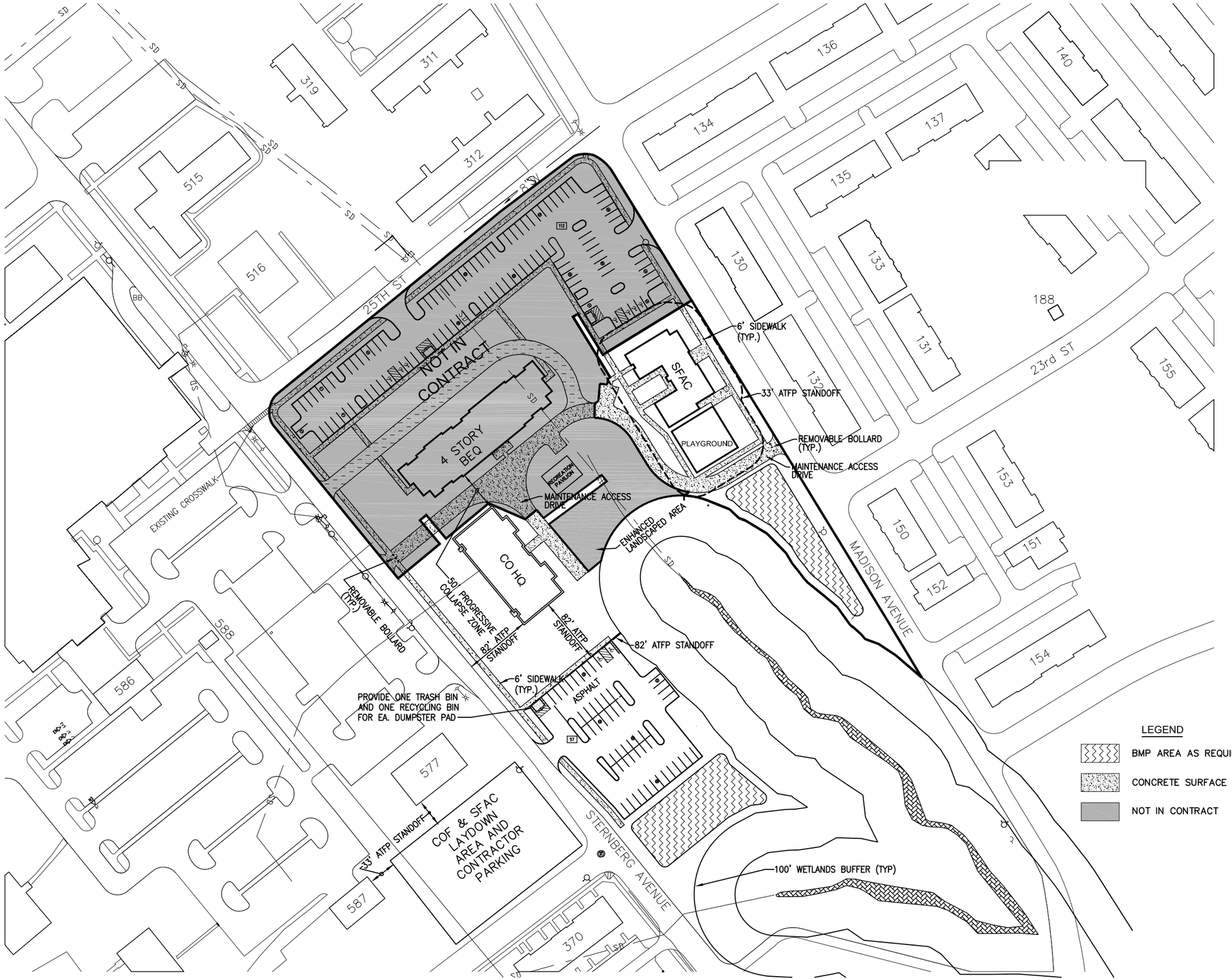
WARRIOR IN TRANSITION COMPLEX
FT. EUSTIS VIRGINIA
PN 071539

SFAC/CO HQ DEMOLITION PLAN

SHEET REFERENCE NUMBER
C-101
SHEET XXX OF XXX



US Army Corps of Engineers
Norfolk District

MARK	DATE	DESCRIPTION	BY	APP

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SUBMITTED: XXXXXX
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NORFOLK DISTRICT FILE NO. XXXXXXX-
DRAWING NO. XXX-XX-XX
SPECIFICATION NO.
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NORFOLK DISTRICT
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NORFOLK, VIRGINIA

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WARRIOR IN TRANSITION COMPLEX
FT. EUSTIS VIRGINIA
PN 071539

SFAC/CO HQ SITE LAYOUT PLAN

SHEET REFERENCE NUMBER
C-102
SHEET XXX OF XXX

US Army Corps of Engineers
Norfolk District

MARK	DATE	DESCRIPTION	BY	APP

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DRAWN: SAB/GAP
CHECKED: GAP
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DATE: 28-MAY-10
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SPECIFICATION NO.
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NORFOLK DISTRICT
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NORFOLK, VIRGINIA

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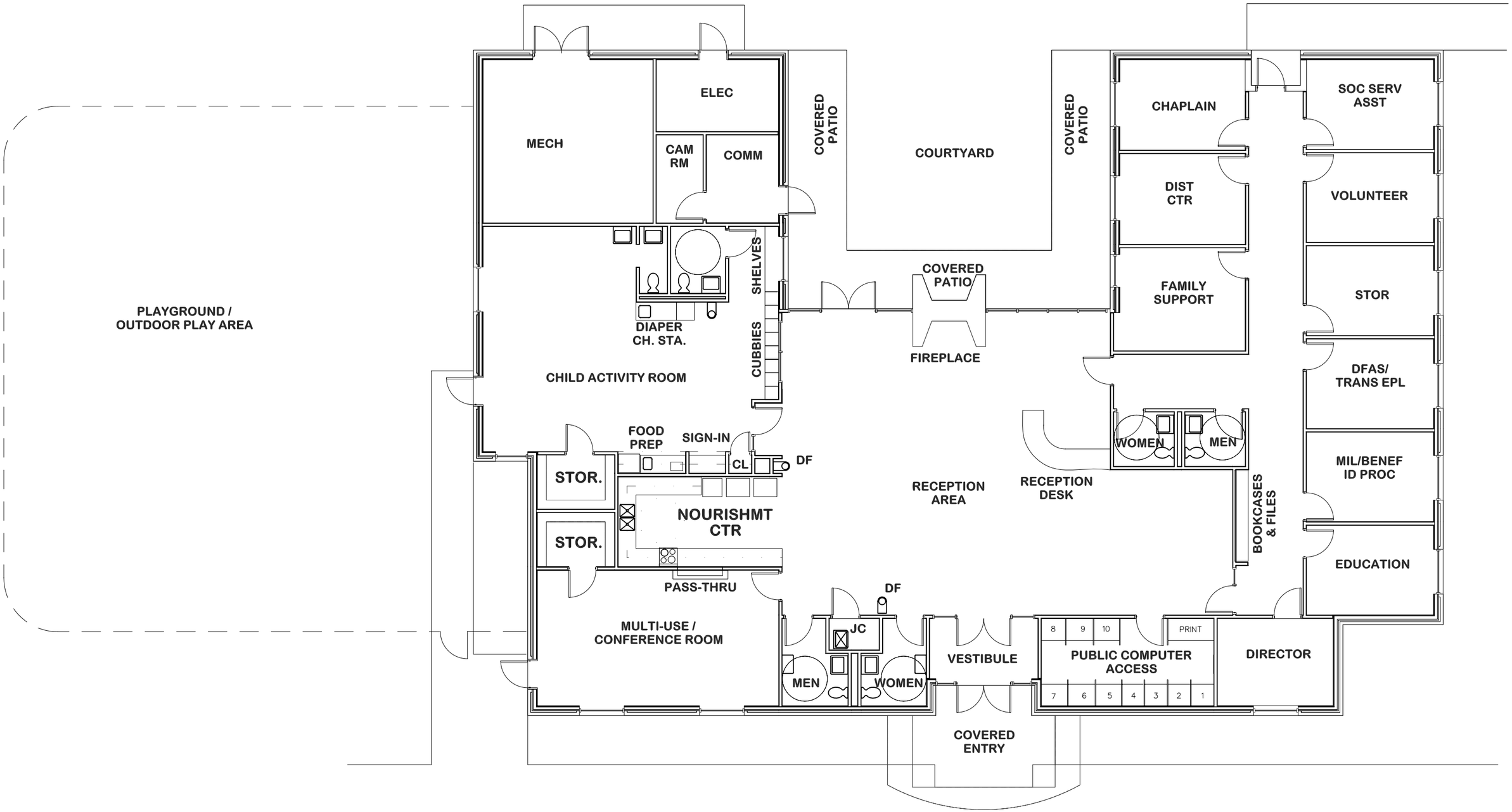
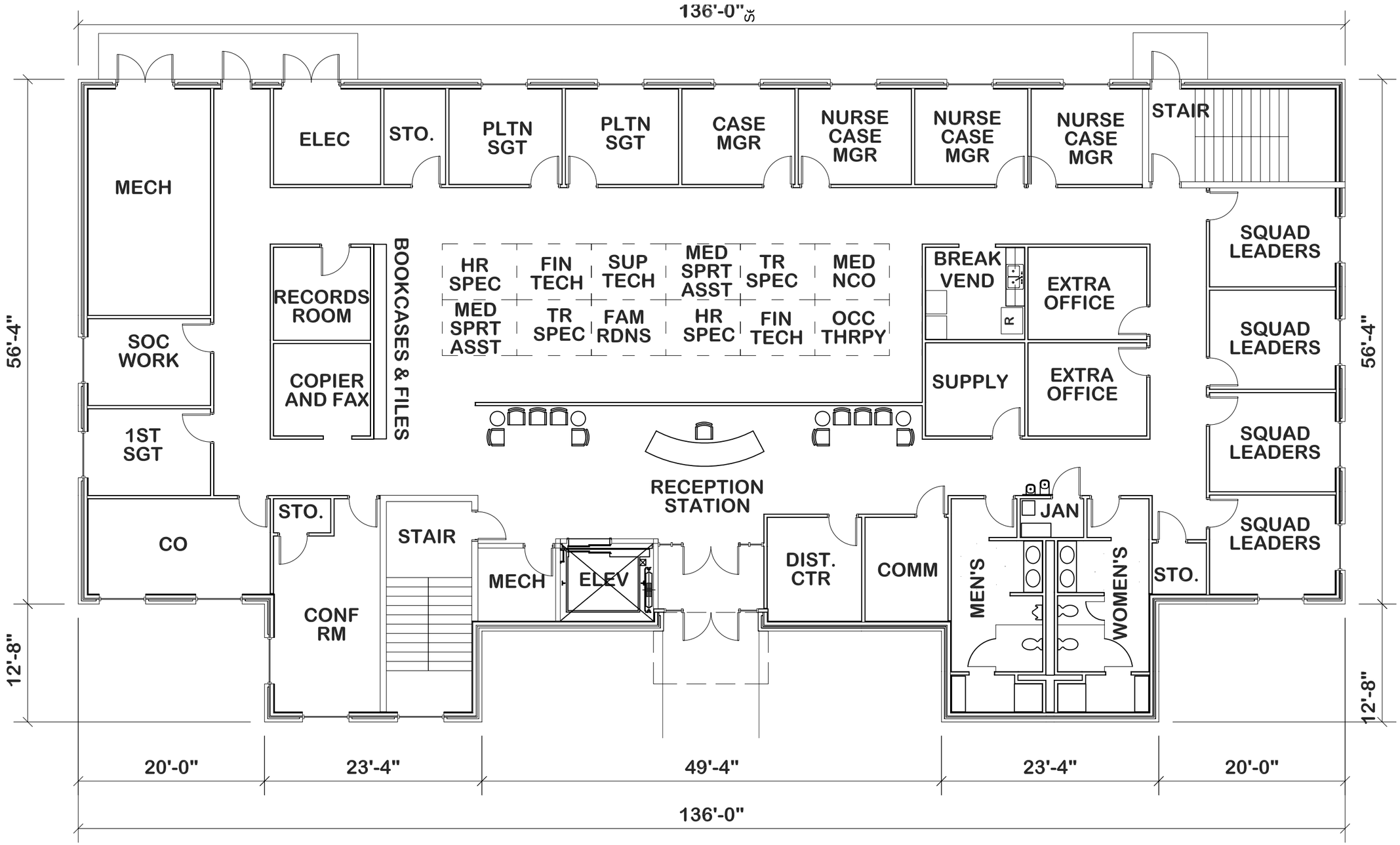
WARRIOR IN TRANSITION COMPLEX
FT. EUSTIS VIRGINIA
PN 071539

SFAC/CO HQ UTILITY PLAN

SHEET REFERENCE NUMBER
C-103
SHEET XXX OF XXX

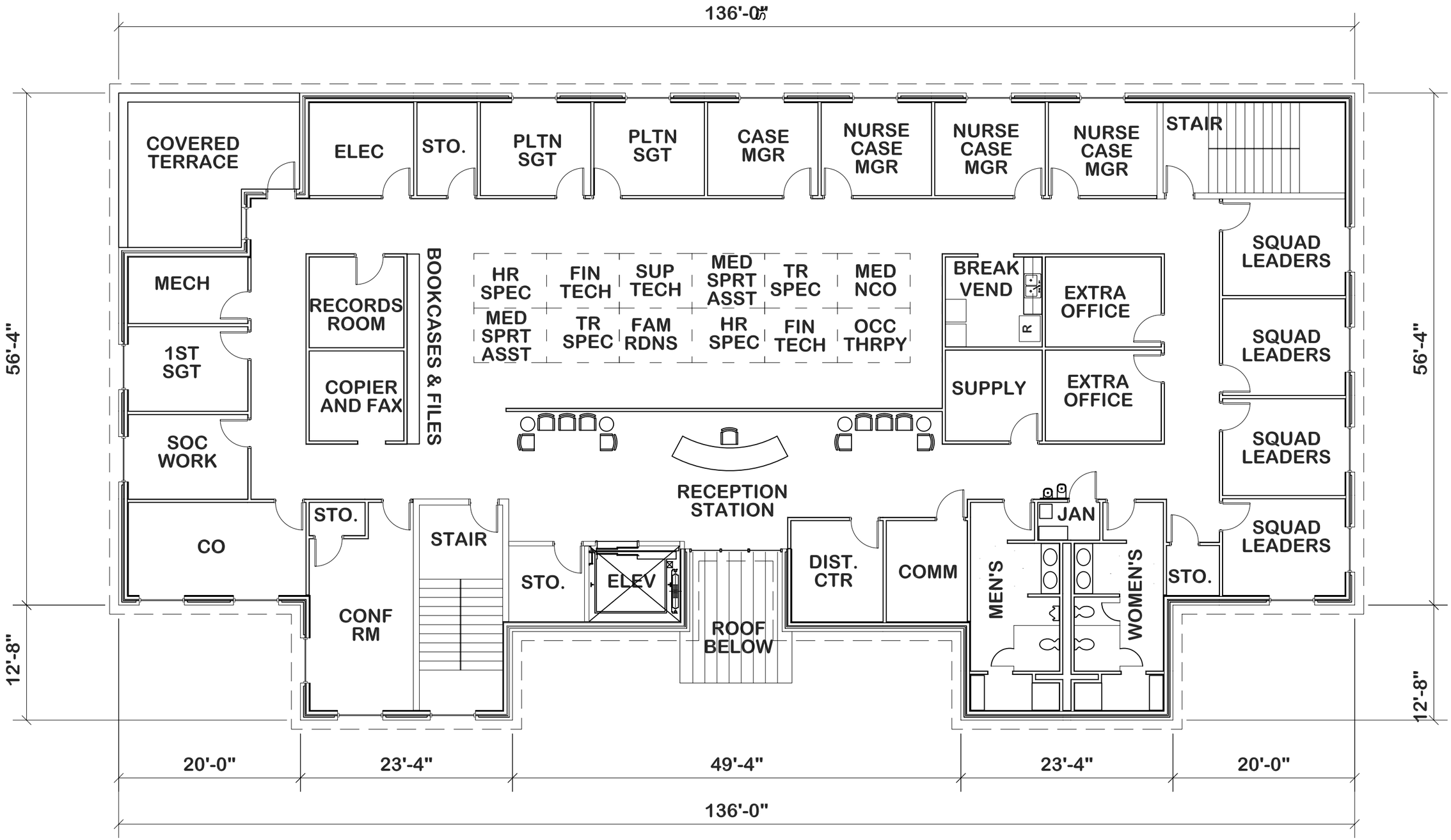

PLAYGROUND /
OUTDOOR PLAY AREA
MECH
ELEC
CAM
RM
COMM
COVERED
PATIO
COURTYARD
COVERED
PATIO
CHAPLAIN
SOC SERV
ASST
DIST
CTR
VOLUNTEER
SHELVES
CUBBIES
DIAPER
CH. STA.
COVERED
PATIO
FIREPLACE
FAMILY
SUPPORT
STOR
CHILD ACTIVITY ROOM
DFAS/
TRANS EPL
FOOD
PREP
SIGN-IN
CL
DF
STOR.
STOR.
NOURISHMT
CTR
PASS-THRU
RECEPTION
AREA
RECEPTION
DESK
WOMEN
MEN
BOOKCASES
& FILES
MIL/BENEF
ID PROC
EDUCATION
DF
MULTI-USE /
CONFERENCE ROOM
JC
MEN
WOMEN
VESTIBULE
8
9
10
PRINT
PUBLIC COMPUTER
ACCESS
7
6
5
4
3
2
1
DIRECTOR
COVERED
ENTRY



SMALL COMPANY HEADQUARTERS - STACKED FIRST FLOOR

8,376 GSF

16,598 GSF BUILDING TOTAL



SMALL COMPANY HEADQUARTERS - STACKED SECOND FLOOR

8,010 GSF

16,598 GSF BUILDING TOTAL

APPENDIX K
Life Cycle Cost Analysis Fuel Cost Information
(REV 1.0, 25 Jan 2007)

The following utility rates for this installation are provided for the purpose of performing life cycle cost calculations in response to this solicitation and for design development in accordance with Section 01 13 16 Design After Award:

Electrical:
Demand Charge - **$12.003** per kilowatt

Energy Charge - **$0.03893** per kilowatt-hour
Blended Rate - **$0.067628** per kilowatt-hour (blended annual energy and demand cost)

Natural Gas:
Commodity Charge Rate - **$6.81** per thousand cubic feet

Water:
Commodity Charge Rate - **$4.08** per Kgal

Sewer:
Commodity Charge Rate - **$3.795** per Kgal

Purchased/Central Steam:
Commodity Charge Rate - $x.xx per [unit of measure] **NOT APPLICABLE TO FT EUSTIS**

Purchased High Temperature Water:
Commodity Charge Rate - $x.xx per [unit of measure] **NOT APPLICABLE TO FT EUSTIS**

Purchased Chilled Water:
Commodity Charge Rate - $x.xx per [unit of measure] **NOT APPLICABLE TO FT EUSTIS**

Data per e-mail June 04, 2009 [Daniel B. Wood -- IMCOM]

LEED Project Credit Guidance (OCT 09)

This spreadsheet indicates Army required credits, Army preferred credits, project-specific ranking of individual point preferences, assumptions guidance for individual credits, and references to related language in the RFP for individual credits.

LEED 2.2 Credit Paragraph	LEED Project Credit Guidance	**Army Guidance:** Required - Preferred - Avoid	**Project Preference Ranking**: (1=most preferred, blank=no preference, X=preference not applicable to this credit, Rqd=required)	
PAR	**FEATURE**			**REMARKS**
SUSTAINABLE SITES				
SSPR1	Construction Activity Pollution Prevention (PREREQUISITE)	Rqd	Rqd	All LEED prerequisites are required to be met.
SS1	Site Selection		X	See paragraph LEED CREDITS COORDINATION.
SS2	Development Density & Community Connectivity - OPTION 1 DENSITY		X	See paragraph LEED CREDITS COORDINATION.

	Development Density & Community Connectivity - OPTION 2 CONNECTIVITY		X	See paragraph LEED CREDITS COORDINATION.
SS3	Brownfield Redevelopment		X	See paragraph LEED CREDITS COORDINATION.
SS4.1	Alternative Transportation: Public Transportation Access		X	See paragraph LEED CREDITS COORDINATION.
SS4.2	Alternative Transportation: Bicycle Storage & Changing Rooms	Pref		Assume that non-transient building occupants are NOT housed on Post unless indicated otherwise.
SS4.3	Alternative Transportation: Low Emitting & Fuel Efficient Vehicles - OPTION 1			Requires provision of vehicles, which cannot be purchased with construction funds. Assume Government will not provide vehicles unless indicated otherwise. Assume that 50% of GOV fleet is NOT alternative fuel vehicles unless indicated otherwise.
SS4.3	Alternative Transportation: Low Emitting & Fuel Efficient Vehicles - OPTION 2	Pref		
SS4.3	Alternative Transportation: Low Emitting & Fuel Efficient Vehicles - OPTION 3			Requires provision of vehicle refueling stations. Installation must support type of fuel and commit to maintaining/supporting refueling stations.
SS4.4	Alternative Transportation: Parking Capacity	Pref		
SS5.1	Site Development: Protect or Restore Habitat			

SS5.2	Site Development: Maximize Open Space	Pref		Assume AGMBC option for aggregated open space at another location on the installation is not available to the project unless indicated otherwise.
SS6.1	Stormwater Design: Quantity Control	Pref		See paragraph STORMWATER MANAGEMENT.
SS6.2	Stormwater Design: Quality Control	Pref		See paragraph STORMWATER MANAGEMENT.
SS7.1	Heat Island Effect: Non-Roof			
SS7.2	Heat Island Effect: Roof	Pref		Coordinate with nearby airfield requirements, which may preclude this credit.
SS8	Light Pollution Reduction	Pref		
WATER EFFICIENCY				
WEPR1	Water Use Reduction (Version 3 only)	Rqd	Rqd	All LEED prerequisites are required to be met.
WE1.1	Water Efficient Landscaping: Reduce by 50%	Pref		See paragraph IRRIGATION. Project must include landscaping to be eligible for this credit.
WE1.2	Water Efficient Landscaping: No Potable Water Use or No Irrigation	Pref		Project must include landscaping to be eligible for this credit.
WE2	Innovative Wastewater Technologies - OPTION 1			
WE2	Innovative Wastewater Technologies - OPTION 2			
WE3	Water Use Reduction	Pref		See paragraph BUILDING WATER USE REDUCTION.
ENERGY AND ATMOSPHERE				

EAPR1	Fundamental Commissioning of the Building Energy Systems (PREREQUISITE)	Rqd	Rqd	All LEED prerequisites are required to be met.
EAPR2	Minimum Energy Performance (PREREQUISITE)	Rqd	Rqd	All LEED prerequisites are required to be met.
EAPR3	Fundamental Refrigerant Management (PREREQUISITE)	Rqd	Rqd	All LEED prerequisites are required to be met.
EA1	Optimize Energy Performance	Rqd	1	Earning of LEED EA1 points as indicated in paragraph ENERGY CONSERVATION, as a minimum, is required.
EA2.1	On-Site Renewable Energy	Pref		See paragraph ENERGY CONSERVATION.
EA3	Enhanced Commissioning			The Commissioning Authority may be provided through the Design-Build Contractor only if in accordance with USGBC Credit Interpretation Ruling (CIR) dated 9/15/06. Commissioning Authority activities begin during design phase and continue well beyond beneficial occupancy. Assume Government will not provide CxA post-occupancy activities unless indicated otherwise.
EA4	Enhanced Refrigerant Management			
EA5	Measurement & Verification			Assume Government will not provide post-occupancy activities unless indicated otherwise.
EA6	Green Power		X	See paragraph LEED CREDITS COORDINATION.
MATERIALS AND RESOURCES				
MRPR1	Storage & Collection of Recyclables (PREREQUISITE)	Rqd	Rqd	All LEED prerequisites are required to be met. Coordinate with

				Installation during design development on collection service and receptacles.
MR1	Building Reuse			
MR2.1	Construction Waste Management: Divert 50% From Disposal	Pref		See paragraph CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT.
MR2.2	Construction Waste Management: Divert 75% From Disposal	Pref		
MR3	Materials Reuse			
MR4.1	Recycled Content: 10% (post-consumer + 1/2 pre-consumer)	Pref		See paragraph RECYCLED CONTENT.
MR4.2	Recycled Content: 20% (post-consumer + 1/2 pre-consumer)	Pref		
MR5.1	Regional Materials:10% Extracted, Processed & Manufactured Regionally			
MR5.2	Regional Materials:20% Extracted, Processed & Manufactured Regionally			
MR6	Rapidly Renewable Materials	Pref		See paragraph BIOBASED AND ENVIRONMENTALLY PREFERABLE MATERIALS and paragraph FEDERAL BIOBASED PRODUCTS PREFERRED

				PROCUREMENT PROGRAM.
MR7	Certified Wood	Pref		See paragraph BIOBASED AND ENVIRONMENTALLY PREFERABLE MATERIALS.
INDOOR ENVIRONMENTAL QUALITY				
EQPR1	Minimum IAQ Performance (PREREQUISITE)	Rqd	Rqd	All LEED prerequisites are required to be met.
EQPR2	Environmental Tobacco Smoke (ETS) Control (PREREQUISITE)	Rqd	Rqd	All LEED prerequisites are required to be met. Assume all buildings are smoke free unless indicated otherwise (family housing, barracks and other lodging are facility types where smoking may be permitted in some cases).
EQ1	Outdoor Air Delivery Monitoring			
EQ2	Increased Ventilation			
EQ3.1	Construction IAQ Management Plan: During Construction	Pref		See paragraph CONSTRUCTION IAQ MANAGEMENT.
EQ3.2	Construction IAQ Management Plan: Before Occupancy	Pref		See paragraph CONSTRUCTION IAQ MANAGEMENT.
EQ4.1	Low Emitting Materials: Adhesives & Sealants	Pref		See paragraph LOW-EMITTING MATERIALS.
EQ4.2	Low Emitting Materials: Paints & Coatings	Pref		See paragraph LOW-EMITTING MATERIALS.
EQ4.3	Low Emitting Materials: Carpet/Flooring Systems	Pref		See paragraph LOW-EMITTING MATERIALS.
EQ4.4	Low Emitting Materials: Composite Wood & Agrifiber Products	Pref		See paragraph LOW-EMITTING MATERIALS.
EQ5	Indoor Chemical & Pollutant Source Control	Pref		System requiring weekly cleaning to earn this credit is not a permitted option unless indicated

				otherwise.
EQ6.1	Controllability of Systems: Lighting			
EQ6.2	Controllability of Systems: Thermal Comfort			
EQ7.1	Thermal Comfort: Design	Pref		See paragraph APPLICABLE CRITERIA
EQ7.2	Thermal Comfort: Verification			Project must earn credit EQ7.1 to be eligible for this credit. Assume Government will not provide post-occupancy activities unless indicated otherwise.
EQ8.1	Daylight & Views: Daylight 75% of Spaces	Pref		See paragraph DAYLIGHTING.
EQ8.2	Daylight & Views: Views for 90% of Spaces	Pref		
INNOVATION & DESIGN PROCESS				
IDc1.1	Innovation in Design			See paragraph INNOVATION AND DESIGN CREDITS. Assume Government will not provide any activities associated with ID credits.
IDc1.2	Innovation in Design			
IDc1.3	Innovation in Design			
IDc1.4	Innovation in Design			
IDc2	LEED Accredited Professional	Rqd	Rqd	LEED AP during design and construction is required.
REGIONAL PRIORITY CREDITS (Version 3 only)				See paragraph LEED CREDITS COORDINATION.

Owner's Project Requirements Document for LEED Fundamental Commissioning

Project: _____

Approved: _____ _____ _____
Name Owner's Representative Date

_____ _____ _____
Name Design Agent's Representative Date

Overview and Instructions

The purpose of this document is to provide clear and concise documentation of the Owner's goals, expectations and requirements for commissioned systems, and shall be utilized throughout the project delivery and commissioning process to provide an informed baseline and focus for design development and for validating systems' energy and environmental performance.

The Owner's Project Requirements Document is a required document for LEED Version 2.2 EA Prerequisite 1, Fundamental Commissioning of the Building Energy Systems. It shall be completed by the Corps District/Design Agent based on coordination with the Installation/User/Proponent and shall be approved by the Installation/User/Proponent representative.

Use of this template is not required, nor are there any restrictions on editing of it. It is provided simply as a tool to assist project teams in meeting the documentation requirements for LEED Fundamental Commissioning.

The intent of the Owner's Project Requirements Document, per the LEED v2.2 Reference Guide, is to detail the functional requirements of a project and the expectations of the building's use and operation as it relates to commissioned systems. This template contains the basic recommended components indicated in the LEED v2.2 Reference Guide. It should be adapted as needed to suit the project, remaining reflective of the LEED intent.

The Owner's Project Requirements Document should ideally be completed before the start of design and furnished to the design team. It must be completed prior to the approval of Contractor submittals of any commissioned equipment or systems to meet LEED requirements.

Updates to the Owner's Project Requirements Document throughout the course of project delivery shall be made by the Corps District/Design Agent based on decisions and agreements coordinated with and agreed to by the Installation/User/Proponent.

The Owner's Project Requirements Document shall be included in the project's LEED documentation file under EA PR1, Fundamental Commissioning of the Building Energy Systems.

Owner's Project Requirements Document for LEED Fundamental Commissioning

Table of Contents

1. Owner and User Requirements
   - Primary Purpose, Program and Use
   - Project History
   - Broad Goals
2. Environmental and Sustainability Goals
   - Energy Efficiency Goals
   - General
   - Siting
   - Building Façade
   - Building Fenestration
   - Building Envelope
   - Roof
   - Other
3. Indoor Environmental Quality Requirements
   - Intended Use
   - Occupancy Schedule
   - Accommodations for After-Hours Use
   - Lighting, Temperature, Humidity, Air Quality, Ventilation, Filtration
   - Acoustics
   - Occupant Ability to Adjust System Controls
   - Types of Lighting
4. Equipment and Systems Expectations
   - Space Heating
   - Ventilation
   - Air Conditioning
   - Refrigeration
   - HVAC Controls
   - Domestic Hot Water
   - Lighting Controls
   - Daylighting Controls
   - Emergency Power
   - Other
5. Building Occupant and O&M Personnel Requirements
   - Facility Operation
   - EMCS
   - Occupant Training and Orientation
   - O&M Staff Training and Orientation

TABLE 1

1. *Owner and User Requirements*

What is the primary purpose, program and use of this project? (example: office building with data center)

_____
_____
_____

Describe pertinent project history. (example: standard design development)

_____
_____
_____

Broad Goals

What are the broad goals relative to program needs?

_____
_____
_____

What are the broad goals relative to future expansion?

_____
_____
_____

What are the broad goals relative to flexibility?

_____
_____
_____

What are the broad goals relative to quality of materials?

_____
_____
_____

What are the broad goals relative to construction costs?

_____
_____
_____

What are the broad goals relative to operational costs?

_____
_____
_____

What are the broad goals relative to life cycle of the equipment?

Other broad goals: *(Insert as applicable)*

2. Environmental and Sustainability Goals

What are the project goals relative to sustainability and environmental issues? (example: LEED Silver rating)

What are the project goals relative to energy efficiency? (example: Meet EPACT)

What are the project goals and requirements for building siting that will impact energy use?

What are the project goals and requirements for building facade that will impact energy use?

What are the project goals and requirements for building fenestration that will impact energy use?

What are the project goals and requirements for building envelope that will impact energy use?

What are the project goals and requirements for building roof that will impact energy use?

Other: *(Insert as applicable)*

_____
_____
_____

3. Indoor Environmental Quality Requirements

What is the intended use for all spaces? For all spaces that have an intended use that is not readily apparent from the space name, provide this information in Table 1.

_____
_____
_____

What is the anticipated occupancy schedule (numbers of occupants and time frames) for all occupied spaces? Indicate the default occupancy schedule below and for all spaces that have an occupancy schedule that differs from the default, provide this information in Table 1.

_____
_____
_____

What accommodations for after-hours use are required? (example: access control, lighting controls, HVAC controls) Indicate general accommodations required below and for all spaces that have special requirements, provide this information in Table 1.

_____
_____
_____

What are the lighting, temperature, humidity, air quality, ventilation and filtration requirements for all spaces? Indicate the default requirements below and for all spaces that have a requirement that differs from the default, provide this information in Table 1.

Lighting: _____
Temperature: _____

Humidity: _____
Air Quality: _____

Ventilation: _____

Filtration: _____

What are the acoustical requirements for all spaces? Indicate the default acoustical requirements below and for all spaces that have a requirement that differs from the default, provide this information in Table 1.

_____
_____
_____

What is the desired level of occupant ability to adjust systems controls? Indicate the default desired levels below and for all spaces that have a desired level that differs from the default, provide this information in Table 1.

Lighting: _____

Temperature: _____
Humidity: _____
Air Quality: _____

Ventilation: _____

What, if any, specific types of lighting are desired? (example: fluorescent in 2x2 grid, accent lighting, particular lamps)

_____
_____
_____

4. Equipment and System Expectations

(Complete for each category as applicable or indicate "none identified" or "N/A". Add desired features information for other anticipated commissioned systems as applicable)

Indicate desired features for the following commissioned system: Space Heating

Desired Type: _____

Quality: _____

Preferred Manufacturer: _____
Reliability: _____
Automation: _____

Flexibility: _____
Maintenance Requirements: _____
Efficiency Target: _____

Desired Technologies: _____

Indicate desired features for the following commissioned system: Ventilation

Desired Type: _____

Quality: _____

Preferred Manufacturer: _____
Reliability: _____
Automation: _____

Flexibility:_____
Maintenance Requirements: _____
Efficiency Target: _____

Desired Technologies: _____

Indicate desired features for the following commissioned system: Air Conditioning

Desired Type: _____

Quality: _____

Preferred Manufacturer: _____
Reliability: _____
Automation: _____

Flexibility:_____
Maintenance Requirements: _____
Efficiency Target: _____

Desired Technologies: _____

Indicate desired features for the following commissioned system: Refrigeration

Desired Type: _____

Quality: _____

Preferred Manufacturer: _____
Reliability: _____
Automation: _____

Flexibility:_____
Maintenance Requirements: _____
Efficiency Target: _____

Desired Technologies:

Indicate desired features for the following commissioned system: HVAC Controls

Desired Type: _____

Quality: _____

Preferred Manufacturer: _____
Reliability: _____
Automation: _____

Flexibility:_____
Maintenance Requirements: _____
Efficiency Target: _____

Desired Technologies: _____

Indicate desired features for the following commissioned system: Domestic Hot Water

Desired Type: _____

Quality: _____

Preferred Manufacturer: _____
Reliability: _____
Automation: _____

Flexibility:_____
Maintenance Requirements: _____
Efficiency Target: _____

Desired Technologies: _____

Indicate desired features for the following commissioned system: Lighting Controls

Desired Type: _____

Quality: _____

Preferred Manufacturer: _____
Reliability: _____
Automation: _____

Flexibility:_____
Maintenance Requirements: _____
Efficiency Target: _____

Desired Technologies: _____

Indicate desired features for the following commissioned system: Daylighting Controls

Desired Type: _____

Quality: _____

Preferred Manufacturer: _____
Reliability: _____
Automation: _____

Flexibility:_____
Maintenance Requirements: _____
Efficiency Target: _____

Desired Technologies: _____

Indicate desired features for the following commissioned system: Emergency Power

Desired Type: _____

Quality: _____

Preferred Manufacturer: _____
Reliability: _____
Automation: _____

Flexibility:_____
Maintenance Requirements: _____
Efficiency Target: _____

Desired Technologies: _____

Indicate desired features for the following commissioned system: Other - _____

Desired Type: _____

Quality: _____

Preferred Manufacturer: _____
Reliability: _____
Automation: _____

Flexibility:_____
Maintenance Requirements: _____
Efficiency Target: _____

Desired Technologies: _____

5. Building Occupant and O&M Personnel Requirements

How will the facility be operated? Who will operate the facility?

_____
_____
_____

Will the facility be connected to an EMCS? If so, what are the interface requirements? (example: monitoring points, control points, scheduling)

_____
_____
_____

What is the desired level of training and orientation for building occupants to understand and use the building systems?

_____
_____
_____

What is the desired level of training and orientation for O&M staff to understand and maintain the building systems?

_____
_____
_____

Table 1

Space	Use / Activity	Num of Occs	Special Occupancy Schedule	After Hours Use Reqmt.	Special Cooling Reqmt.	Special Heating Reqmt.	Special Humidity Reqmt.	Special Ventil./Filtration Reqmt.	Special Acoustic Reqmt.	Special Lighting Reqmt.	Special Occup Adjustability Reqmt.

APPENDIX N
LEED Requirements for Multiple Contractor Combined Projects

Not Used

APPENDIX O
LEED Strategy Tables

Not Used

APPENDIX P

LEED Registration of Army Projects

15 April 2010

Number of Registrations
Each building must be registered separately, except multiple instances of a standard building on a shared site may be registered as a single project. If a single registration for multiple buildings is chosen, all buildings under the single registration must earn exactly the same points. Do not register buildings that are exempt from a specific LEED achievement requirement.

Typical Registration Procedure
1. Login, complete the online registration form (see guidance below) at the GBCI LEED Online website http://www.gbci.org/DisplayPage.aspx?CMSPageID=174 and submit it online.
2. Pay the registration fee via credit card (USACE staff: credit card PR&C is funded by project design or S&A funds).
3. GBCI will follow up with a final invoice, the LEED-online passwords and template information.
4. The individual who registers the project online is, by default, the Project Administrator.

Completing the Registration Form

BEFORE YOU BEGIN:
Create a personal account with USGBC if you do not have one.
You will need the following information:
Project name as it appears in P2 (obtain from USACE Project Manager)
Building number/physical address of project
Zip code for Installation/project location
Anticipated construction start and end dates
Total gross area all non-exempt buildings in registration
Total construction cost all non-exempt buildings only (see Project Details Section instructions below)

ACCOUNT/LOGIN INFORMATION
1. The person registering the project **must have an account with USGBC** (login and password) to complete the form. Go to http://www.gbci.org/ , click on “register a project” at the drop-down menu for project certification (at the top of the page) and select “register now for LEED 2009” to start the project registration process. If you have an account, login with your email address and password and select “register new project” to proceed. If you do not have an account, you may select “register a new account” and follow the instructions. It is recommended that you create an account separately on the USGBC website before you start the form. IMPORTANT: USACE team members are members of USGBC and are eligible for Member prices. USACE team members registering projects should be sure to include the USACE Corporate Access ID in their personal account profile (if you do not have it contact richard.l.schneider@usace.army.mil or judith.f.milton@usace.army.mil for the number).
2. The Account/Login Information section is filled out by the person registering the project. It may be a Contractor or a USACE staff member.

ELIGIBILITY SECTION
Follow directions (accepting the terms and conditions)
Review your profile information and make corrections if needed

RATING SYSTEM SELECTION SECTION
Select single project registration and I know which rating system.
Select the rating system - currently only LEED-NC and LEED for Homes are approved for Army use without special approval.
LEED Minimum Program Requirements: select YES

RATING SYSTEM RESULTS SECTION

Confirm selected rating system.

PROJECT INFORMATION SECTION

Project Title: Begin the project title with a one-word identifier for the Installation. Do not include the word “Fort”. After this match the project name used in P2 (contact the USACE Project Manager for this information) and identify the building being registered. Example: “Stewart 4th IBCT - DFAC”.
Project Address 1 and 2: This is the physical location of the project. Provide building number, street address, block number or whatever is known to best describe the location of the project on the Installation.
Project City: Installation Name
State, Country, Zip Code: Self-explanatory
Anticipated Construction Start and End Dates: Self-explanatory – give your best guess if unknown. Note that required data entry format is: 1 or 2 digit month/1 or 2 digit date/4 digit year (example 3/23/2010)
Gross Square Footage: Provide total area all buildings in LEED project. Exclude the area of any buildings that are exempt from the LEED achievement requirement (for example, exclude an unconditioned storage shed to be constructed with a barracks complex).
Is Project Confidential: Indicate NO except, if project has security sensitivity (elements that are FOUO or higher security), indicate YES.
Notification of Local Chapter: Indicate NO unless Government/USACE Project Manager requests you to indicate YES.
Anticipated Project Type: Select the most appropriate option from the drop-down menu.
Anticipated Certification Level: Select the applicable option from the drop-down menu (Silver is the usual level).

PROJECT OWNER INFORMATION SECTION

Project Owner First Name, Last Name, email, phone, address: The Project Owner is the USACE Project Manager. Obtain this info from the USACE Project Manager.
Organization: U.S. Army Corps of Engineers. This field MUST be completed this way because it will be used as a search field by higher HQ to find all USACE registered projects. You may supplement it with district name at the end but DO NOT revise or use an acronym.
May we publish Owner information: Indicate NO
Owner Type: Pick Federal Government from drop-down menu.
Project Owner Assertion: Check the box

PAYMENT INFORMATION

Self-explanatory

APPENDIX Q
REV 1.1 – 31 MAY 2009
AREA COMPUTATIONS

Computation of Areas: Compute the "gross area" and "net area" of facilities (excluding family housing) in accordance with the following subparagraphs:

(1) Enclosed Spaces: The "gross area" is the sum of all floor spaces with an average clear height ≥6′-11″ (as measured to the underside of the structural system) and having perimeter walls which are ≥4′-11″. The area is calculated by measuring to the exterior dimensions of surfaces and walls.

(2) Half-Scope Spaces: Areas of the following spaces shall count as one-half scope when calculating "gross area":

- Balconies
- Porches
- Covered exterior loading platforms or facilities
- Covered but not enclosed passageways and walks
- Open stairways (both covered and uncovered)
- Covered ramps
- Interior corridors (Unaccompanied Enlisted Personnel Housing Only)

(3) Excluded Spaces: The following spaces shall be excluded from the "gross area" calculation:

- Crawl spaces
- Uncovered exterior loading platforms or facilities
- Exterior insulation applied to existing buildings
- Open courtyards
- Open paved terraces
- Uncovered ramps
- Uncovered stoops
- Utility tunnels and raceways
- Roof overhangs and soffits measuring less than 3′-0″ from the exterior face of the building to the fascia

(4) Net Floor Area: Where required, "net area" is calculated by measuring the inside clear dimensions from the finish surfaces of walls. If required, overall "assignable net area" is determined by subtracting the following spaces from the "gross area":

- Basements not suited as office, special mechanical, or storage space
- Elevator shafts and machinery space
- Exterior walls
- Interior partitions
- Mechanical equipment and water supply equipment space
- Permanent corridors and hallways
- Stairs and stair towers
- Janitor closets
- Electrical equipment space
- Electronic/communications equipment space

RMS SUBMITTAL REGISTER INPUT FORM

CONTRACT NUMBER

DELIVERY ORDER

TITLE AND LOCATION

Button <-----Right click for Instructions

SECTION	PARAGRAPH NUMBER	DESCRIPTION OF ITEM SUBMITTED	TYPE OF SUBMITTAL											CLASSIFICATION						REVIEWING OFFICE					
			01 - PRECON SUBMITTALS	02 - SHOP DRAWINGS	03 - PRODUCT DATA	04 - SAMPLES	05 - DESIGN DATA	06 - TEST REPORTS	07 - CERTIFICATES	08 - MFRS INSTRUCTIONS	09 - MFRS FIELD REPORT	10 - O&M DATA	11 - CLOSEOUT SUBMITTALS	FIO - FOR INFORMATION ONLY	GA - GOVERNMENT APPROVED	DA - DESIGNER OF RECORD APPROVAL	CR - CONFORMANCE REVIEW	DA / CR	DA / GA	DO - DISTRICT OFFICE	AO - AREA OFFICE	RO - RESIDENT OFFICE	PO - PROJECT OFFICE	DR - DESIGNER OF RECORD	AE - ARCHITECT / ENGINEER
00 72 00	52.236-13	Accident Prevention Plan	X														X				X				
00 73 00	1.11	Dev. From Accept. Design. No Deviation from Contract					X											X			X			X	
00 73 00	1.11	Dev. From Accepted Design - Deviates from Contract					X												X		X			X	
00 73 00	1.17	Supplemental Price Breakdown	X											X							X				
00 73 00	1.18	SSHO Qualifications	X												X						X				
01 10 00	5.2.3.1	(if concrete pavement) Joint Layout Plan with design drawings					X										X								
01 10 00	5.5.2	Building Envelope Sealing Performance Testing						X						X							X				
01 10 10	***	Tests as Req by Codes - DOR Develops Test Program						X						X							X			X	
01 10 00	5.8.3	BAS Review Information		X														X		X	X			X	
01 10 00	5.8.3	BAS Performance Verification Test						X						X							X			X	
01 10 00	5.8.4	Testing Adjusting and Balancing						X						X							X			X	
01 10 00	5.8.5	Commissioning						X						X							X			X	
01 10 00	6.15	Environmental As Required for Site Specific					X										X				X			X	
01 10 00	6.16	Permits as required for Site specific					X										X				X			X	
01 10 00	5.10.2	Fire Protection Tests						X	X					X							X			X	
01 32 01.00 10	3.4.1	Preliminary Project Schedule	X												X						X				
01 32 01.00 10	3.4.2	Initial Project Schedule	X												X						X				
01 32 01.00 10	3.4.3	Design Package Schedule	X												X						X				
01 32 01.00 10	3.6.1	Periodic schedule updates from the Contractor	X												X						X				
01 32 01.00 10	3.7	Time Extension Request (Schedule)	X												X						X				
01 33 00	1.8	Submittal Register - DOR Input Required	X												X						X			X	
01 33 00	1.8	Submittal Register Updates (Design Packages, etc.)	X												X						X			X	
01 33 00	1.3.1	Substitution of Manuf or Model Named in Proposal		X	X													X			X			X	
01 33 16	1.2	Identify Designer(s) of Record	X												X						X				
01 33 16	1.1.2 / 3.2.4	Fast Track Design Package(s)					X										X			X	X				
01 33 16	1.2	Identification of all Designers of Record	X														X				X				
01 33 16	3.2.1	Site and Utility Des Package, incl. Substantiation					X										X			X	X				
01 33 16	3.2.2/3.5	Interim Des Subm Package(s), incl. Substantiation					X										X			X	X				
01 33 16	3.5.1	Drawings					X										X			X	X				
01 33 16	3.5.2.2	Sitework Design Analyses					X										X			X	X				
01 33 16	3.5.2.3	Structural Design Analyses					X										X			X	X				
01 33 16	3.5.2.4	Security Design Analyses					X										X			X	X				
01 33 16	3.5.2.5	Architectural Design Analyses					X										X			X	X				
01 33 16	3.5.2.6	Mechanical Design Analyses					X										X			X	X				
01 33 16	3.5.2.7	Life Safety Design Analyses					X										X			X	X				
01 33 16	3.5.2.8	Plumbing Design Analyses					X										X			X	X				
01 33 16	3.5.2.9	Elevator Design Analyses (as Applicable)					X										X			X	X				
01 33 16	3.5.2.10	Electrical Design Analyses					X										X			X	X				
01 33 16	3.5.2.11	Telecommunications Design Analyses					X										X			X	X				
01 33 16	3.5.2.12	Cathodic Protection Design Analyses					X										X			X	X				
01 33 16	3.5.3	Geotechnical Investigations and Reports					X										X			X	X				
01 33 16	3.5.4	LEED Submittals					X										X			X	X				
01 33 16	3.5.5	Energy Conservation Documentation					X										X			X	X				
01 33 16	3.5.6	Specifications					X										X			X	X				
01 33 16	3.5.7	Building Rendering					X										X			X	X				
01 33 16	3.2.4/3.7	Final Des Submittal Package(s), incl. Substantiation					X										X			X	X				
01 33 16	3.7.5	DD Form 1354 (Transfer of Real Property)											X				X				X				
01 33 16	3.2.5/3.8	Design Complete Submittal Package(s)					X										X			X	X				
01 33 16	3.3.3	Design and Code Review Checklists					X										X			X	X				
01 33 16	A-2.0	SID - Interim and Final (as applicable)			X	X	X								X						X				
01 33 16	B-2.0	FFE (as Applicable)					X								X						X				
01 45 04.00 10	3.2	Design and Construction QC Plan	X														X				X				
01 57 20.00.10	1.2	Environmental Protection Plan	X														X				X				
01 78 02.00 10	1.2.1	Final as-Built Drawings											X		X										
01 78 02.00 10	1.2.3.11	Non-Hazardous Solid Waste Diversion Reports							X					X							X				
01 78 02.00 10	1.2.7	Provide final as-built CADD and BIM Model files											X		X						X				
01 78 02.00 10	1.2.9	Provide scans of all other docs in Adobe.pdf format											X		X						X				
01 78 02.00 10	1.3.1	Equip-in-Place list of all installed equip and cost											X		X						X				
01 78 02.00 10	1.3.2	Data on equip not addressed in O&M manuals											X		X						X				
01 78 02.00 10	1.3.3	Final as-built specs - electronic files											X		X						X				
01 78 02.00 10	1.4.2.1	Warranty management plan - FAR 52.246-21											X		X						X				
01 78 02.00 10	1.4.2.1	Certificates of Warranty for extended warranty items											X		X						X				
01 78 02.00 10	1.4.2.1	Contractor's POCs for implementing warranty process											X		X						X				
01 78 02.00 10	1.4.2.1	List of each warranted equip, item, feature or system											X		X						X				
01 78 02.00 10	1.5	See also Section 01 10 00 par. 5.8.4 and 5.8.5											X		X						X				
01 78 02.00 10	1.6.1.2	Equipment O&M Manuals - 1 electronic / 2 hard copies											X		X						X				
01 78 02.00 10	1.7	Field Training DVD Videos										X		X							X				
01 78 02.00 10	1.8	Pricing of CF/CI and GF/CI Property											X	X							X				
01 78 02.00 10	1.11	List of Completed Cleanup Items											X				X				X				

SECTION 07 25 00.00 06

BUILDING AIR BARRIER SYSTEM
03/09

PART 1 GENERAL

1.1 CONTRACTOR RESPONSIBILITY

The Contractor is responsible for the construction of an air barrier system that is contiguous and connected across the six surfaces of the building envelope meeting the performance requirements as outlined in this specification.

The Contractor shall perform a building air tightness test and thermography test to demonstrate that the building envelope is properly sealed and insulated. The testing shall be performed in accordance with the procedures outlined in this specification.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C 779	(2003) Standard Test Method fro Determining Air Leakage Rate by Fan Presurization
ASTM C 1060	(90; R 2003) Standard Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings
ASTM E 1186	(2003) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
ASTM E 1677	(2005) Standard Specification for an Air Barrier (AB) Material or System for Low-Rise Framed Building Walls
ASTM E 1827	(96; R 2002) Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
ASTM E 2178	(2003) Standard Test Method for Air Permeance of Building Materials
ASTM D 4541	(2002) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 6781	(1983) Thermal Insulation - Qualitative Detection of Thermal Irregularities in Building Envelopes - Infrared Method, First Edition

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES

SD-03 Product Data

Building Air Tightness Test Technician

The testing technician shall have 2 years experience in air tightness testing using the specified testing standard.

Building Air Tightness Test Procedures; G

The contractor shall submit detailed test procedures indicating the test apparatus, the test methods and procedures, and the analysis methods to be employed for the Building Air Tightness Test. The Building Air Tightness Test Procedures shall be submitted not later than 60 days after Notice to Proceed.

The contractor shall submit detailed test procedures indicating the test apparatus, the test methods and procedures, and the analysis methods to be employed for the Thermography Test. The Thermography Test Procedures shall be submitted not later than 60 days after Notice to Proceed.

SD-06 Test Reports

Test Reports; G

The inspection and testing agency will submit a certified written report, in duplicate, of each inspection, test, or similar service to the Contractor with duplicate copies to the Contracting Officer not later than 10 days after each test.

Report Data: Written reports of each inspectionand test or similar service shall include all the Report items described in ASTM E 1827. Additionally, the report shall also include the following information:

a. Date of Issue
b. Project title and number
c. Name, address, and telephone number of testing agency
d. Dates and locations of samples and tests or inspections
e. Names of individuals making the inspection or test

f. Designation of the Work and test method
g. Identification of product and Specification Section
h. Complete inspection or test data
i. Test results and an interpretation of test results
j. Comments or professional opinion on whether inspected or tested Work complies with Contract Document requirements
k. Name and signature of laboratory inspector
l. Recommendations on retesting

Building Air Tightness Test Reports; G, ED

The Building Air Tightness Test analysis, and report shall be submitted not later than 10 days after the test.

Thermography Test Report; G, ED

The Thermography Test analysis, and report shall be submitted not later than 10 days after the test.

1.4 ADMINISTRATIVE AND PROCEDURAL REQUIREMENTS

This section includes administrative and procedural requirements for accomplishing an airtight building enclosure that controls infiltration or exfiltration of air.

1. The airtight components of the building enclosure and the joints, junctures and transitions between materials, products, and assemblies forming the airtightness of the building enclosure are called "the air barrier system".

2. The Contractor is responsible for the coordination between the trades, the proper scheduling and sequencing of the work, preconstruction meetings, inspections, tests, and related actions including reports by independent inspection and testing agencies.

3. The Contractor shall ensure that the intent of constructing the building enclosure with a continuous air barrier system to control air leakage into or out of the conditioned space is achieved. The air barrier system shall have the following characteristics:

a. It must be continuous with all joints sealed.
b. It must be structurally supported to withstand positive and negative air pressures applied to the building enclosure.
c. Connection shall be made between:
1) Foundation and walls
2) Walls and windows
3) Walls and doors
4) Different wall systems
5) Walls and roof
6) Walls and roof over unconditioned space
7) Walls, floors, and roofs across construction, control, and expansion joints.
8) Walls, floors, and roofs to utility, pipe and duct penetrations.

4. It is the Contractor's responsibility to ensure that all penetrations through the air barrier system, and all paths of air

infiltration or exfiltration, are sealed airtight.

5. Inspection and testing services are required to verify compliance with requirements specified or indicated.

6. The Contractor is required to coordinate between subcontractors required to provide an airtight building enclosure, customized fabrication and installation procedures and the following:

a. Continuity of the air barrier materials and products with joints to provide assemblies. Continuity of all the enclosure assemblies with joints and transition materials to provide a whole building air barrier system.

b. Specific quality control requirements for individual construction activities are specified in the sections of the specifications. Requirements in those sections may also cover production of standard products. It is the Contractor's responsibility to ensure that each subcontractor is adequately and satisfactorily performing the quality assurance documentation, tests, and procedures required by each section.

c. Specified inspections, tests, and related actions do not limit the Contractor's quality control procedures that facilitate compliance with Contract Document requirements.

1.5 BUILDING AIR TIGHTNESS TEST TECHNICIAN RESPONSIBILITIES

The technician shall:

a. Describe the test procedures, test apparatus, and analysis method.

b. Perform the Building Air Tightness Test.

c. Perform the Thermography Test.

d. Participate in identifying deficiencies in the building construction upon failure of a test to meet the specified leakage rate.

e. Submit a report of each air tightness test whether successful or not.

e. Submit a report of each thermography test identifying problem areas.

1.6 QUALITY CONTROL

Qualifications for Air Barrier Inspection and Testing Agencies: The Contractor shall engage a prequalified third party organization, including independent testing laboratories, specialized in the types of air barrier system inspections and tests to be performed.

1.6.1 Air Barrier Association of America Quality Assurance Program (ABAA QAP)

An Air Barrier Association of America Quality Assurance Program (ABAA QAP) shall be implemented to provide a level of assurance that specific products are installed correctly and specific services are being provided to the highest possible standards. An ABAA QAP monitors standards and

specifications, manufacturer accreditation, contractor accreditation, installer training and accreditation, documentation and reporting, third party audits, and database tracking.

1.6.2 ABAA Accredited Contractors

The Contractor shall have met the ABAA's mandatory quality assurance and training requirements and shall be accredited through the ABAA prior to installation of products that form part of the air barrier system. Failure to meet this requirement shall be grounds for the Contracting Officer to stop the work.

1.6.3 ABAA Certified Installers

The Installer(s) shall have met the ABAA's mandatory quality assurance and training requirements and shall be accredited through the ABAA prior to installation of products that form part of the air barrier system.

1.6.4 On-Site Quality Control

The Installers are required to undertake quality control measures on a daily basis. They shall have completed air barrier training and shall utilize equipment to inspect and test the quality of their work to ensure the installation of products that form a part of the air barrier system conform to the standards outlined in the ABAA QAP.

1.6.5 Documentation and Reporting

Installers shall document the entire installation process on daily job site reports. These reports include information on the Installer, substrates, substrate preparation, products used, ambient and substrate temperature, the location of the air barrier installation, the results of the quality control procedures, and testing results. Every job site report is data based and reviewed by the Quality Assurance Program Manager.

1.6.6 Third Party Audits

Third party audits are part of the ABAA QAP. Independent auditors shall review the contractor's and installer's adherence to the ABAA QAP, which includes installation instructions, manufacturer's recommendations, and the overall quality of the air barrier system. All administrative and managerial aspects of the ABAA Quality Assurance Program, such as accreditation, audits, conflict resolution, and documentation review are handled by third party organizations. The Contractor shall notify the Contracting Officer 5 days in advance of a scheduled audit and a report shall be provided to the Contracting Officer within 14 days following the onsite audit. A minimum number of audits ABAA will conduct is based on the contract value. However, if additional audits are required by the Contracting Officer due to installation procedures not meeting the QAP the contractor shall bear all additional costs.

1.7 CONTRACTOR RESPONSIBILITIES

1.7.1 Coordination of Sub-Contractor(s)

The Contractor shall provide coordination between the Sub-Contractors involved in the construction of the air barrier system, coordinate the

sequence of construction to ensure continuity of the air barrier system joints, junctures, and transitions between materials and assemblies of materials and products from substructure to walls to roof. The Contractor shall provide quality assurance procedures, testing and verification as specified herein. The Contractor shall facilitate inspections, tests, and other quality control services specified elsewhere in the Contract Documents and required by the Contracting Officer. These coordination efforts are critical to avoid costly removal and replacement of construction materials to accommodate inspections and tests. The cost of all tear out and rework shall be at the Contractors expense, not the expense of the subcontractor(s).

1.7.2 Pre-Construction Conferences

The Contractor shall organize pre-construction conferences between the sub-contractors involved in the construction of the air barrier system to discuss where each sub-contractor begins and ends, the sequence of installation, and each sub-contractor's responsibility to ensure airtight joints, junctures, and transitions between materials, products, and assemblies of products specified in the different sections to be installed by the different sub-contractors.

1.7.3 Construction Mock-Up

The Contractor shall build a construction mock-up of every joint, juncture, and transition between materials, products, and assemblies of products specified in the different sections to be installed. Work will not begin until the mock-up is satisfactory to the Contracting Officer.

1.7.4 Coordination with Third Party Audit Agency

The Contractor shall coordinate with the Third Party Audit Agency performing required inspections, tests, and similar services, and provide reasonable auxiliary services as requested. The Contractor shall notify the Third Party Audit Agency sufficiently in advance of operations to permit assignment of personnel. Auxiliary services required include, but are not limited to, the following:

1. Provide access to the Work.
2. Furnish incidental labor and facilities necessary to facilitate inspections and tests.
3. Take adequate quantities of representative samples of materials that require testing or assist the third party audit agency in taking samples.
4. Deliver samples to testing laboratories.
5. Provide security and protection of samples and test equipment at the project site.

1.8 THIRD PARTY AUDIT AGENCY RESPONSIBILITIES

The third party audit agency engaged to perform inspections, sampling, and testing of the air barrier system materials, components, and assemblies specified throughout the different specification sections shall coordinate with the Contractor and the Contracting Officer. The third party audit agency shall notify the Contractor and the Contracting Officer of any irregularities or deficiencies observed in the Work during the performance of its services. The third party audit agency is not authorized to release, revoke, alter, or enlarge the requirements of the Contract

Documents or approve or accept any portion of the Work. The third party audit agency shall not perform any duties of the Contractor.

1.9 AIR BARRIER SYSTEM PERFORMANCE REQUIREMENTS

The air barrier system performance requirements shall comply with this section as follows:

a. Materials: materials used for the air barrier system in the opaque envelope shall have an air permeance not to exceed 0.004 cfm/sqft under a pressure differential of 0.3-inches water gage (1.57psf) (0.02L/s.m2@75Pa) when tested in accordance with ASTM E 2178, and

b. Assemblies: assemblies of materials and components shall have an air permeance not to exceed 0.03 cfm/sqft under a pressure differential of 0.3-inches water gage(1.57psf)(0.15L/s.m2@75Pa) when tested in accordance with ASTM E 1677, and

c. Air Barrier System: the air leakage of the entire building shall meet the requirements as specified in this SECTION.

PART 2 PRODUCTS
2.1 AIR BARRIER SYSTEM

1. Floor Slab On Grade Air/Vapor Barrier:
Specified in Section _____

2. Spray Foam Air/Vapor/Thermal Barrier:
Specified in Section _____

3. Sheet Applied Air/Vapor Barrier:
Specified in Section _____

4.

5.

6.

PART 3 EXECUTION

3.1 REPAIR AND PROTECTION

Repair and protection is the Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing, or sample taking and similar services. Upon completion of inspection, testing, or sample taking and similar services, the Contractor shall repair damaged construction and restore substrates and finishes, protect construction exposed by or for quality control service activities, and protect repaired construction.

3.2 TESTING AND INSPECTION

The following qualitative and quantitative tests and inspections shall be conducted by the Contractor in the presence of the Contracting Officer during installation of the air barrier system.

1. Qualitative Testing and Inspection:

a. Provide a Daily Report of Observations with a copy to the Contracting Officer.

b. Ensure continuity of the air barrier system throughout the building enclosure and that all gaps are covered, the covering is structurally sound, and all penetrations are sealed allowing for no infiltration or exfiltration through the air barrier system.

c. Ensure structural support of the air barrier system to withstand design air pressures.

d. Ensure masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions and mortar droppings, with mortar joints struck flush or as required by the manufacturer of the air barrier material.

e. Ensure site conditions for application temperature, and dryness of substrates are within guidelines.

f. Ensure substrate surfaces are properly primed.

g. Ensure laps in materials are at least a 2-inch minimum, shingled in the correct direction or mastic applied on exposed edges with no fishmouths.

h. Ensure that mastic is applied on cut edges.

i. Ensure that a roller has been used to enhance adhesion.

j. Measure application thickness of liquid applied materials to manufacturer's specifications for the specific substrate.

k. Ensure that the correct materials are installed for compatibility.

l. Ensure proper transitions for change in direction and structural support at gaps.

m. Ensure proper connection between assemblies (membrane and sealants) for cleaning, preparation and priming of surfaces, structural support, integrity and continuity of seal.

2. Quantitative Tests:

a. Provide written test reports of all tests performed with a copy to the Contracting Officer.

b. Determine the bond strength of coatings to substrate in accordance with ASTM D 4541.

3.3 BUILDING AIR TIGHTNESS TEST

Test the building for air tightness. This test is intended to demonstrate that the building construction has produced an effective air barrier so that air infiltration and exfiltration are minimized. An adequate air barrier demands close attention to construction and installation of the

building envelope components. For example, close attention must be paid to all seals, to caulking around window, door, and louver frames, to sealing of joints between panels, to sealing the wall-to-floor interface and especially to sealing the wall-to-roof interface.

a. The test shall be performed when the building envelope is enclosed and prior to the installation of the finished ceilings.

b. The contractor shall notify the Government at least 48 hours prior to the Building Air Tightness Test. A Government representative will witness the test and record test readings.

c. Prior to the test, the contractor shall submit evidence that the test equipment has been calibrated within the past year.

d. The measuring instruments used in the tests shall be digital meters, not analog gages. Tests shall be performed when the wind speed is less than 10 mph, and no rain.

e. The following conditions will be observed in the building during the testing:

(1) All exterior doors and windows shall be closed;
(2) All interior doorways including stairway doors shall be open;
(3) All HVAC systems shall be de-energized;
(4) All appliances shall be de-energized;
(5) All plumbing traps shall be full;
(6) The contractor shall follow the Recommended Test Envelope Conditions in ASTM E 1827, Table 1, for the Closed Envelope condition.

f. The contractor shall first test the building by pressurizing the building positively relative to outdoors at multiple pressures up to at least 0.30 in.w.g. (inches water gauge). From the positive pressure test, the building leakage rate shall be measured in accordance with ASTM E 1827 or ASTM E 779.

g. The contractor shall then perform a negative pressure test at multiple pressures up to at least 0.30 in.w.g. and compare the results to the positive test. Where differences of 10% exist between the tests, the contractor shall investigate the causes and resolve the reasons for the differences. The contractor shall retest the building.

h. The acceptable leakage is [ ] cubic feet per minute maximum at a differential pressure of 0.3 in. w.g. If the building fails to meet the acceptable leakage rate, use techniques described in ASTM E 1186 to located the leak sources, then correct the deficiencies in the building construction, then retest. Fog agents used to identify leaks shall be the non-toxic type.

i. For each test, the contractor shall take a minimum of 5 readings at various pressures and air flows within the range of the calibrated equipment. In the test report, test points shall be shown in graphical form on a log-log scale with pressure in inches water column displayed on the horizontal axis and flow in cfm displayed on the vertical axis. A report shall be submitted for each leak test whether successful or not.

3.4 THERMOGRAPHY TEST

The building envelope shall be tested using Infrared Thermography technology. The thermography testing shall be completed in accordance with the requirements of ASTM C 1060 and ISO 6781. The Contracting Officer shall witness the testing. The contractor shall note any areas of compromise in the building envelope, and shall note all actions taken to correct those areas. The thermography shall be used to demonstrate the problem areas have been corrected.

--End of Section--

SECTION 01 91 00

COMMISSIONING
01/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED	(2002; R 2005) Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

ASSOCIATED AIR BALANCE COUNCIL (AABC)

ACG Commissioning Guideline	(2005) Commissioning Guideline

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB Commissioning Standard	(1999) Procedural Standards for Building Systems Commissioning

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA Commissioning Manual	(1994, 1st Ed) HVAC Systems Commissioning Manual

1.2 DEFINITIONS and Abbreviation's

1.2.1 Abbreviation's

The following are common abbreviations used in the Specifications and in the Commissioning Plan. Definitions are found in Section 1.6.

A/E Architect/Design Engineer(Gov't)	FIO For Information Only
CA Commissioning Authority/Specialist	FT Functional Performance Test
CC Controls Contractor	CG General Contractor (prime)
Cx Commissioning	MC Mechanical Contractor
Cx Plan Commissioning Plan document	PC Prefunctional checklist
EC Electrical Contractor	PM Project Manager(Gov't)
TAB Test and Balance Contractor	Subs Subcontractors to General

1.2.2 Definitions

a. "Basis of design" is the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the design intent. The basis of design describes the systems, components, conditions and methods chosen to meet the intent. Some reiterating of

the design intent may be included.

b. "Commissioning (Cx)" is a comprehensive and systematic process to verify that the building systems perform as designed to meet Government requirements and the design intent.

c. "Commissioning Plan" (Cx Plan) is an overall plan that provides the structure, schedule and coordination planning for the Cx process.

d. "Data logging" records data such as flows, currents, status, and pressures over time using stand-alone data loggers separate from the control system.

e. "Deferred functional tests" are performed after substantial completion, due to partial occupancy, equipment, seasonal requirements, design, or other site conditions that disallow the test from being performed before substantial completion.

f. A "deficiency" is a condition in the installation or function of a component, piece of equipment, or system that is not in compliance with the Contract documents.

g. The "design intent" represents the ideas, concepts, and criteria that are conveyed through the Contract documents.

h. "Factory testing" tests equipment on-site or at the factory by factory personnel.

i. A "functional performance test" (FT) tests the dynamic function and operation of equipment and systems under full operation using manual (direct observation) or monitoring methods. For example, the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint.

j. "Indirect indicators" indicate a response or condition, such as a reading from a control system screen reporting a damper to be 100 percent closed.

k. A "manual test" uses hand-held direct reading instruments, immediate control system readouts, or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the observation).

l. "Nonconformance" means a piece of equipment or a system does not perform properly or comply with the design intent.

m. An "overwritten value" is a sensor value in the building control system that is overridden to see the response of a system. For example, changing the outside air temperature value from 50 degrees F to 75 degrees F to verify economizer operation. See also "simulated signal."

n. "Phased commissioning" is completed in phases (by floors or buildings, for example) due to the size of the structures or other scheduling issues, in order to minimize the total construction time.

o. A "prefunctional checklist" (PC) is a list of items to inspect and elementary component tests to conduct to verify proper installation of

equipment, provided by the Contractor with the assistance of the Commissioning Agent. PCs are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated). However, some PC items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three phase pump motor of a chiller system). PCs augment and are combined with the manufacturer's startup checklist.

p. "Sampling" functionally tests only a fraction of the total number of identical or near identical pieces of equipment.

q. "Seasonal performance tests" are FTs that are deferred until the system(s) will experience conditions closer to their design conditions.

r. "Simulated conditions" are created conditions for the purpose of testing the response of a system (e.g., applying a hair blower to a space sensor to see the response in a VAV box).

s. A "simulated signal" uses a signal generator to send an amperage, resistance or pressure to the transducer and DDC system to simulate a sensor value.

t. "Startup" includes the initial starting or activating of dynamic equipment and executing PCs.

u. "Test requirements" specify what modes, functions, and conditions shall be tested. The test requirements are not the detailed test procedures. The test requirements are specified in the individual sections of the Contract documents.

v. "Trending" uses the building control system for monitoring.

w. The "warranty period" involves the entire project, including equipment components. Warranty begins at substantial completion and extends for at least one year, unless specifically noted otherwise in the Contract documents and accepted submittals.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; The following shall be submitted:

SD-02 Shop Drawings

Commissioning Plan; G

Commissioning Plan prepared in accordance with Commissioning Standard, no later than 28 days after the approval of the Commissioning Specialist.

SD-03 Product Data

Pre-Functional Performance Test Checklists; G

At least 28 days prior to the start of Pre-Functional

Performance Test Checks. Submit the schedule for the test checks at least 14 days prior to the start of Pre-Functional Performance Test Checks.

Functional Performance Tests; G

Test procedures at least 28 days prior to the start of Functional Performance Tests. The schedule for the tests at least 14 days prior to the start of Functional Performance Tests.

SD-07 Certificates

Commissioning Firm; G

Certification of the proposed Commissioning Firm's qualifications by one of the following ACG, NEBB, or TABB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. Include in the documentation the date that the Certification was initially granted and the date when the current Certification expires. Any lapses in Certification of the proposed Commissioning Firm or disciplinary action taken by ACG, NEBB, or TABB against the proposed Commissioning Firm shall be described in detail.

Commissioning Authority; G

Certification of the proposed Commissioning Authority's qualifications by one of the following ACG, NEBB, or TABB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. The documentation shall include the date that the Certification was initially granted and the date when the current Certification expires. Any lapses in Certification of the proposed Commissioning Specialist or disciplinary action taken by ACG, NEBB, or TABB against the proposed Commissioning Authority shall be described in detail.

SD-11 Closeout Submittals

Commissioning Report; G

No later than 14 days after completion of Functional Performance Tests.

1.4 QUALITY ASSURANCE

1.4.1 Commissioning Firm

Provide a Commissioning Firm that is either a member of ACG or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, immediately notify the Contracting Officer and submit another Commissioning Firm for approval. Any firm that has been the subject of disciplinary action by the ACG, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties

related to the HVAC systems, including Commissioning. All work specified in this Section and in other related Sections to be performed by the Commissioning Firm shall be considered invalid if the Commissioning Firm loses its certification prior to Contract completion and must be performed by an approved successor. These Commissioning services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The Commissioning Firm shall be a subcontractor of the prime Contractor and shall be financially and corporately independent of all other subcontractors. The Commissioning Firm shall report to and be paid by the prime Contractor.

1.4.2 Commissioning Authority

1.4.2.1 General

The Commissioning Authority shall be an ACG Certified Commissioning Agent, a NEBB Qualified Commissioning Administrator, or a TABB Certified Commissioning Supervisor and shall be an employee of the approved Commissioning Firm. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Commissioning Specialist loses subject certification during this period, immediately notify the Contracting Officer and submit another Commissioning Specialist for approval. Any individual that has been the subject of disciplinary action by the ACG, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including Commissioning. All work specified in this Section and in other related Sections performed by the Commissioning Specialist shall be considered invalid if the Commissioning Specialist loses his certification prior to Contract completion and must be performed by the approved successor.

1.4.2.2 Responsibilities

Perform all Commissioning work specified herein and in related sections under the direct guidance of the Commissioning Specialist. The Commissioning Specialist shall prepare the Commissioning Plan, which will be a comprehensive schedule and will include all submittal requirements for procedures, notifications, reports and the Commissioning Report. After approval of the Commissioning Plan, revise the schedule to reflect the schedule requirements in the Commissioning Plan.

1.5 DESCRIPTION

The Cx process shall encompass and coordinate system documentation, equipment startup, control system calibration, testing and balancing, performance testing, and training. Cx shall begin in the design phase by documenting the design intent and continue through the construction phase and warranty period with actual verification of performance. Cx shall be completed before substantial completion. Cx does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

1.5.1 Process

The following activities outline the Cx tasks specified in this section and the general order in which they occur. The Commissioning Agent (CA) shall coordinate all activities. The Quality Control System established under Section 01 45 01 USACE Quality Control Shall be maintained.

a. Review design development and construction documents and document the basis of design and design intent.

b. Conduct a scoping meeting to review the Cx process with the Cx team members.

c. Develop a Cx Plan.

d. Schedule additional meetings throughout construction with necessary parties attending, to plan, scope, coordinate, schedule future activities, and resolve problems.

e. Collect equipment documentation during normal submittals, including detailed startup procedures.

f. Review submittals.

g. Develop startup plans, startup documentation formats, and PCs to be completed during the startup process.

h. Perform startup and initial checkout.

i. Develop and execute FT procedures.

j. Correct items of nonconformance in materials, installation, or setup and retest the system.

k. Submit a Deficiency Report and Resolution Record.

l. Review documentation for completeness.

m. Complete and submit the Final Cx Report.

n. Review, pre-approve and coordinate Government personnel training and verify completion.

o. Perform deferred testing as specified and required, including unforeseen deferred tests, seasonal testing, short-term diagnostic testing, and end-of-warranty review.

1.5.2 Written Work Products

The Cx process generates a number of written work products. The Cx Plan shall list all the formal written work products, describe briefly their contents, who is responsible to create them, their due dates, who receives and approves them and the location in the specification to create them. In summary, the written products are:

Product	Developed By	Approved by
Design and document review	CA	PM, A/E
Draft and Final Cx Plan	CA	PM, A/E
Meeting minutes	Contractor	
Cx schedules	Contractor, CA,	
Equipment documentation submittals	Contractor	CA
Sequence clarifications	Contractor	CA
PCs	Contractor with CA assistance	CA, A/E

Product	Developed By	Approved by
Startup and initial checkout plan	Contractor, CA compiles existing documents	CA
Completed startup, initial checkout, and PC forms	Contractor	CA, A/E
TAB Plan	Contractor	CA
Final TAB report	Contractor	CA
Issues log (deficiencies)	CA	PM, A/E
Cx Progress Record	CA	PM, A/E
Deficiency reports	CA	PM, A/E
FT forms	Contractor	CA, PM
Completed FT forms	Contractor	
O&M manual data	Contractor	
Cx record book	CA	
Training Plan	Contractor, CA	
Specific training agendas	Contractor	
Final Cx Report	CA	
Miscellaneous approvals	PM	

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

SD-02 Shop Drawings

SD-11 Closeout Submittals G

Final Cx Report

1.7 SYSTEMS TO BE COMMISSIONED

The following equipment and systems shall be commissioned in accordance with the procedures described in this section.

a. Division 23 systems (all mechanical HVAC Equipment including ductwork and piping, on passive and mechanical systems, and DDC Control)

b. Division 7 Building Air Barrier

c. Division 22 Plumbing systems and technologies (including water collection, treatment, and heating)

d. Division 26 Daylighting systems (including lighting controls)

1.8 COORDINATION

1.8.1 Commissioning Team

The members of the Cx team shall consist of the CA, the CG, the PM, A/E, subcontractors, QC Specialists, Government representative(s) including operation and maintenance (O&M) staff. All members shall work together and with vendors to fulfill their contracted responsibilities and meet the

objectives of the Contract documents and Cx process. The CA shall regularly communicate with all members of the Cx team, keeping them apprised of Cx progress and scheduling changes through memos, progress reports, or other methods of communication.

1.8.2 Cx Schedule

The CA shall work with the CG and the PM to schedule the Cx activities. The CA shall provide the initial schedule of primary events at the Cx scoping meeting. The Draft Cx Plan shall provide a format for this schedule, and both shall be submitted together. The CA shall provide sufficient notice to the CG and the PM for scheduling Cx activities. The Contractor shall integrate all Cx activities into the master schedule. As the construction progresses the CA shall update the Cx schedule with more details. Notify the PM and CA ahead of time when Cx activities not yet performed or not yet scheduled will impact the construction schedule.

1.8.3 Meetings

1.8.3.1 Scoping Meeting

The Cx scoping meeting shall be scheduled by the CA within 90 days of award of the construction Contract. The CA shall plan and conduct the Cx scoping meeting with the entire Cx team in attendance. Meeting minutes shall be distributed to all parties within one week. The agenda shall include a review of each building system to be commissioned, including its intended operation, Cx requirements, and completion and startup schedules. The scope of work, tasks, schedules, deliverables, and responsibilities for implementation of the Cx Plan shall be established. Information gathered from this meeting will allow the CA to update the Cx Plan, which shall also be distributed to all parties.

1.8.3.2 Miscellaneous Meetings

Other meetings will be planned and conducted by the CA as construction progresses. These meetings will cover coordination, deficiency resolution, and planning issues. These meetings shall be held monthly, until the final three months of construction when they shall be held weekly. Cx shall also be discussed in all weekly progress meetings.

1.9 RESPONSIBILITIES

The responsibilities of various parties in the Cx process are as specified. The PM, A/E and CA are not responsible for construction means, methods, job safety, or management function related to Cx on the job site.

1.9.1 CA Responsibilities

The CA is responsible for writing and verification of compliance with the Cx Plan and the preparation of Cx checklists and reports. This shall involve coordinating and directing the Cx activities in a logical, sequential, and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules, and technical expertise. All submittals applicable to systems being commissioned shall be reviewed and evaluated by the CA for compliance with Cx needs and the Contract documents. The CA shall ensure proper

coordination and submission of all documents. During construction, the CA shall perform site visits as necessary to observe component and system installations; attend selected planning and job-site meetings to obtain information on construction progress; review construction meeting minutes for potential revisions or substitutions related to the Cx process; and assist in resolving any discrepancies.

1.9.2 Contractor Responsibilities

During construction, the CG shall maintain as-built red-line drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. These drawings shall be updated after completion of Cx (excluding deferred testing).

1.10 COMMISSIONING PLAN

The CA shall develop a Draft Cx Plan to identify how Cx activities will be integrated into general construction and trade activities. Various templates are available on the PECI website. The Plan shall identify how Cx responsibilities are distributed. The Specifications will take precedence over the Cx Plan in the event of conflicting requirements between the two. The Cx Plan shall include the following components:

a. A brief overview of the Cx process, including goals, objectives, and general project information.

b. A list of systems to be commissioned.

c. Identification of Cx participants and responsibilities.

d. A description of the management, communication, and reporting of the Cx Plan.

e. An outline of the Cx process scope including:

1. Documentation of basis of design and design intent.

2. Startup and testing procedures, including sampling procedures.

3. Observation procedures. Provide copy of applicable section of QC Plan. Highlight the requirements for verification of the correct installation of all systems.

4. System performance verification.

5. Submittal review procedures. Provide a copy of Section VI of the QC Plan.

6. O&M documentation. Describe the information to be provided to the client as required by Contract under operation and maintenance data.

7. Training activities. Provide a copy of Section within the QC Plan.

8. Warranty period activities.

f. A list and description of the written work products, as specified in the paragraph Written Work Products.

g. An activity schedule.

h. A description of the rigor, scope, and procedures of testing and acceptance. Provide a copy of applicable section of the QC Plan.

The Draft Cx Plan shall be submitted to the PM before the scoping meeting. Within 30 days after the initial Cx scoping meeting the CA shall update and submit the Draft Cx Plan for PM and A/E final review and approval. The CA shall adjust the Draft Cx Plan as required and submit as the Final Cx Plan prior to commencement of work. The Final Cx Plan shall include specific scheduling of required testing procedures for commissioned equipment and systems. A Commissioning Agent Certification Letter signed by the CA shall be submitted, certifying the Cx Plan has been successfully executed and the design intent of the facility has been achieved.

1.11 CX TEAM TRAINING

The CG shall provide training according to a written training plan to Cx team members as determined by the CA prior to commencement of construction. The first training session shall describe the overall system design concept and the design concept of each equipment section. This presentation shall include a review of systems using the simplified system schematics (one-line drawings) including chilled water systems, condenser water or heat rejection systems, heating systems, fuel oil and gas supply systems, supply air systems, exhaust systems, and/or outside air strategies, as determined by the CA. For the primary HVAC equipment, the CG shall provide a short discussion of the control of the equipment during the mechanical or electrical training. One training session shall include a presentation discussing the use of the blank FT forms for recommissioning equipment.

1.12 COMMISSIONED EQUIPMENT DATA

The CA shall request in writing from the CG specific information needed about each piece of commissioned equipment or system to fulfill requirements of the Cx Plan, and shall review and evaluate this information for compliance with Cx needs, in accordance with this section and specification Section addressing SUBMITTAL PROCEDURES. This information shall include normal cut sheets; addenda; change orders; full details of any required testing; full factory testing reports, if any. In addition, the installation, startup, and checkout materials that are shipped inside the equipment and the actual field checkout forms to be used by the factory or field technicians shall be submitted to the CA. The CA may request further documentation as necessary for the Cx process. Any request for additional data shall be made prior to receipt of normal submittal data from equipment manufacturers. This information is to be used in the Cx process prior to the regular formal O&M manual submittals, and shall be compiled and maintained in a building systems book to be included in the O&M manuals.

1.13 REPORTING

The CA shall provide Cx progress reports monthly to the PM and Cx team, with increasing frequency as construction and Cx progress. Sample standard forms shall be provided and referenced in the Cx Plan. Example standard

forms are available for reference in Appendix B and on the PECI website. Testing or review approvals and nonconformance and deficiency reports shall be made regularly.

1.13.1 Cx Report

The CA shall compile a Cx Report focusing on evaluating Cx process issues, and provide four copies to the PM within 30 days after occupancy. The report shall summarize all of the tasks, findings, conclusions, and recommendations of the Cx process. A list of participants and roles, brief building description, overview of Cx and testing scope, and general description of testing and verification methods shall be included. The CA shall provide the following for each piece of equipment:

a. Assessment of how the equipment meets the specifications and design intent.

b. Equipment installation verification.

c. O&M documentation evaluation.

d. Operator training evaluation.

e. Assessment of the value of the Cx process.

Specifically list all outstanding nonconformance items. Each nonconformance issue shall be referenced to the specific item where the deficiency is documented. List any uncorrected compromises in the environmentally responsive features. List recommendations such as improvements to equipment or operations, future actions including testing justified by seasonal conditions, or Cx process changes. Include a brief description of the verification method used and observations and conclusions from the testing of each piece of equipment. All acquired Cx documentation, including completed FTs, logs, minutes, reports, deficiency lists, communications, findings, and unresolved issues, shall be compiled in appendices and provided with the Cx Report.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

Equipment shall be maintained in good repair and operational condition throughout the duration of use on this project.

2.1.1 Equipment Provisions

The CG shall provide all test equipment necessary to perform startup and initial checkout and required FT. Special equipment, tools and instruments available only from the vendor, specific to a piece of equipment, and required for testing equipment shall be turned over to the PM after testing has been completed.

2.1.2 Equipment Calibration

All testing equipment shall be of sufficient quality and accuracy to test and measure system performance within the tolerances specified. Unless otherwise noted, the following minimum requirements apply. Temperature

sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.9 degrees F and a resolution of plus or minus 0.2 degrees F. Pressure sensors shall have an accuracy of plus or minus 2.0 percent of the value range being measured (not the full range of the meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available. Calibration documentation of all testing equipment shall be turned in with each testing episode. Serial numbers of equipment and standards used for QC, zeroing, and calibration shall be included.

PART 3 EXECUTION

3.1 STARTUP AND PREFUNCTIONAL CHECKOUT

Each piece of equipment or system to be commissioned shall receive a full prefunctional checkout. No sampling strategies shall be used. Equipment shall not be temporarily started for Cx.

3.1.1 Responsibilities

The CG has startup responsibility and shall complete systems and subsystems so they are fully functional and meeting the design objectives of the Contract documents. The Cx procedures and FT do not relieve or lessen this responsibility or shift that responsibility partially to the CA or the Government. Parties responsible for PC execution and startup shall be identified in the Cx scoping meeting and in the PCs.

3.1.2 Startup and Checkout Plan

The CA shall assist the CG in developing PCs and detailed startup plans for all equipment. The primary role of the CA in this process is to witness and ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.

3.1.2.1 PCs

The PCs shall indicate required procedures to be executed as part of startup and prefunctional checkout of the systems. The CG shall determine which trade is responsible for executing and documenting each of the line item tasks and note that trade on the PC. Each task may have more than one trade responsible for its execution.

3.1.2.2 Startup

The CG shall develop the full startup plan and submit the plan to the CA PM and A/E for review and approval. The CA PM and A/E shall review and evaluate the procedures and the procedure documentation format, noting any procedures that need to be revised or added. The plan shall contain a minimum of the following:

a. PCs.

b. The manufacturer's standard written startup procedures copied from the installation manuals with check boxes by each procedure and a summary statement with a signature block added at the end.

c. The manufacturer's field checkout sheets.

3.1.3 Execution of PCs and Startup

Four weeks prior to startup, the CG shall schedule startup and checkout activities with the Contracting Officer and CA. The performance of the PCs, startup, and checkout shall be directed and executed by the CG and witnessed by the CA. The CG shall provide skilled technicians to execute starting of equipment and shall ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments, and problem-solving. The CA and PM representative shall observe the procedures for each piece of equipment.

3.1.4 Documentation

After startup completion, the CG shall provide the CA with a signed and dated copy of the completed startup and prefunctional tests and checklists. Only individuals that have direct knowledge and witnessed that a line item task on the PC was actually performed shall initial or check that item off. Witnessing supervisors shall not fill out these forms.

3.1.5 Nonconformance and Approval in PCs and Startup

The CG shall clearly list any outstanding items of the startup and prefunctional procedures that were not completed successfully at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies shall be provided to the PM and the CA within two days of test completion. The CA shall review the report and submit either a nonconformance report or an approval form to the PM. The CA shall work with the CG to correct and retest deficiencies or uncompleted items. The CA will involve the PM and others as necessary. The CG shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CA as soon as outstanding items have been corrected and resubmit an updated startup report and a Statement of Correction on the original nonconformance report. When satisfactorily completed, the CA shall recommend approval of the execution of the PCs and startup of each system to the PM using a standard form.

3.1.6 Phased Commissioning

The project may require startup and initial checkout to be executed in phases. This phasing shall be planned and scheduled in a coordination meeting of the CA, PM, and the CG. Results will be added to the master and Cx schedule.

3.2 SENSOR AND ACTUATOR CALIBRATION

All field-installed temperature, relative humidity, CO2 and pressure sensors and gages, and actuators (dampers and valves) on all equipment shall be calibrated. Test instruments shall have had a certified calibration within the last 12 months. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated. Procedures used shall be fully documented on the PCs or other suitable forms, along with written documentation of initial, intermediate and final results.

3.2.1 Calibration Methods

Alternate methods may be used, if approved by the Government beforehand.

3.2.1.1 All Sensors

The CG shall verify that all sensor locations are appropriate and away from causes of erratic operation. Verify that sensors with shielded cables are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, verify they are reading within 0.4 degrees F of each other for temperature and within a tolerance of each other equal to two percent of the reading for pressure. Tolerances for critical applications may be tighter.

3.2.1.2 Sensors Without Transmitters

Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage, or building automation system (BAS)) is within the tolerances listed in the table below in paragraph Tolerances, Standard Applications of the instrument-measured value. If not, install offset in BAS, calibrate, or replace sensor.

3.2.1.3 Sensors With Transmitters

Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the BAS. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship, and P/I reaction. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage, or BAS) is within the tolerances listed in the table below in paragraph Tolerances, Standard Applications of the instrument-measured value. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

3.2.2 Tolerances, Standard Applications

Sensor	Required Tolerance (+/-)
Cooling coil, chilled and condenser water temps	0.7 F
Flow rates, water	4% of design
Relative humidity	4% of design
AHU wet bulb or dew point	3.6 F
Combustion flue temps	9.0 F
Hot water coil and boiler water temp	2.7 F
Oxygen or CO2 monitor	0.1% pts
Outside air, space air, duct air temps	0.7 F
CO monitor	0.01% pts
Watt-hour, voltage & amperage	1% of design
Natural gas and oil flow rate	1% of design
Pressures, air, water and gas	3% of design
Steam flow rate	3% of design
Flow rates, air	10% of design

Sensor	Required Tolerance
Barometric pressure	1.0 inch of Hg

3.2.3 Valve and Damper Stroke Setup and Check

3.2.3.1 EMS Readout

For all damper actuator positions checked, verify the actual position against the BAS readout. Set pumps or fans to normal operating mode. Command damper closed, visually verify that damper is closed and adjust output zero signal as required. Command damper open, verify position is full open and adjust output signal as required. Command damper to three intermediate positions. If actual damper position doesn't reasonably correspond, replace actuator.

3.3 CONTROLS

Controls shall be tested and verified after startup and prefunctional checkout and after sensor and actuator calibration, as specified here and in Section Specification Section 23. The CG shall be responsible for Cx activities related to controls. Before initial startup, the CG shall gather and review the current control sequences and interlocks and with the CA write detailed testing procedures.

3.3.1 Control Drawings

Submit control drawings that include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications.

3.3.1.1 Content

Drawings shall include:

a. An overview narrative of the system (one or two paragraphs) generally describing system purpose, components, and function.

b. All interactions and interlocks with other systems.

c. Detailed delineation of control between any packaged controls and the BAS, listing what points the BAS monitors only and what BAS points are control points and are adjustable.

d. Written sequences of control for packaged controlled equipment.

e. Startup sequences.

f. Warm-up mode sequences.

g. Normal operating mode sequences.

h. Unoccupied mode sequences.

i. Shutdown sequences.

j. Capacity control sequences and equipment staging.

k. Temperature and pressure control (e.g., setbacks, setups, resets).

l. Detailed sequences for all control strategies (e.g., economizer control, optimum start/stop, staging, optimization, demand limiting).

m. Effects of power or equipment failure with all standby component functions.

n. Sequences for all alarms and emergency shut downs.

o. Seasonal operational differences and recommendations.

p. Initial and recommended values for all adjustable settings, setpoints, and parameters that are typically set or adjusted by operating staff. Include any other control settings, fixed values, or delays that will be useful during testing and operating the equipment.

q. Schedules, if known.

3.3.1.2 Format

To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered. The control drawings shall have a key to all abbreviations, and shall contain graphic schematic depictions of the systems and each component. The schematics shall include the system and component layout of any equipment that the building control system monitors, enables, or controls, including equipment primarily controlled by packaged or integral controls. Provide a full points list with the following included as a minimum for each point:

a. Controlled system

b. Point abbreviation

c. Point description (e.g., DB temp, airflow)

d. Display unit

e. Control point or setpoint (Yes / No) (Point that controls equipment and can have its setpoint changed)

f. Monitoring point (Yes / No) (Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification)

g. Intermediate point (Yes / No) (Point whose value is used to make a calculation which then controls equipment; e.g., space temperatures that are averaged to a virtual point to control reset)

h. Calculated point (Yes / No) ("Virtual" point generated from calculations of other point values)

The CG keep the PM, A/E and the CA informed of all changes to this list during programming and setup. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls

O&M manual submittal, as specified in Division 01 of Specifications.

3.3.2 Controls Initial Checkout

Indicate what tests on what systems should be completed prior to TAB using the building control system for TAB work. Coordinate with the CA, PM and TAB contractor for this determination. Provide a signed and dated certification to the CA and PM upon completion of the checkout of each controlled device, equipment, and system prior to FT for each piece of equipment or system, that all system programming is complete with reference to all aspects of the Contract documents, except FT requirements. Beyond the control points necessary to execute all documented control sequences, provide monitoring, control, and virtual points as specified. List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air, water, and building pressure). The CG shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout, and adjust the building control system prior to FT. At a minimum, the plan shall include for each type of equipment controlled by automatic controls:

a. System name.

b. List of devices.

c. Step-by-step procedures for testing each controller after installation, including:

1. Process of verifying proper hardware and wiring installation.

2. Process of downloading programs to local controllers and verifying that they are addressed correctly.

3. Process of performing operational checks of each controlled component.

4. Plan and process for calibrating valve and damper actuators and all sensors.

5. A description of the expected field adjustments for transmitters, controllers, and control actuators should control responses fall outside of expected values.

d. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.

e. A description of the instrumentation required for testing.

3.3.3 Controls FT

The CA shall assist the CG in executing controls testing. Using a skilled technician who is familiar with this building, execute the FT of the controls system as specified for the controls contractor in Section Section 23 09 23 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS.

Execute all control system trend logs specified in Section 23 09 23 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS Section 23 09 23 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS. The building control system shall be sufficiently tested and approved by the CA and the PM before it is used for TAB or to verify performance of other components or systems.

3.4 TAB

TAB shall be completed after controls are tested, checked out, and adjusted. The CG shall be responsible for TAB preparation and activities, as specified here and in Section 23 05 93.00 10 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.4.1 TAB Plan

Six weeks prior to starting TAB, submit an outline of the TAB plan and approach for each system and component to the CA, PM, and the controls contractor. This plan shall be developed after the TAB contractor has some familiarity with the building control system, and shall be reviewed by the CA. The TAB contractor shall review the TAB plan to determine the capabilities of the building control system toward completing TAB. The submitted plan shall include:

a. Certification that the TAB contractor has reviewed the construction documents and the systems with the CG to sufficiently understand the design intent for each system.

b. An explanation of the intended use of the building control system. The controls contractor will comment on feasibility of the plan.

c. Field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted, and balanced with the data cells to be gathered for each.

d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.

e. Final test report forms to be used.

f. Detailed step-by-step procedures for TAB work for each system and issue (e.g., terminal flow calibration for each terminal type, diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions). Criteria for using air flow straighteners or relocating flow stations and sensors shall be discussed. Provide the analogous explanations for the water side.

g. List of all air flow, water flow, sound level, system capacity, and efficiency measurements to be performed and a description of specific test procedures, parameters, and formulas to be used.

h. Details of how total flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pilot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic.).

i. Identification and types of measurement instruments to be used and their most recent calibration date.

j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.

k. Confirmation that the TAB contractor understands the outside air ventilation criteria under all conditions.

l. Details of whether and how minimum outside air infiltration will be verified and set, and for what level (e.g., total building, zone).

m. Details of how building static and exhaust fan/relief damper capacity will be checked.

n. Proposed selection points for sound measurements and sound measurement methods.

o. Details of methods for making any specified coil or other system plant capacity measurements.

p. Details of any TAB work to be done in phases (e.g., by floor, by building).

q. Details regarding specified deferred or seasonal TAB work.

r. Details of any specified false loading of systems to complete TAB work.

s. Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.

t. Details of any required interstitial cavity differential pressure measurements and calculations.

u. Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests, and lists of completed tests (scope and frequency).

v. Plan for formal progress reports (scope and frequency).

w. Plan for formal deficiency reports (scope, frequency, and distribution).

3.4.2 Scheduling

Prepare a preliminary schedule for Division 23 pipe and duct system testing, flushing, cleaning, equipment startup, and TAB start and completion for use by the CA. Update the schedule as appropriate, and notify the PM and CA prior to the start of each activity.

3.4.3 Preparation

Meet with the TAB contractor prior to beginning TAB. Provide the TAB contractor any needed unique instruments for setting terminal unit boxes and instructions for their use; for instance, handheld control system

interface for use around the building during TAB. For a given system, have required PCs, calibrations, startup, and selected FTs completed and approved by the CA prior to TAB. Install a P/T plug at each water sensor that is an input point to the control system. List and clearly identify on the as-built drawings the locations of all air-flow stations. Provide test holes in ducts and plenums where directed by the TAB contractor to allow air measurements and air balancing, providing an approved plug. Provide temperature and pressure taps according to the Contract documents for TAB and Cx testing. Provide sufficient FT of the HVAC control system and evaluate its use for TAB before TAB is executed. Put all HVAC equipment and systems into operation and continue the operation during each working day of TAB and Cx, as required.

3.4.4 TAB Execution

Provide a qualified technician to operate the controls to assist the TAB contractor in performing TAB, or provide sufficient training for the TAB contractor to operate the system without assistance. The CA shall witness the HVAC piping test and flushing procedures and the ductwork testing and cleaning procedures, sufficiently to be confident that proper procedures are followed. Testing results shall be documented and copies provided to include in the O&M manuals. Notify the PM of any deficiencies in results or procedures. The CA shall evaluate air and water systems balancing by initiating spot testing, by reviewing completed reports, and by selected site observation. Air and water TAB shall be completed with discrepancies and problems remedied before FT of the respective air- or water-related systems.

3.4.5 TAB Reports

A running log of events and issues shall be kept by the TAB contractor. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests, and lists of completed tests to the CA and PM a minimum of twice a week. Communicate in writing to the controls contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the building control system setup and operation. Provide a draft TAB report to the CA within two weeks of TAB completion. The report shall contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. Provide the CA and PM with any requested data gathered but not shown on the draft reports. Provide a final TAB report with details for CA review and PM and A/E approval.

3.5 FUNCTIONAL PERFORMANCE TESTING

The CA shall direct, witness, and document the FT of all equipment and systems. The CG shall execute the tests with skilled technicians provided under the direction of the CA. Systems shall be tested under all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, full range of part- and full-load) and under abnormal modes and conditions (power failure, interlocks with other equipment, alarms, no flow, equipment failure). The CG shall verify that systems are run through all the building control system's sequences of operation, and components shall be verified to be responding as the sequences state. The CA shall assist the CG to develop the FT procedures in a sequential written form, and coordinate, oversee, and document the actual testing.

3.5.1 Development of Test Procedures

Before test procedures are written, the CG shall obtain all requested documentation regarding equipment sequence of operation and testing procedures, including procedures for equipment installed by factory representatives and a current list of change orders affecting equipment or systems. The change orders shall include an updated points list, program code, control sequences, and parameters. Using the testing parameters and requirements found in the technical sections manufacturer's recommendations of commissioned equipment and systems the CG shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. The CG shall assist the CA in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings, or equipment documentation is not sufficient for writing detailed testing procedures. Prior to execution, the CG shall provide a copy of the test procedures to the CA who shall review the tests for feasibility, safety, equipment operation, sequences, and warranty protection. The test procedure forms shall include the following, at a minimum:

a. System and equipment or component name(s) and configuration(s).

b. Equipment location and ID number.

c. Unique test ID number, and reference to unique PC and startup documentation ID numbers.

d. Date.

e. Project name.

f. Participating parties.

g. A copy of the section describing the test requirements.

h. A copy of the specific sequence of operations or other specified parameters being verified.

i. Formulas used in any calculations.

j. Required pre-test field measurements.

k. Instructions for setting up the test, including special cautions, alarm limits, or other equipment-specific information.

l. Specific step-by-step procedures to execute the test in a clear, sequential, and repeatable format.

m. Acceptance criteria of proper performance with a Yes / No check box to allow for clear marking of whether or not proper performance of each part of the test was achieved.

n. A section for comments.

o. Signature and date blocks for the CA, Contractor, PM and A/E.

3.5.2 Test Methods

3.5.2.1 Functional Performance

FT and verification shall be achieved by manual testing or by monitoring the performance and analyzing the results using the energy management control system's trend log capabilities or by stand-alone data loggers. A combination of methods may be required to test the complete sequence of operations. The A/E and CA shall determine which method, or combination of methods, is most appropriate for tests that do not have a method specified. The CG shall provide FT of commissioned equipment and systems. CA and A/E shall analyze any functional performance trend logs and monitoring data to verify performance, and witness and evaluate manual FTs performed by the CG. The CG shall assist the CA in interpreting the monitoring data, as necessary.

3.5.2.2 Simulated Conditions

Simulating conditions (not by an overwritten value) shall be allowed only when timing the testing to experience actual conditions is not practical. Sensors, transducers, and devices shall have been calibrated before simulating conditions.

3.5.2.3 Overwritten Values

Overwriting sensor values to simulate a condition shall be allowed only when simulating conditions in other ways is not practical, and shall be used with caution. Sensors, transducers and devices shall have been calibrated before overwriting values.

3.5.2.4 Altering Setpoints

Altering setpoints to test a sequence is an acceptable alternative to overwriting sensor values when simulating conditions in other ways is not practical.

3.5.2.5 Indirect Indicators

Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the building control system represent actual conditions and responses. Much of this verification shall be completed during prefunctional testing.

3.5.2.6 Setup

Each function and test shall be performed under conditions that simulate actual conditions as close as possible. The CG shall provide materials, system modifications, and other necessities to produce the flows, pressures, temperatures, or other values necessary to execute the test according to the specified conditions. Where equipment requires integral safety devices to stop or prevent equipment operation unless minimum safety standards or conditions are met, FT procedures shall demonstrate the actual performance of safety shutoffs in real or closely-simulated conditions of failure. At completion of the test, the CG shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test conditions.

3.5.3 Coordination and Scheduling

FT shall be performed after PCs, startup, calibration, and TAB are complete for a given system. The CA shall schedule FTs through the CG and PM. Testing shall proceed from components to subsystems to systems; when the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems shall be checked.

3.5.4 Documentation

The CA shall document the results of all FTs using the specific test procedure forms developed by the CA for that purpose. The CG shall submit copies of the completed forms with the O&M manual data and as part of the Cx Report.

3.6 NONCONFORMANCE

Every effort shall be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. Nonconformance and deficiencies observed in materials, installation, or operation shall be addressed immediately, in terms of notification to responsible parties, and providing recommended actions to correct deficiencies. The CG shall have responsibility for resolving construction deficiencies, and the CA shall assist with problem solving as necessary. If a design revision is deemed necessary and approved by the PM, the designer shall have responsibility for providing design revision. The CA shall maintain a master deficiency and resolution log, and shall provide the PM with written progress reports and test results with recommended actions.

3.6.1 Procedure

All deficiencies or nonconformance issues shall be noted and reported to the PM on a standard nonconformance form. The CG shall report in writing to the CA and PM weekly, or at a minimum as often as Cx meetings are being scheduled, concerning the status of each apparent outstanding discrepancy identified during Cx. The report shall include explanations of any disagreements and proposals for their resolution, and a copy shall be included in the deficiency report and resolution record. Corrections of minor deficiencies may be made during the tests at the discretion of the CA, and the deficiency and resolution shall be documented on the test procedure form.

3.6.1.1 Non-Disputed Deficiencies

When a deficiency is identified, the CA shall discuss the issue with the CG. When there is no dispute on the deficiency and the CG accepts responsibility to correct it, the CA shall document the deficiency, the adjustments or alterations required to correct it, and the CG's response and intentions. The next test or sequence may then be performed. After the day's work, the CA shall submit all the nonconformance reports to the PM for signature. Copies shall be provided to the CG and PM. The CG shall correct the deficiency, sign the statement of correction at the bottom of the nonconformance form certifying that the equipment is ready to be retested and shall send it back to the CA. The CA shall reschedule the test and the test shall be repeated as specified in the paragraph Retesting.

3.6.1.2 Disputed Deficiencies

If there is a dispute about a deficiency, regarding whether it is a

deficiency or who is responsible, the deficiency shall be documented on the nonconformance form with the CG's response and a copy given to the PM and CG. Resolutions shall be made at the lowest management level possible. Additional parties shall be brought into the discussions as needed. Final interpretive and acceptance authority is with the PM. The CA shall document the resolution process. Once the interpretation and resolution have been decided, the CG shall correct the deficiency, sign the statement of correction on the nonconformance form and provide it to the CA. The CA shall reschedule the test and the test shall be repeated as specified in the paragraph Retesting.

3.6.2 Retesting

The cost to retest a prefunctional test or FT shall be solely the responsibility of the CG. Any required retesting by the CG shall not be considered a justified reason for a claim of delay or for a time extension by the CG. The CA and PM representative shall witness retesting as necessary until satisfactory performance is achieved.

3.6.3 Failure Due to Manufacturer Defect

If the greater of 10 percent of, or three, identical pieces of equipment (size alone does not constitute a difference) fail to perform to the Contract documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the PM. In such case, the CG shall provide the PM with the following:

a. Within one week of notification from the PM, the CG or manufacturer's representative shall examine all other identical units making a record of the findings.

b. Within two weeks of the original notification, the CG or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation. The PM shall determine whether a replacement of all identical units or a repair is acceptable.

c. Two examples of the proposed solution shall be installed by the CG and the PM shall be allowed to test the installations for up to one week, upon which the PM will decide whether to accept the solution.

d. Upon acceptance, the CG and manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

3.6.4 Deficiency Report and Resolution Record

The CA shall submit original nonconformance forms with the deficiency report and resolution record at the end of the project. The deficiency report and resolution record shall contain documented items of nonconformance in materials, installation, or operation, including the master deficiency and resolution log, and documented results from startup, PCs, FT, and short-term diagnostic monitoring, as specified. Details of

the components or systems found to be noncompliant with the drawings and specifications shall be included. Adjustments and alterations performed or required to correct the deficiencies and the responsible parties shall be identified.

3.7 DEFERRED TESTING

3.7.1 Unforeseen Deferred Tests

If any check or test cannot be completed due to the building structure, required occupancy condition, or other deficiency, a request for delay execution of checklists and FT may be delayed contingent on approval of the PM. These tests shall be conducted as soon as possible in the same manner as seasonal testing.

3.7.2 Seasonal Testing

The CA shall schedule, coordinate, and observe additional testing for seasonal variation in operations and control strategies during the opposite season to verify performance of the HVAC system and controls. The CG shall execute and document tests and correct deficiencies with facilities staff and the CA and PM witnessing. Testing shall be completed during the warranty period to fully test all sequences of operation. The CG shall make necessary revisions to O&M manuals and records due to the testing.

3.7.3 Short-Term Diagnostic Testing

After initial occupancy, the CG shall perform short-term diagnostic testing, using data acquisition equipment or the building automation system to record system operation over a two- to three-week period. The dynamic interactions between components in the building system shall be investigated. The scheduling, interaction between heating and cooling, and effectiveness of the HVAC system in meeting the comfort requirements a design conditions shall be evaluated. The CG shall document tests and findings, and correct deficiencies according to the original testing requirements.

3.8 REVIEW AND APPROVAL

The CA shall validate that the testing requirements of this Contract are accomplished, and shall note each satisfactorily demonstrated function on the test form. Formal approval of the FT shall be made after review by the A/E, CA and PM. The CA shall evaluate each test and report to the PM and A/E using a standard form. The PM and A/E shall give final approval on each test using the same form, and provide signed copies to the CA and the CG.

-- End of Section --

US Army Corps of Engineers®
Engineer Research and Development Center

U.S. Army Corps of Engineers Air Leakage Test Protocol for Measuring Air Leakage in Buildings

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1 Introduction

The 2005 Energy Policy Act requires that Federal facilities be built to achieve at least 30 percent energy savings over the 2004 American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 90.1-2004. The U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) of the U.S. Army Corps of Engineers (USACE), in collaboration with Headquarters, USACE and centers of standardization for respective building types, the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL), and the ad hoc ASHRAE Military Technology Group has developed design guides to help U.S. Department of Defense (DOD) facilities achieve at least 30 percent energy savings over a baseline built to the minimum requirements of the ASHRAE Standard 90.1-2004 for new buildings to be constructed under the Military Transformation Program.

The design guides were completed in 2007 and 2008, and pertain to building types that include barracks ("Unaccompanied Enlisted Personnel Housing," or UEPH), trainee barracks, administrative buildings (e.g., a battalion headquarters, a company operation facility), a maintenance facility, a dining facility, a child development center, and an Army reserve center.

Among the major factors contributing to mold prevention and reduced energy use in all climate zones is air leakage through the building envelope. Over the past several years, ERDC-CERL has conducted building envelope leakage tests on existing facilities to gain a better understanding of the general leakiness of Army buildings, and to analyze the effect of increased air tightness on building energy consumption, and to develop air tightness criteria and performance requirements to include in design/construction strategies.

Based on the results of these studies USACE set a requirement that all new buildings and buildings undergoing major renovation shall pass an air leakage test, the results of which must be less than or equal to 0.25 CFM/sq ft of exterior envelope at 0.3 in. of water gage (75 Pa) pressure difference. The test is to be performed as outlined in the protocol developed by ERDC-CERL together with industrial partners. Depending on the climate, the total building energy cost savings due to improved building air tightness can range from 5 to 25 percent.

Since introduction of the requirements to air barrier and a maximum allowable air leakage rate, several Army buildings were constructed and tested for air tightness. Some of them were proven to have an air leakage rate between 0.16 and 0.25 CFM/sq ft at a pressure difference of 0.3 inches of water gage (75Pa). Few buildings have to be sealed and re-tested to meet these requirements. This experience has shown that, when buildings are designed and constructed with attention to details, they can meet U.S. Army requirements for air tightness with only a minimal cost increase (due primarily for development of architectural details and testing).

2 USACE Requirements For Building Air Tightness

The following sections outline USACE requirements for building air tightness and building air leakage testing for new Army construction:

2.1 Building Air Tightness Requirement

Design and construct the building envelopes of office buildings, office portions of mixed office and open space (e.g., company operations facilities), dining, barracks and instructional/training facilities with a continuous air barrier to control air leakage into (or out of) the conditioned space. Clearly identify all air barrier components of each envelope assembly on construction documents and detail the joints, interconnections and penetrations of the air barrier components. Clearly identify the boundary limits of the building air barriers, and of the zone or zones to be tested for building air tightness on the drawings.

Trace a continuous plane of air tightness throughout the building envelope and make flexible and seal all moving joints. The air barrier material(s) must have an air permeance not to exceed 0.004 CFM/sq ft at 0.3 in. wg [0.02 L/s.m^2 @ 75 Pa] when tested in accordance with American Society for Testing and Materials (ASTM) E 2178. Join and seal the air barrier material of each assembly in a flexible manner to the air barrier material of adjacent assemblies, allowing for the relative movement of these assemblies and components.

Support the air barrier so as to withstand the maximum positive and negative air pressure to be placed on the building without displacement, or damage, and transfer the load to the structure. Seal all penetrations of the air barrier. If any unavoidable penetrations of the air barrier by electrical boxes or conduit, plumbing, and other assemblies are not air tight, make them air tight by sealing the assembly and the interface between the assembly and the air barrier or by extending the air barrier over the assembly. The air barrier must be durable to last the anticipated service life of the assembly. Do not install lighting fixtures with ventilation holes through the air barrier

Provide a motorized damper in the closed position and connected to the fire alarm system to open on call and fail in the open position for any fixed open louvers such as at elevator shafts. Damper and control to close all ventilation or make-up air intakes and exhausts, atrium smoke exhausts and intakes, etc when leakage can occur during inactive periods. Compartmentalize garages under buildings by providing air-tight vestibules at building access points. Provide air-tight vestibules at building entrances with high traffic.

Compartmentalize spaces under negative pressure such as boiler rooms and provide make-up air for combustion.

2.2 Building Air Leakage Testing – Performance Requirement and Substation:

1. Submit the qualifications and experience of the testing entity for approval.
2. Demonstrate performance of the continuous air barrier for the building envelope by the following tests:
   a. Test the completed building and demonstrate that the air leakage rate of the building envelope does not exceed 0.25CFM/sq ft at a pressure differential of 0.3 in. wag (75 Pa) in accordance with ASTM E- 779 (2003) or E- 1827-96 (2002). Accomplish tests using BOTH pressurization and depressurization. Divide the average measured air leakage flow rate in both directions in CFM @ 0.3 in. wag (L/s @ 75 Pa) by the surface area of the envelope enclosed by the continuous air barrier of the building, including roof or ceiling, walls and floor to produce the air leakage rate in CFM/sq ft @ 0.3 in. wag (L/s.m2 @ 75 Pa). Do not test the building until verifying that the continuous air barrier is in place and installed without failures in accordance with installation instructions so that repairs to the continuous air barrier, if needed to comply with the required air leakage rate, can be done in a timely manner.
   b. Test the completed building using Infrared Thermography testing. Use infrared cameras with a resolution of 0.1 °C or better. Perform testing on the building envelope in accordance with International Organization for Standardization (ISO) 6781:1983 and ASTM C1060-90(1997). Determine air leakage pathways using ASTM E 1186-03 Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier

Systems, and perform corrective work as necessary to achieve the whole building air leakage rate specified in (a.) above.

c. Notify the Government at least 3 working days before the tests to provide the Government the opportunity to witness the tests. Provide the Government written test results confirming the results of all tests.

Existing buildings undergoing major renovations (especially the ones located in cold or hot and humid climates) shall be sealed to the same standard as newly constructed ones.

3 Specifier and Witness Guidance

3.1 Application and Scope

Use this Guide to gain a general understanding of the air leakage test, how it should be specified, and how to monitor whether the air leakage test has been properly performed. This air leakage test specification and the required pass/fail result must be applied to the entire exterior enclosure area as a single entity. See the included glossary (p 26) for definitions. In many circumstances, it is useful (but not currently required) to isolate components such as individual walls or floors to diagnose more closely the source of air leakage. In the future, individual components such as horizontal floor slabs may have their own more stringent requirements, but for now, only the air leakage of the entire exterior envelope is measured.

The architect or design engineer is responsible for defining the bounds of the enclosure and for calculating its surface area to be used in the results calculation. The surface area will include the floor, walls/fenestrations, and roof/ceiling. This enclosure is often the "exterior envelope" of the building, but does not always include all exterior walls. Of interest is the functional "air barrier" for the enclosure under test, which may not be the exterior envelope. For example, heating, ventilating, and air-conditioning (HVAC) rooms with large louvers open to outdoors, laundry rooms with dampers opening to outdoors, and loading docks with overhead coiling may be outside the air barrier enclosure if the design dictates such. This would force their interior walls to be insulated and air sealed to the same standard as other parts of the enclosure that face the outdoors.

The boundary of the air barrier must be clearly defined in the project drawings. Once properly considered by the design professional, the calculated surface area of the air barrier should be indicated on the design drawings.

For buildings where doorways from each apartment, office, meeting room, or other area that open from a common hallway or zone and not at the air barrier boundary, the entire building air barrier system must be tested as a whole.

For buildings where doorways of each apartment/office/room lead to the outdoors (i.e., where there is no direct interior connection between all the rooms), each apartment/office/room must be tested individually. Walls abutting adjacent apartments are to be treated as part of the envelope in spite of the fact that an argument can be made that leakage of the adjacent walls would be to another conditioned apartment and could therefore be ignored. To allow for efficient testing, common walls will be treated as part of the total envelope for the apartment and each apartment must pass the criteria. In multi-unit apartments, each style of apartment must be tested, including all corner rooms, and at least 20 percent of all other apartments must be tested.

Buildings over 500,000 sq ft. of envelope area may require special test techniques not covered in this protocol. The building may have to be broken up into zones separated using boundary pressure neutralization techniques or by the erection of temporary walls. In other cases, the use of the building HVAC or large truck mounted fans may be required to establish useful test pressures. These special techniques will require a higher level of experience and engineering to establish useful results. It is up to the specifier to establish conformance criteria and test procedures for these unique buildings. The Canadian General Standards Board (CGSB) standard CAN/CGSB-149.15, "*Determination of the Overall Envelope Airtightness of Buildings by Fan Pressurization Method Using the Building's Air Handling Systems*" could be referenced by the specifier and used by the testing agency. However, the importance of air tightness should not be lost on buildings with enclosures over 500,000 sq ft.

3.2 Air Leakage Specification

The air leakage test specification could be written as follows:

> The air leakage test must be performed in accordance with ASTM E- 779 with the following additions and exceptions shown below.

The test consists of measuring the flow rates required to establish a minimum of 12 positive and 12 negative building pressures. The lowest test pressure shall be 25 Pa; the highest test pressure shall be 75 Pa; and there must be at least 25 Pa difference between the lowest and highest test pressures. The test pressure must be measured in a representative location such that pressures in the extremities of the enclosure can be shown to not exceed ∀10% of the measured test pressure. At least 12 bias pressure readings must be taken across the envelope and averaged over at least 20 seconds each before and after the flow rate measurements. None of the bias pressure readings must exceed 30 percent of the minimum test pressure when testing in both directions. Where it can be shown that it is impossible to test in b0th directions, then the building may be tested in the positive direction only, provided the bias pressure does not exceed 10% of the minimum test pressure.

The mean value of the air leakage flow rate calculated from measured data at 0.3 in wg (75 Pa) must not exceed 0.25 cu ft/ minute per square foot of envelope area (0.25 CFM75/ft^2) and the upper confidence limit as defined by ASTM E-779 must not exceed (0.27 CFM75/ft^2) or the upper confidence limit must not exceed (0.25 CFM75/ft^2). Measurements must be referenced at standard conditions of 14.696 psi (101.325 KPa) and 68F (20°C). The envelope area is to be supplied and/or confirmed by the architect of record (AOR).

Additional information for the specifier

The Testing Agency Guide provides detailed information as to exactly how the test must be performed. The Air Leakage Test Form details the exact procedure that the testing agency followed. A completed test must consist of all pages of the Air Leakage Test Form with required attachments plus a seventh page titled Air Leakage Test Results, upon which the testing agency must make a pass or fail declaration.

Of note to anyone specifying the air leakage test, or under the requirement of an air leakage test, is that:

1. The test is conducted with ventilation fans and exhaust fans turned off and the outdoor air inlets and exhaust outlets sealed (by dampers or masking). In some cases, recirculating air handlers may also need to be turned off. The contractor must provide a responsible HVAC technician with the authority to place the HVAC system in the correct mode for the pressure test. The testing agency must have unhindered access to mechanical rooms, air handlers, exhaust fans, and outdoor air and exhaust dampers.
2. Portable pressurization door fans manufactured for the purpose of pressure testing buildings often require significant electrical power (e.g., 20 amps) and may trip circuit breakers. The contractor must have someone on site with access to and the authority to reset circuit breakers or must have access and authority granted to them.
3. Airflow and enclosure pressure differences are drastically affected when exterior doors or windows are opened. At the time of the test, if subcontractors are still working in the building, the contractor must ensure that all windows in the bounding enclosure are kept closed. Entry and exit through doors in the test enclosure must be eliminated during the test. Data collected while the pressures and flows are affected by a door opening and closing must be discarded.
4. Portable fan pressurization doors are placed in doors or windows in the bounding enclosure. The testing agency must have access to these locations, be able to open them, and to remove closure hardware that interferes with equipment set-up.
5. The contractor shall ensure that no sub-contractors are working in the area of the fan pressurization test equipment. During pressurization tests, air will be blown into the building at high enough velocity that it will cause debris, dust, and litter to become air borne. When exhausting nearby debris and litter may be drawn to the fan guards or become entangled in fan blades where it can block airflow and result in erroneous measurements.
6. The fan pressurization test to determine final compliance with the airtightness requirement shall be conducted when all components of the air barrier system have been installed and inspected, and have passed any

intermediate testing procedures as detailed in the construction drawings and specifications. The test may be conducted before finishes that are not part of the air barrier system have been installed. For example, if suspended ceiling tile, interior gypsum board, or cladding systems are not part of the air barrier system, the test may be conducted before they are installed.

7. The testing agency is required to perform a diagnostic evaluation in accordance with ASTM E1186, whether the building achieves the air tightness requirement or not. The diagnostic evaluation will assist the contractor and responsible parties in identifying and eliminating air leakage so the building meets the requirement upon re-testing. The testing results will also be expressed in terms of the Equivalent Leakage Area (EqLA) at 75 Pa. The EqLA is a the equivalent area of a flat plate that leaks the same amount as the building envelope at 75 Pa. This information helps those responsible for further sealing the envelope know the approximate size of total hole area they should be seeking. Air leaks can consist of many small cracks, or a few very large openings or a combination of both. It is not unusual for large buildings to have a leakage area of up to 100 sq ft. Is also common for air sealing efforts to be focused on the small cracks while large holes that are a major contributor to failing the test, go unnoticed. Even if the building achieves the air tightness requirement, a diagnostic evaluation should be conducted to help the construction team identify additional areas of leakage that could be sealed on the current building or similar future buildings.

4 Testing Agency Guide

4.1 U.S. Army Corps of Engineers (USACE) standard for air leakage

The USACE requires all new buildings to pass an air leakage test where the results are less than or equal to 0.25 CFM/sq ft of exterior envelope at 75 Pa pressure at standard conditions.

4.2 USACE Procedure

The following sections provide useful background information that will give the testing agency more information so that they can more easily understand the step-by-step approach in the Air Leakage Test Form and the Air Leakage Test Form Guide. This test protocol was developed by the U.S. Army Corps of Engineers with assistance from the private industry using ASTM E- 779-03 as a basis. This protocol includes modifications and adjustments needed to account for the potential for bias pressures (due to wind and stack) that are found in high-rise buildings and unobstructed environments, and to strike a balance between accuracy, repeatability and ease of use with a variety of test equipment, test methods, and testing agencies. The section titled “Technical Justification for Differences with ASTM” (p 22) documents the main deviations from ASTM and the reasons why such deviations may occur.

4.3 Application and Scope

See the “Application and Scope” under the Specifier’s Guidance section.

The four-story building shown in Figure 1 (top left) has an enclosure that is described by the shape (bottom left top right), and that is accessed by an exterior stairway with no direct interior connection between floors. It therefore must be tested with multiple door fans simultaneously to measure the total enclosure leakage (top right bottom left). Note that a variety of fan setups are allowed under this protocol as long as a single zone with uniform pressure differentials is achieved.

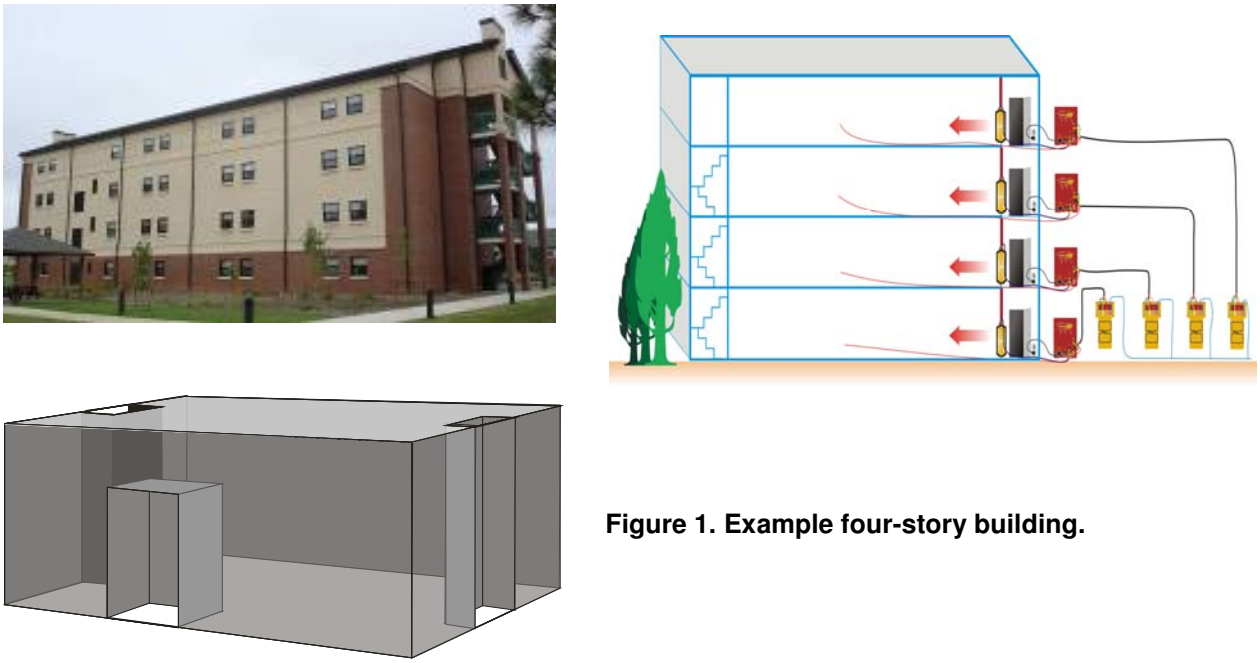

Figure 1. Example four-story building.

In buildings where individual apartments have doors to the outside (Figure 2, top left), the test must be performed on an individual apartment with the adjacent apartments open to outdoors. Perform door fan tests on all corner apartments plus a random 20 percent of those remaining. If they all pass then it can be assumed the rest of the apartments would also pass. Should any one apartment fail, an additional apartment must be added for each failure to the test until at least 90 percent of the tested units pass.

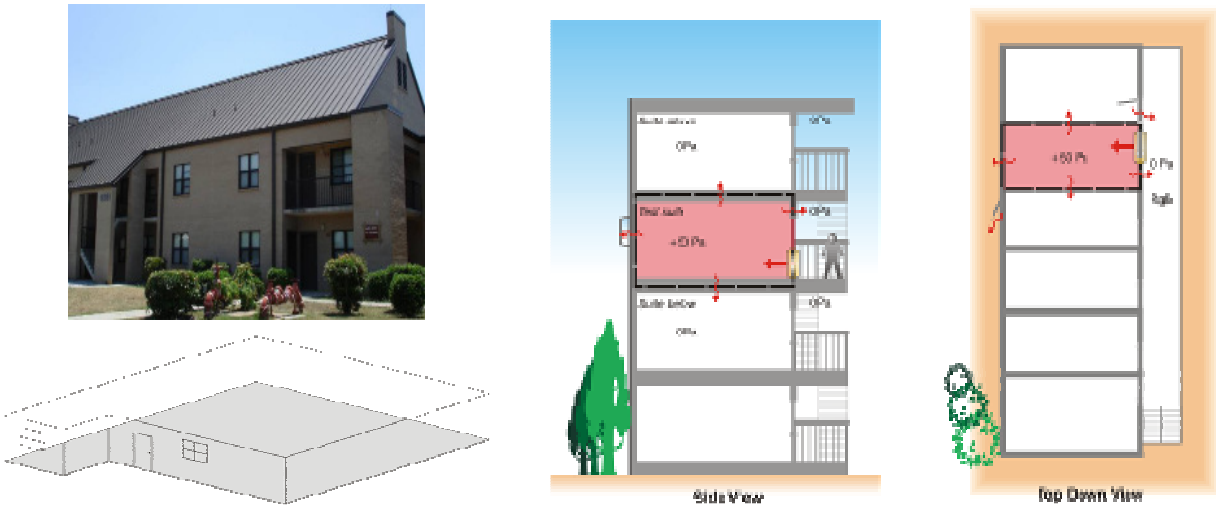

Figure 2. Example building where individual apartments have doors to the outside

4.4 Equipment Selection

Since a passing building requires the envelope to attain a leakage rate of 0.25 CFM/sq ft of envelope or less, multiply the envelope square footage that will be tested by 0.25 to get the approximate "passing" CFM needed at a 75 Pa pressure. Using the fan equipment manufacturer's literature, you can select the amount of airflow-producing equipment needed to perform the test. Portable fans that can test in both positive and negative directions must be used unless it can be shown that it is impossible to do so. The testing agency must have sufficient airflow-producing equipment to achieve at least 100 percent of the required passing CFM under the 0.25 requirement.

For example, if the building had 100,000 sq ft of envelope area, then it would require 100,000 x 0.25 = 25,000 CFM to be supplied by the testing agency. This generally requires the simultaneous operation of multiple portable fans and pressure monitoring equipment strategically placed throughout the building. If the specifications call for an air leakage requirement that is relaxed to a greater leakage rate such as 0.75 CFM/sq ft for special buildings (i.e., storage facilities with overhead coiling doors), then the testing agency should use the 0.25 value as a minimum fan capacity required for the test. Building HVAC systems may be used to measure envelope leakage in some cases where a proficient testing agency is capable of measuring air flows through outdoor air and exhaust ventilation equipment using:

- Pitot tube or hot wire anemometer traverse.
- Pressure compensated shrouds (which work well on rooftop exhaust units, and which are very accurate because they include air from duct leakage as well as through grilles).
- Tracer methods for measuring airflows in ducts (ASTM 2029 Volumetric and Mass Flow Rate Measurement in a Duct Using Tracer Gas Dilution). NOTE: Tracer decay, constant injection and constant concentration methods for estimating total ventilation rate of the test zone itself are prohibited.
- Outdoor air flow stations may be used if one of the above methods is used to check accuracy at least on air flow for each station, or if the design of the HVAC system specifically placed outdoor air flow stations in good measurement locations that are field verified.

For whole building tests on buildings with air handling systems that have been designed to provide accurate outdoor airflow stations or for very large buildings, with over 500,000 sq ft of envelope, this may be the practical option.

The standard CAN/CGSB-149.15, *Determination of the Overall Envelope Airtightness of Buildings by Fan Pressurization Method Using the Building's Air Handling Systems* could be referenced and used by the testing agency. In the hands of experienced personnel, reasonable results may be achieved, but note that accuracies have been no better than ∀20 percent when 75 Pa was achieved.

It may be possible to isolate and test individual floors for buildings in excess of four stories, if the testing agency's equipment is not capable of achieving a full building uniform pressure due to the geometry of the interior partitions and limited shaft areas. However, the floor-by-floor method requires exceptional preparation and knowledge of airflow characteristics within chases, shafts, and wall cavities, in addition to maintaining an identical or balanced pressure at the floors above and below. Refer to the ASHRAE study, *Protocol for Field Testing of Tall Buildings to Determine Envelope Air Leakage Rate 935-RP* (Bahnfleth 1998) for additional information on the floor-by-floor method of testing. It is recommended that the whole building achieve a uniform pressure to avoid the uncertainty inherent in the floor-by-floor method, but this protocol does not prohibit the application of the floor-by-floor method as an option for buildings greater than four stories in height.

Pressure gauges must be digital and accurate to within ∀1 percent of reading or ∀0.25 Pa, whichever is greater, and must have adjustable time averaging to compensate for wind. Calibrated fans must be accurate to within ∀5 percent of the flow reading. Sufficient tubing must be available so that all gauges used can be manifolded together and referenced to the same outdoor pressure. These tubes will be connected to the negative port of all gauges. Tubing must also be available to run from the center of each separate test zone to the positive port of a gauge.

A minimum of one exterior pressure monitoring station is required. The testing agency is allowed to use additional exterior pressure monitoring stations, especially if bias pressures exceed the values stipulated in Section 4.5 of the Air Leakage Test Form.

The pressure difference between interior zones shall be monitored to determine whether pressure differences between interior locations are within 10 percent of the indoor-outdoor pressure difference during all tests or not. If they are not, then adjustments to test set-up shall be made until they are within 10 percent. Interior pressure difference measurements shall be referenced to a single interior zone that is unaffected by velocity pressure created by test equipment. Thus, at an average 75 Pascal pressure difference across the enclosure, the difference between the highest and lowest interior pressure difference measurements should be within 15 Pascals of each other. The number of indoor pressure difference measurements required depends on the number of interior zones separated by bottle necks that could create significant pressure drops (e.g., doorways and stairwells).

4.5 Pre-Test Inspection

A pre-test inspection must be performed to determine whether there is something that would prevent the test from being completed. Check local weather forecasts for rain or strong winds before travelling to the test site. Ensure that the test equipment has arrived at the test site on time, and that it is in operable condition. The operation of the equipment is the simplest part of the test, whereas preparing the building is the most complex, takes the most time, and is the most likely factor to prevent the testing agency from completing the test.

4.5.1 Record Set-up Conditions

Accurately record the exact set up conditions. Pictures should be taken of representative setup conditions and should be attached to the final report. The intent of this protocol is to ensure buildings are set-up and prepared in an identical manner so the tests are repeatable. The testing agency is responsible to ensure the building is properly prepared and maintained throughout the test, but the contractor typically performs the actual preparation labor described below.

4.5.2 Preparation of the Building

Seal or otherwise effectively isolate all “intentional” holes in the building enclosure. This includes air intake or exhaust louvers, make-up air intakes, pressure relief dampers or louvers, dryer and exhaust vent dampers and any other intentional hole that is not included in the air barrier design or construction. Intentional openings can be sealed by using an air-tight film or by motorized or manual dampers held in the closed position.

NOTE: Exterior windows and doors (fenestrations) are not intentional openings. Fenestrations are included in the air barrier test boundary. Exterior windows and doors shall be in the closed and locked position only; no additional films or additional means of isolation at fenestrations is allowed.

Ensure that all plumbing traps are filled with water.

The HVAC system must be shut down or disabled for the duration of the test. If the HVAC system activates during the test, additional air movement across the enclosure is introduced and is not measured by the agency, resulting in inaccurate data.

All interior doors that access the building enclosure (roof, walls and fenestrations, floor) must be held open during the test to create a single uniform zone. If the door services only an interior room such as a storage closet, it is allowed to remain closed only if a dropped ceiling plenum is present above and it does not access an air barrier boundary. If doorways cannot be opened and the volume on the other side of the door is considered to be within the envelope, then the pressure across that doorway must be measured with the door fan running to ensure that the pressure on the other side of the door, as measured with an under door probe, is within ∀10% of the average building pressure.

Buildings with a dropped ceiling plenum must have tiles removed at a rate of one per every 500 sq ft. Additional tiles may be removed at the discretion of the testing agency so a uniform pressure distribution in the plenum space is achieved.

Combustion equipment must be disabled or be in the “pilot” position.

If the test zone is within a larger building enclosure such as a Tactical Equipment Maintenance Facility or Company Operations Facility, the areas outside of the test zone must be at ambient (outdoor) conditions. This can be achieved by open man-doors or overhead coiling doors in the open position.

Optional: Set-up the door fan and run preliminary test

If using door fans to pressurize the air barrier, perform a test with only one door fan. Occasionally, no additional testing will be required, as a preliminary test can help determine the following:

1. The quantity of additional door fans needed to achieve the desired test pressure.
2. A rough estimate as to whether the enclosure could pass, which may force the testing agency to spend more time investigating enclosure problems, instead of using time to verify an obvious failing enclosure.

For the preliminary test:

1. Record interior and exterior weather conditions
2. Record average and maximum wind speed and direction at least 5-feet off the ground and 25-feet away from the building in the direction of the wind.
3. Record interior and exterior temperatures before and after the test.
4. Record site elevation in feet above sea level.
5. Perform a multi-point test in both directions from at least + 25 to + 50 Pa, then - 25 to - 50 Pa.

Because this test is performed by pressurizing and depressurizing the air barrier envelope, bias pressure effects are minimized, yielding more accurate results. This is the preferred test method since it is not only more tolerant of test conditions, but also gives a more accurate representation of the envelope leakage under ambient conditions, where pressures can be either positive or negative in direction. Bias pressures may be up to 30 percent of the lowest test pressure, allowing this method to be used in a wider range of weather conditions. If fan power is sufficient, then

testing up to 75 Pa would be even more accurate and would allow tests to be completed where bias pressures were higher.

The testing agency must achieve at least 50 Pa, but there is no requirement that it must achieve a maximum pressure of 75 Pa. The agency is encouraged to achieve the highest building pressure possible, but should not exceed 75 Pa.

It is noted that some buildings will have air barrier systems that have not been properly designed and/or installed, resulting in the maximum building pressure being less than 50 Pa. Although the building does not meet the air leakage requirement of 0.25 CFM/sq ft, the testing agency must still perform a multi-point test in general accordance with this protocol so an approximate air leakage value can be provided to the prime contractor. This will allow them to estimate the magnitude of the repairs necessary to meet the air leakage requirement.

4.6 Reporting of Results

The data collected during the multi-point tests will be corrected for standard conditions and used to determine the air leakage coefficient, *C*, and the pressure exponent, *n*, in accordance with ASTM E779-03, from:

$$CFM = C * \Delta P^n$$

In general, the *C* and *n* values are obtained by plotting the data in log-linearized fashion to obtain a curve fit that will produce the required coefficients. The testing agency must use a minimum of 12 data points from each test, but is not limited to the maximum number of data points taken during the test. It is recommended to take additional data points so in the analysis the "outliers" can be omitted from the calculation procedure. Outliers are most frequently caused by wind gusts, changes in wind direction at the time that data pair was recorded, among other reasons.

One flow rate must be calculated for both the pressurization and depressurization tests at a ΔP of 75Pa (CFM@75Pa). The average of those CFM values will be divided by the enclosure area given in the project drawings to determine the normalized air leakage rate. This average value will be used as the basis for determination if the building meets or does not meet the requirement of 0.25 CFM/sq ft $_{envelope}$@75-Pa. The value is to be rounded to the nearest hundredth. Therefore, a value of 0.255CFM/sq ft does not meet the USACE requirement.

In addition to reporting the normalized air leakage as CFM/sq ft $_{envelope}$@75Pa, the agency is also required to report the correlation coefficient (r^2) and 95 percent Confidence Intervals (95%CI) to determine the accuracy of the data collected and the quality of the relationship between flow and pressure that was established during the test. The 95%CI should be calculated in strict accordance with the methodology contained in ASTM E779-03 and the r^2 value can be obtained by data analysis of the plotted data.

In general, a narrower 95%CI to the mean value and higher r^2 value indicates a clear relationship for the building's air leakage characteristics was established. For the collected data to be statistically significant, the 95%CI must not exceed ∀0.02 for mean values of 0.25 or less, which equates to approximately 8 percent. For example, if the calculated mean value is 0.25 and the 95%CI is shown to be 0.23 to 0.27, the test data is statistically significant. However, if the mean value is 0.25 and the 95%CI is 0.16 to 0.33, this exceeds 0.02 and indicates that the data is not statistically significant, and that a clear relationship between flow and pressure was not established during the test; the test must be repeated. In cases where the 95%CI exceeds ∀0.02, but the upper limit is 0.25 or less, the test would be considered a pass in spite of the statistical insignificance because there is a strong likelihood that the building passes the requirement. Likewise, the r^2 value must be above 0.98 for the data to be statistically significant. Test data should have correlations above 0.99.

Similarly, the pressure exponent, *n*, will also provide some insight as to the accuracy of the test and relative tightness of the building enclosure. Exponent values less than 0.5 or greater than 1.0 in theory indicate a bad test, but in practice, tests outside the range of 0.45 to 0.8 would generally indicate an inaccurate test or calculation methodology. The reason comes down to basic fluid dynamics and the characteristics of developing airflow through orifices, which is too lengthy to discuss within this protocol. Except for very rare circumstances, *n* values should not take on values less than 0.45 or greater than 0.8. If the *n* value exceeds these boundaries, the test must be repeated. In general, an *n* value closer to 0.5 indicates large holes that are much shorter in length than they are wide, where an

n value above 0.65 indicates the hole characteristics that are smaller cracks or holes that are much longer than they are wide. Most "tight" residential homes exhibit an *n* value of 0.60 to 0.65, where larger buildings will likely have an *n* value slightly less.

The testing agency is required to produce the data used in the analysis and results in tabular and graphical form, including the curve fitted coefficients and correlation coefficient.

Several common conditions that will cause test results to be very low are:

1. Interior pressure monitoring stations are placed too close to direct air flow that is typically produced by the test fans.
2. Usually tests are conducted with the fan orifice fully open, allowing maximum airflow. For testing smaller envelopes that require smaller test flows, a flow restriction device such as a plug or plastic ring can be installed on the fan. When limiting the fan air flow, the gage manufacturer requires that the digital gage's configuration be adjusted. If the gauge is incorrectly set on a lower range than the fan, then the measured flow will be much lower than the actual flow.
3. Interior doors have been left closed.
4. Exterior envelope is very tightly sealed.

Several common conditions will cause results to be very high are:

1. Intentional openings have not been properly sealed or have opened during the test (i.e., pressure relief dampers, plumbing traps).
2. Windows or exterior doors are left open.
3. HVAC equipment is not properly disabled.
4. If the gauge is set on a higher range than the fan, then the measured flows will be much higher than the actual flow.
5. It is possible the building contains significant holes in the air barrier enclosure and the high readings are simply an indication of the performance of the building.

4.7 Locating Leakage Sites with Pressurization and Depressurization

If the building fails the test, it is important to determine the source of the air leakage. It is also beneficial for the design-build team to understand the locations and details that are susceptible to leakage, even if the building as a whole passes the test. The testing agency is required to perform a diagnostic evaluation in accordance with ASTM E1186. The testing agency can use additional methods to discover leaks.

Neutral buoyancy smoke, theatrical smoke and infrared (IR) are effective means to find leakage sites. When testing equipment pressurizes the enclosure, air leaks can be seen from outdoors (provided exterior walls have not been heated by radiation from the sun) using infrared thermography or large scale smoke generation. When testing equipment depressurizes the enclosure, air leaks can be observed from the inside using infrared thermography and smoke generation. The manipulation of the HVAC system is required to perform an effective infrared thermography scan to achieve a temperature differential of at least 10 °F.

An Infrared Training Center (ITC) Level I Certified Infrared Thermographer is required by this protocol to perform the infrared diagnostic evaluation. Otherwise, the agency must submit the qualifications of the infrared thermographer, who must have at least 5 years experience in building science applications with infrared thermography. Anomalies such as thermal bridges and emissivity reflections are commonly mistaken as air leakage. The testing agency must employ thermographers with experience in building enclosures and building physics to achieve accurate diagnoses and to make effective recommendations to the design-build contractor in the event of failure and repair.

In general, when locating leaks, the airflow equipment should be adjusted to establish a minimum of +25 Pa pressure differential to use smoke and infrared while viewing the building from outdoors. A pressure differential of -25 Pa should be used for using infrared from the interior. Additional information is required in the diagnostic evaluation in accordance with ASTM E1186.

5 Air Leakage Test Form

For buildings constructed in compliance with the U.S. Army Corps of Engineers Air Leakage Protocol

Building name:
_____

Building address: _____
Prime Contractor: _____ Contact: _____

Testing agency: _____ _____
Address: _____ _____
Testing Agency Contact: _____ Phone: _____
Lead on-site personnel: _____ Phone: _____
Test date: _____

Witnesses:

Name	Organization	Telephone/email
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

INSERT PHOTOGRAPH OF SUBJECT BUILDING

Testing agency to provide a Compact Disk (CD) with digital photographs of subject building, setup, test procedures, and diagnostic evaluation.

Step	Description	Result
1	**Enclosure Area:** Record the total exterior enclosure surface area including walls, floor and ceiling from design plans as supplied by the Architect of Record (AOR). Verify the dimensions used by the AOR in the calculations match as-built conditions and that the arithmetic was performed correctly.	sq ft
NOTE: Testing agency to attach a description of the building characteristics, including intended use, wall, roof, and floor construction, fenestrations, HVAC system, air barrier system, and any additional information that may be relevant to the air leakage test.		

2	Set Up Checklist				
2.1	Confirm HVAC shutdown/disabling.		2.2	Confirm all dampers in the enclosure perimeter are closed and/or isolated.	
2.3	Confirm exhaust fans & dryers are off and isolated at the enclosure level.		2.4	Confirm combustion appliances are on pilot or are disabled.	
2.5	Confirm all air inlets at the enclosure perimeter are sealed or isolated.		2.6	Confirm all interior doors are propped open.	
2.7	Confirm all air outlets at the enclosure perimeter are sealed or isolated.		2.8	Note rain or snow conditions that may be affecting leakage of walls.	
2.9	Confirm exterior doors and windows are closed and latched.		2.10	Confirm ambient conditions provided are outside of air barrier envelope.	
2.11	Confirm all plumbing traps are filled with water.		2.12	Confirm dropped ceiling tiles are removed at specified rate.	
2.14	Confirm uniform interior pressure distribution by establishing at least 30 Pa and using a minimum of four pressure monitoring stations with one common exterior pressure monitoring station. Measure pressures at the four interior stations to ensure the interior pressure is within ∀10% of target value. List interior stations and pressures measured: Interior Station Locations: _____ _____ _____ _____ Pressure: ____ Pa ____ Pa ____ Pa ____ Pa				

2.15	Describer the approximate locations of the exterior pressure monitoring stations and whether the stations will be manually averaged or a manifold used. Exterior Station Locations: _____ _____ _____ _____ Means of averaging: _____
Additional Set up notes:	

3	Testing equipment used			
Gage 1	Model:	Serial #:	Accuracy:	Calibration Date:
Gage 2	Model:	Serial #:	Accuracy:	Calibration Date:
Gage 3	Model:	Serial #:	Accuracy:	Calibration Date:
Gage 4	Model:	Serial #:	Accuracy:	Calibration Date:
The gage must have an accuracy of ± 1 % or 0.5 Pa, whichever is greater and must have had its calibration checked against a National Institute of Standards and Technology (formerly National Bureau of Standards, or NIST) traceable standard within 2 years.				
Fan 1	Model:	Serial #:	Accuracy:	Calibration Date:
Fan 2	Model:	Serial #:	Accuracy:	Calibration Date:
Fan 3	Model:	Serial #:	Accuracy:	Calibration Date:
Fan 4	Model:	Serial #:	Accuracy:	Calibration Date:
The fan must have an air flow measurement accuracy of ± 5 percent of the measured flow and must have had its calibration checked against a NIST traceable standard within 5 years.				
Infrared Camera	Model:	Serial #:	Accuracy:	Calibration Date:
The infrared camera must have a sensitivity of ∀0.1℃ and must have been calibrated within 1 year of the test date.				
Attach calibration certificates for all equipment listed above to air leakage test form. If additional fans or gauges are used during the test, attach calibration certificates.				

4	**Perform a multipoint pressurization door fan test**		
4.1	Record indoor and outdoor temperatures before and after the test.	Indoor Pre-Test	Indoor Post-Test
		Outdoor Pre-Test:	Outdoor Post-Test:
4.2	Record wind speed and direction	Average mph	Direction
4.3	Record elevation of building above sea level.		ft
4.4	Record 12 **Bias Pressure Test Points** where each test point consists of at least 12 readings taken over at least 10 seconds. Show positive and negative signs.		

Bias Pressure Test Points	1	2	3	4	5	6	7	8	9	0	11	12
	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa

4.4.1	Record the magnitude of the greatest **Bias Pressure Test Point**.	Pa
4.4.2	Record the amount of time taken to collect each **Bias Pressure Test Point.**	___sec
4.5	If this value is 15 Pa or less, proceed with step 4.6. If greater than 15 Pa, repeat step 4.3 over a longer time period.	

Pressurization test. Adjust the door fan speed to establish a series of a minimum of 12 equally spaced **Building Pressure Test Points** where each **Test Point** is an accumulation of at least 10 readings taken over a time period that is at least double the time taken to collect **Bias Pressure Test Points** in 4.4.

Testing in two directions: the minimum test pressure must be at least 25 Pa and must also be at least the absolute value of greatest **Bias Pressure Test Point** X 10/3 = _____ Pa. The maximum test pressure should be at least 25 Pa greater than the minimum test pressure. The testing agency is required to supply 100% of the estimated "passing" flow using 0.25 CFM/sq ft $_{envelope}$ to estimate the passing flow.

4.6	Record the actual **Building Pressures** (Pa) from one or more interior pressure monitoring stations and the exterior pressure station(s), averaged or manifolded, with corresponding **Flows** (CFM) for each fan.	
4.6.1	Attach to this test form the results of the pressure and flow readings taken during the test. Results should be provided in tabular and graphical form. Graph should include correlation coefficient (r^2) and plotted in log-linearized fashion. A minimum of 12 points must be provided, but the testing agency is allowed to take additional data points to assist in data analysis and increase the accuracy of the test. There is no limit to the number of data points taken during the test, but a minimum of 12 must reported for data analysis and results.	
4.7	Record the amount of time to be taken to collect each **Building Pressure Test Point**.	sec

4.8	Record 12 **Bias Pressure Test Points** over the same time periods as step 4.4.												
		1	2	3	4	5	6	7	8	9	10	11	12
	Bias Pressure Test Points	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa
4.9	Calculate the **Average Bias Pressure** for all 24 **Test Points** taken in step 4.												Pa
4.10	Subtract value in 4.9 from all pressure readings taken in 4.6. This is the total corrected building pressure used in the analysis. See step 6.												

5.	**Perform a multipoint depressurization door fan test** Testing in both directions is the preferred method, but if in section 4.6 if it was noted that the test was to be performed in only one direction, then step 5 can be omitted.		
5.1	Record indoor and outdoor temperatures before and after the test.	Indoor Pre-Test	Indoor Post-Test
		Outdoor Pre-Test:	Outdoor Post-Test:
5.2	Record wind speed and direction	Average mph	Direction
5.3	Record elevation of building above sea level.		ft.
5.4	Record 12 **Bias Pressure Test Points** where each test point consists of at least 10 readings taken over the time period determined in step 4.5. Show positive and negative signs.		

		1	2	3	4	5	6	7	8	9	10	11	12
	Bias Pressure Test Points	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa
5.4.1	Record the magnitude of the greatest **Bias Pressure Test Point**.												Pa
5.4.2	Record the amount of time taken to collect each **Bias Pressure Test Point.**												___sec

Depressurization test. A pressurization test must already have been performed. Take depressurization test points at the same absolute values of **Building Pressure** as used in section 4.

5.5	Record the actual **Building Pressures** (Pa) from one or more interior pressure monitoring station and a minimum of four exterior pressure stations, averaged or manifolded, with corresponding **Flows** (CFM) for each fan.	
5.5.1	Attach to this test form the results of the pressure and flow readings taken during the test. Results should be provided in tabular and graphical form. Graph should include correlation coefficient (r^2) and plotted in log-linearized fashion. A minimum of 12 points must be provided, but the testing agency is allowed to take additional data points to assist in data analysis and increase the accuracy of the test. There is no limit to the number of data points taken during the test, but a minimum of 12 must be used for data analysis and results.	
5.4	Record the amount of time taken to collect each **Building Pressure Test Point.**	sec

5.7	Record 12 **Bias Pressure Test Points** in exactly the same fashion as step 4.4.												
		1	2	3	4	5	6	7	8	9	10	11	12
Bias Pressure Test Points		Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa
5.8	Calculate the **Average Bias Pressure** for all 24 **Test Points** taken in step 5.												Pa
5.9	Subtract value in 5.8 from all pressure readings taken in 4.6. This is the total corrected building pressure used in the analysis. See step 6.												

6. Calculate and Report Results

Subtract the **Average Bias Pressure** from all **Building Pressures** to arrive at **Corrected Building Pressure**. Curve fit pressures and flows from the tables and calculate the following values in strict accordance with ASTM E779-03. Provide tabulated and graphical data as an attachment to this test form.

	Pressurization	
6.2	The air leakage coefficient C_p for	CFM/Pa^n
6.3	The exponent n_p for pressurization. (NOTE: if n_p is less than 0.45 or greater than 0.8, test data is invalid and test must be repeated.)	
6.4	CFM referenced to standard temperature and pressure (STP) at +75 Pa.	CFM
6.5	CFM/sq ft of envelope at +75 Pa	CFM@75/sq ft
6.6	The correlation coefficient, r^2, of the curve fitted data with a minimum of 12 points. (NOTE: if r^2 is less than 0.98, test data is invalid and test must be repeated.)	
6.7	Calculate the 95% confidence interval at +75 Pa for test in pressurization. (NOTE: if the upper confidence interval exceeds 0.27 the test data is invalid and test must be repeated. If the upper confidence limit is 0.25 or more and the lower confidence limit is 0.04 lower, the test data is invalid and the test must be repeated.	CFM@75/sq ft CFM@75/sq ft
	Depressurization	
6.8	The air leakage coefficient C_d for depressurization.	CFM/Pa^n
6.9	The exponent n_d for depressurization. (NOTE: if n_p is less than 0.45 or greater than 0.8, test data is invalid and test must be repeated.)	
6.10	Calculate CFM referenced to STP at -75 Pa.	CFM
6.11	CFM/sq ft of envelope at -75 Pa	CFM@75/sq ft
6.12	The correlation coefficient, r^2, of the curve fitted data with a minimum of 12 points. (NOTE: if r^2 is less than 0.98, test data is invalid and test must be repeated.)	
6.13	Calculate the 95% confidence interval at +75 Pa for test in pressurization. (NOTE: if the upper confidence interval exceeds 0.27 the test data is invalid and test must be repeated. If the upper confidence limit is 0.25 or more and the lower confidence limit is 0.04 lower, the test data is invalid and the test must be repeated.	CFM@75/sq ft CFM@75/sq ft

	Both Pressurization and Depressurization	CFM
6.14	Calculate the average CFM/sq ft from 6.5 and 6.10	CFM@75/sq ft
6.15	Building passes if the value 6.14 is less than 0.25 CFM/sq ft at 75 Pa.	Pass/fail
6.16	For the purpose of visualizing the magnitude of the air leakage of the enclosure, calculate the equivalent leakage area in square feet at 75 Pa.	sq ft
7.	Perform a diagnostic evaluation in accordance with ASTM C1060 and ASTM E1186. Attach results of diagnostic evaluation to this test form.	

8.	**Restore the building to pre-test conditions**

6 Air Leakage Test Results

Testing Agency Certified Compliance with U.S. Army Corps of Engineers air leakage protocol

1	The enclosure area was obtained from the architect of record and was checked on site for reasonableness.	Initial
2	Set up conditions were performed according to section 2 and all deviations and their impact noted.	initial
3	Test equipment used was in compliance respect to accuracy and calibration date.	Initial
4	The test procedure used was in compliance except as noted here.	initial
5	The calculations were done in strict accordance with ASTM E779-03 except as noted in the Protocol.	initial
6	Provide the value calculated in step 6.14.	CFM@75/sq ft
7	Building passes if the value in step 6.14 is less than 0.25 CFM/sq ft $_{envelope}$ at 75 Pa.	Pass/fail
8	All accuracies, pressure limits and data correlations and confidence intervals are within the bounds specified in sections 4, 5 and 6 and all deviations are noted.	
9	Supporting documentation described in 1, 3, 4.6.1, 5.5.1, and 7 is attached to this test form, including all digital photographs of the building and test procedure.	initial

I hereby certify that the results above are in conformance with the U.S. Army Corps of Engineers protocol.

Testing Agency Name

_____

Testing Agency Authorized Representative Signature

_____

Testing Agency Authorized Representative Printed Name

_____

Date _____

7 Technical Justification for Differences with ASTM

7.1 Development of this Standard

The development of this standard and the associated testing protocol considered virtually every standard in widespread use. Standards that played an important part in this development were:

- ASTM E779-03 “Standard Test Method for Determining Air Leakage Rate by Fan Pressurization”
- ASTM E1827-96 “Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door”
- The Canadian Building Code
- Various applicable ASHRAE standards
- Air Tightness Testing and Measurement Association (ATTMA) Technical Specification 1 (United Kingdom [UK])
- CGSB 149.10, Canadian air leakage standard.

Key differences among these standards are:

- Choice of test pressures (10 Pa, 50 Pa versus 75 Pa)
- Way of expressing results (EqLA, CFM50, ACH50, CFM/sq ft @ 75Pa)
- Necessity and method for accounting for bias pressures (called “zero flow pressures” for the pressure measured with zero flow going through the door fan).
- Necessity and method for accounting for additional parameters (barometric pressure, humidity, temperature, elevation).

Both ASTM standards were originally intended for the testing of residential detached housing. Under these standards, multiple test points are gathered from 10 Pa up to 60 Pa and results are expressed in CFM @ 50 Pa or air changes per hour (ACH) @ 50 Pa (where CFM @ 50 Pa is the flow rate, in CFM, required to depressurize the house to – 50 Pa). It is also referred to as “CFM at 50 Pa,” “CFM @ 50,” or simply “CFM50.” ACH @ 50 Pa is CFM50 divided by the house volume. It is also referred to as “Air Changes at 50 Pa” or “ACH50”). The other commonly required result is Effective Leakage Area (EfLA) at 4 Pa (which is not to be confused with EqLA).

Both ASHRAE and the Canadian Building Code use testing points up to 75 Pa and express their results in terms of flow per square foot of surface area at 75 Pa.

The preferred test method for this standard includes:

1. Multiple test points from 75 Pa to 25 Pa
2. Testing in both the pressurization and the depressurization directions
3. Taking a comprehensive bias pressure over a long time interval to determine the lowest possible test pressure and to provide a more accurate bias correction
4. Expressing results in terms of CFM @ 75 per sq ft of enclosure area

The higher test pressure of 75 Pa was chosen for this standard since larger buildings are subject to higher bias pressures from wind and stack effects. Since wind velocity increases with height above ground, higher pressures due to wind are experienced. As height doubles, the increased bias pressures experienced due to wind roughly double. Houses typically experience bias pressures of 2 to 5 Pa whereas larger buildings can experience 10 to 20 Pa. Taking results at higher pressures helps achieve a more consistent result. A 75 Pa test pressure is about as high a pressure as is practical without vastly increasing door fan power, which would substantially increase the risk of damage due to higher wind velocities and pressures, and which is about the maximum a well-hung suspended ceiling can withstand without tearing it down in depressurize mode or blowing the tiles out in pressurize mode.

A sensitivity analysis was done on the sixth floor of an office building. Data was gathered in no-wind conditions and in conditions with a 10 to 15 mph wind blowing. Six test points were taken per test except for tests in both directions where six points were taken in each direction. Results were measured in CFM at 75 Pa. Twenty-three tests were performed under low wind conditions and another 26 tests were performed under windy conditions. All low wind tests were averaged and that average was used as the true result. The deviation result shown was the average deviation from the true result.

Direction	Pressure range	No wind CFM75			
		Deviation (%)	Error range (%)	Deviation (%)	Error range (%)
Depressurize with Bias	-60 to -12.5 Pa	2	-2.5 to + 1.5	17	-24 to -10
Depressurize with Bias	-50 to -25 Pa	2	-2.5 to + 1.5	10	-13 to -6
Depressurize with Bias	-75 to -50 Pa	1.4	-2 to + 0.5	5.3	-7 to -3
Both Directions with Bias	∀75 to ∀50 Pa	1.1	-1.1 to + 1.5	4.9	-6 to -3
Both Directions without Bias	∀75 to ∀50 Pa	1.5	-1.8 to + 1.5	3	-6 to -1
Both Directions without Bias	∀50 to ∀25 Pa	1.5	-1.8 to + 1.9	4.9	-8 to -3

Direction	Pressure range	CFM75 in 2 to 4 mph wind, deviation %	CFM75 in 10 to 15 mph wind, deviation %
Depressurize	-60 to -12.5 Pa	2%	17%
	-50 to -25 Pa	2%	10%, 30%, 16%
	-75 to -50 Pa	1.4%	5.3%, 9%
Pressurize	+50 to+25 Pa	2%	9%, 15%
	+75 to +50 Pa	1%	3%, 6%, 5%
Both ways	∀50 to∀25 Pa		11%, 10%
	∀75 to ∀50 Pa	1.1%	4%, 3%, 4.9%, 3%

7.2 Observations

1. Under windy conditions, the classic ASTM test procedure (measuring the before and after bias pressure and only testing in one direction from 60 to 12.5 Pa) produced the most unacceptable results. Variations in flow readings from 1 minute to the next, even with time averaging in place, varied as much as 25 percent for one reading.
2. If testing was to be completed in only one direction, reasonable results could be achieved by measuring the before and after bias pressures and testing at higher test pressures, from 75 to 50 Pa.
3. Testing in both directions and averaging the results always yielded results with less deviation than only testing in one direction.
4. Bias pressures taken with 30 second averaging would vary markedly from one sample to the next leading us to conclude that an even more rigorous method was required, such as 12 readings taken over at least 120 seconds.

7.3 Conclusions

7.3.1 General

1. The classic ASTM set of test points from 10 to 60 Pa was unacceptable under windy conditions.
2. The preferred test method is to test in both directions, from 50 to 75 Pa up to a maximum of 75 Pa. Allow for larger bias pressures by taking numerous readings to establish a test point over at least 10 seconds and then taking 12 test points in total. Then the door fan readings would be taken over a time period that is twice as long.
3. If testing in both directions is not possible due to the equipment characteristics, then pressurize only readings would be acceptable, but the test must be from 50 to 75 Pa.

ASTM encourages testing under ideal weather conditions of less than 4 mph wind and a temperature range of 41 to 95 F to keep bias pressures to a minimum, but these ideal conditions are seldom experienced in tall buildings due to their height or their specfic environment, increasing the likelihood that the test will be canceled. A more robust procedure is required to handle bias pressures that allow buildings to be tested in virtually any weather conditions short of storms. ASTM makes small corrections for temperature, barometric pressure, and elevation that do not help much with overall accuracy, but give the impression of accuracy. The overriding source of accuracy and repeatability is due to bias pressure.

7.3.2 Testing in Both Directions

The preferred way to eliminate bias pressure problems is to test the building in both the pressurization and depressurization directions and average the results. Bias pressure errors are non linear and cannot be properly allowed for by merely subtracting the bias from the reading. Testing in both directions cancels out these errors very effectively thus tolerating much larger bias pressures, up to 30 percent of the lowest test pressure.

7.3.3 Allowance to Test in One Direction Only

Making allowances for testing in only one direction acknowledges that very large buildings may require truck- or trailer-mounted blower equipment or that they may require the use of the building HVAC system that logistically will not easily allow testing in both positive and negative directions. Because bias pressures will have a greater impact on single-direction tests, the maximum allowable bias pressure under these circumstances has been reduced to 10 percent of the lowest test pressure of50 Pa in this case. On the other hand, the upper test pressure achieved must be at least 75 Pa. At these pressures, the bias pressure is somewhat masked by the higher test pressure and extrapolation is no longer an issue. Because buildings often leak more in one direction versus the other, testing in only one direction must be considered less accurate than testing in both directions.

The bias pressure in a 40-ft high building where the temperature was 0 °F outside and 68 °F inside and negligible wind for example, would be 10.5 Pa. This bias would typically be broken up into say +5 at the top and -5.5 at the bottom of the building. If bias pressure was a problem during the test the indoor temperature could be brought closer to the outdoor temperature by running door fan for about 5 minutes, which would be sufficient time to replace most of the indoor air with outdoor air, and thereby reduce the bias pressure somewhat.

7.3.4 Summary of Deviations from the ASTM Standard

All pressure tests shall comply with the requirements of ASTM E 779-03 with exceptions indicated in the table below.

ASTM E 779-03	U.S. Army CE Protocol	Reason for change
6.2.2 "accuracy of ∀ 5% of measured pressure."	The gage must have an accuracy of ± 1 % or 0.5 Pa, whichever is greater and must have had its calibration checked against a NIST traceable standard within 2 years.	Modern gauges are typically much more accurate than the analog gauges that ASTM was written to accommodate and there is every reason to take advantage of the increased accuracy.
8.4 "If the product of the absolute value of the indoor/outdoor air temperature difference multiplied by the building height, gives a result greater than 1180 ft °F, do not perform the test, because the pressure difference induced by the stack effect is too large to allow accurate interpretation of the results."	The protocol allows for a wider range of heights and temperatures by limiting bias pressure to 30% of the lowest test pressure when testing both ways and 10% when testing one way.	The ASTM requirement of 1180 ft °F would only permit four-story buildings (48 ft high) to be tested when the indoor/outdoor temperature difference was less than 25 °F, which would be impractical. The Protocol is both more stringent and more flexible due to the higher minimum test pressures that tolerate higher bias pressures. The ASTM requirement of 1180 ft °F produces a stack of about 4.2 Pa, which is 42% of the lowest 10 Pa test point whereas the Protocol permits a maximum bias pressure (wind and stack) of 30% of the lowest test pressure when testing both ways and 10% when testing one way. This results in a maximum allowable bias pressure of 7.5 to 15 Pa and 5 Pa for the Protocol.
8.5 "Preferred test conditions are wind speed of 0 to 2 m/s [0 to 4 mph] and an outside temperature from 5 to 35° C. [41 to 95° F.]."	Preferred test condition superseded by requirement to keep bias pressure within limits.	The ASTM preference of wind speeds less than 4 mph and outside temperature range from 41 to 95°F would mean that the rescheduling of test would be required in about 50% of all cases. This is impractical and the more robust procedure in the protocol takes care of wind and temperature differences by accurately measuring bias pressures over a period of time and then requiring that the air leakage measurements are made over the same time period.
8.10 "…. Pressure difference shall be from 10 to 60 Pa…at least five data points…"	"Adjust the door fan speed to establish a series of 12 equally spaced Building Pressure Test Points where each Test Point is an accumulation of at least 10 readings taken over a time period that is at least double the time taken to collect Bias Pressure Test Points"	Because results are required at 75 Pa, taking data up to and including this point of interest vastly increases accuracy and repeatability. The Protocol is far more stringent than ASTM yet with modern equipment takes less effort than the old manual way of taking readings.
8.13 "For each test, collect data for both pressurization and de-pressurization."	Testing in both directions is preferred. Testing from ∀ 75 Pa to ∀ 50 Pa is acceptable because buildings tend to leak slightly more under positive pressure.	Testing in both directions results in simpler and more repeatable tests. Tests with trailer mounted fans or the building's HVAC systems may only be possible in one direction and the protocol allows for then to be used.

8 Glossary and Acronyms

8.1 Glossary and Acronyms

Term	Definition
air tightness	Pertains to how free air leakage may be in an enclosure. In actual fact, measurements can only be made of air leakage rates not air tightness itself so one could think of these terms as being opposites. In spite of the confusion, the terms are used interchangeably.
air barrier	The air barrier defines the surface that separates the inside air from the outside air. Generally this should be an inner barrier such as sheet rock, which prevents air from moving through the insulation. The air barrier should be in contact with the insulation. The air barrier should not be outside the insulation.
air leakage	Pertains to how leaky an enclosure may be. See Air tightness.
average bias pressure	A series of 12 test pressure points that are averaged to produce one value.
baseline pressure	A method of reading or determining the background or bias pressure by having a digital gauge accumulate readings over an adjustable time period .
background pressure	See bias pressure.
bias pressure	This is defined as the pressure that exists when the enclosure has been prepared for the test, but before the fan pressurization system is activated. There is always some bias pressure due to stack, wind, flues and active HVAC systems. There are two components of bias pressure. A fixed static offset (usually due to stack or HVAC) and a fluctuating pressure (usually due to wind or elevator operation). In ASTM bias pressures are called “zero flow pressures” for the pressure measured with zero flow going through the door fan.
blower door	Commonly used term for a door fan, which means a calibrated fan capable of measuring air-flow. The door fan is temporarily mounted in doorway, hence the adjective “door” prefixing “fan.” Door fans do not use blowers. A blower more accurately describes an air moving device of the squirrel cage variety; hence the adjective “blower” does not normally apply to the bulk of door fans since they do not use a blower.
building envelope	See enclosure.
building enclosure	The boundary or air barrier separating the interior conditioned volume of a building from the outside environment. See enclosure.
CFM @ 50 Pa or CFM50	CFM @ 50 Pa is the flow rate, in CFM, required to depressurize the building to – 50 Pa.
ACH @ 50 Pa	ACH @ 50 Pa is CFM50 x 60 minutes/ hour, divided by the house volume. It is also referred to as “Air Changes at 50 Pa” or “ACH50.”
conditioned volumes	Any space maintained above 50 °F in winter and below 80 °F in summer.
door fan	A calibrated fan capable of measuring air-flow of that is temporarily mounted in a doorway. Door fan is more linguistically correct than the common term “blower door.” Since it is not a “door,” but rather a “fan” and since it does not use a “blower.” a more correct term is door fan.
digital gauge	For the purpose of this Protocol, it is a gauge with an electronic pressure sensor and digital display that is capable of reading in tenths of a Pascal.
Effective Leakage Area	EfLA at 4 Pa using 1.0 discharge coefficient which is not to be confused with EqLA which is normally 50% larger

Term	Definition
enclosure	The surface bounding a volume, which is connected to outdoors directly. For example an apartment whose only access to outdoors was through a doorway that leads directly outdoors. Or, a building with a series of apartments or offices whose only access to the outdoors is through a common hallway then the enclosure would be the volume that bounds all of the apartments or offices.
Equivalent Leakage Area	EqLA, usually taken at 10 Pa using 0.61 discharge coefficient, but for the purposes of this document, it is taken at 75 Pa.
envelope	See enclosure.
exterior enclosure	See enclosure. The addition of the word exterior emphasizes the fact that we are primarily dealing with enclosures that face the outdoors. The boundary or air barrier separating the interior conditioned volume of a building from the outside environment. This represents the enclosure that faces the “exterior,” but is actually measured from inside the building.
fan-pressurization method	Term is used in the ASTM standard and does a decent job of describing what a door fan test is except that it may delude us into thinking that depressurization is not an option.
sq ft	This refers to “square feet.” In this document it usually refers to the surface area of the envelope, which is also called “the enclosure.”
micromanometer	A digital gauge that is capable of reading in tenths of a Pascal.
outdoors	Outside the building in the area around the building.
readings	Discrete pressure or flow values read from the gauge(s). Typically five or six readings or samples are taken every second when using a digital micromanometer, which may not be apparent since the display is updated every second.
test points	Consists of a group of readings taken over a 10–30 second time period, which are typically averaged to produce one test point that could be used as one of the multiple points in a curve fit or overall average.
time averaging	Refers to the digital gauge display that must have an adjustable averaging from 1 second to 1 minute for the purpose of averaging fluctuating pressure signals. Averaging can be block averages that will update for the length of the average or rolling (moving) averages that will update continuously by displaying the average over the past time period.
single zone	A space in which the pressure difference between any two places, differ by no more than 5% of the inside to outside pressure difference.
static pressure	See bias pressure.
zero flow pressure	ASTM terminology for bias pressures.

8.2 Acronyms and Abbreviations

Term	Spellout
ACH	air changes per hour
AOR	Architect of Record
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASTM	American Society for Testing and Materials
ATTMA	Air Tightness Testing and Measurement Association
CD	Compact Disk
CE	

Term	Spellout
CERL	Construction Engineering Research Laboratory
CFM	cubic feet per minute
CGSB	Canadian General Standards Board
CI	Confidence Interval
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
EfLA	Effective Leakage Area
EqLA	Equivalent Leakage Area
ERDC	Engineer Research and Development Center
ERDC-CERL	Engineer Research and Development Center, Construction Engineering Research Laboratory
HVAC	heating, ventilating, and air-conditioning
IR	infrared
ISO	International Organization for Standardization
ITC	Infrared Training Center
NIST	National Institute of Standards and Technology
STP	standard temperature and pressure conditions of 14.696 psi (101.325 KPa) and 68F (20°C).
UEPH	Unaccompanied Enlisted Personnel Housing
UK	United Kingdom
U.S.	United States
USACE	U.S. Army Corps of Engineers

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CHAPTER 1

INTRODUCTION

1-1 BACKGROUND

Designers, installers, and operation and maintenance (O&M) staff have struggled with the complexities and incompatibilities of multi-vendor building automation direct digital control (DDC) systems almost since they were introduced in the 1980's. DDC systems are routinely designed and procured on a building-by-building or sub-system by sub-system basis, most notably for heating, ventilating, and air-conditioning (HVAC) systems. In the absence of specifications and criteria for Open systems, Government procurement rules which require competitive bidding make it extremely difficult if not impossible to procure new DDC systems that are compatible with existing ones and that are also compatible with a basewide or campus-wide supervisory system.

In the absence of sole-source procurement, new but incompatible DDC systems result at best in inefficiencies and at worst in complex and non-functioning systems. This is a problem with system-to-system data sharing and is a problem where multiple individual systems need to communicate with a supervisory monitoring and control (front-end) system such as a Utility Monitoring and Control System (UMCS) specified by UFGS 25 10 10. This inability to interoperate is a result of Closed systems due to vendor-specific proprietary elements.

In contrast, Open DDC systems are now available. An Open DDC system is characterized by the ability for any qualified entity to readily modify, operate, upgrade, and perform retrofits on the DDC system. An Open system:

- Permits multiple devices from multiple vendors to readily exchange information.
- Provides the capability to easily replace any device with another device procured from multiple sources.
- May have proprietary components within devices, but these proprietary components must be a small percentage of the overall device.
- May have fees associated with use of certain components.

In short, an Open system is one (integrated, multi-vendor) system where there is no future dependence on any one Contractor or controls vendor.

Open communications and data sharing between multi-vendor systems and with a third party supervisory system is necessary to achieve effective system operation. Some of the benefits and capabilities of Open multi-vendor DDC systems include:

- Competitive procurement, most notably at the building and sub-system level.

- An operator workstation/user interface that provides for the same look and feel for monitoring and control regardless of which vendor's DDC system or sub-system an operator is viewing. As a result, system operators need only become proficient with one user interface.

- An operator workstation/user interface (software) that provides for management of base-wide system operations such as: remote alarm reporting, remote scheduling (on/off control), remote set point override, data logging and reports, energy management including load shedding, utilities monitoring/measurement for the purpose of monitoring energy performance contracts, and initial diagnosis of service calls. As a result, through a single user interface, system operators and managers are afforded the means to efficiently and effectively manage base-wide operations.

- A whole-building approach to systems integration. This includes the efficient inter-connection of HVAC control sub-systems. For example, terminal unit equipment, such as VAV boxes can be readily interfaced to the servicing air handler to provide a call for cooling. In addition, the whole-building approach provides the capability for integrating non-HVAC sub-systems such as fire and security

- Groundwork for establishment of a non-proprietary and openly accessible 'point-database' in support of communications-network management requirements. The Open database approach further insulates the government from the possibility of single vendor lock-in and resulting proprietary procurement.

1-2 **PURPOSE**

This UFC is intended to be used with UFGS 23 09 23 (LonWorks® Direct Digital Control for HVAC and Other Local Building Systems). The design concept described in this UFC provides definitive guidance intended to streamline DDC system design and installation leading to maintainable, interoperable, extensible, and non-proprietary control systems. The purpose of this UFC is two-fold;

- Commonality. Describe a definitive methodology for the design of building-level control systems and strategies (primarily for HVAC) where the intent is to achieve at least a degree of commonality in systems designed and procured through different channels.

- Compatibility. Describe a definitive methodology to obtain multi-vendor systems that can communicate and interoperate with each other and with a supervisory monitoring and control system such as a basewide UMCS through the use of an Open communications protocol.

The Open systems approach described in this UFC is based on ANSI/CEA standard 709.1-B communications protocol (sometimes referred to as LonTalk®) and on LONWORKS® Network Services (LNS®) network operating system. The standard protocol supports Open communications while LNS supports Open network management.

The design of an Open system is not simple. It requires attention to a great deal of detail. This UFC, the specifications, and accompanying drawings were developed to minimize the time and effort required on the part of the designer.

The level of detail contained in this UFC is necessary because of the variety of approaches that can be used to implement ANSI/CEA-709.1-B where, in the absence of this detail, would very likely result in incompatible systems.

'CEA-709.1' is used in this UFC as the shorthand reference to the ANSI/CEA standard 709.1-B communications protocol. In this UFC the term LONWORKS® is used to loosely describe a collection of technologies (including hardware, and software), vendors and installers relating to or based on the CEA-709.1 communications protocol.

1-3 SCOPE

This UFC describes the design of HVAC control systems and the associated building control network that can interface to a UMCS in an Open and non-proprietary manner. The guidance also provides a foundation for the design of other Open building systems.

1-3.1 HVAC control

This UFC provides Open DDC systems guidance for the design of heating, ventilating and air conditioning (HVAC) control systems and other building-level systems, sub-systems and equipment including: primary (air and water) built-up systems, terminal units, and packaged equipment.

1-3.2 Building control network

This UFC describes designer selections for the Building Control Network (BCN) communications including data exchange, architecture, and cabling.

1-3.3 UMCS interface

The DDC system can function as a stand-alone system with reduced functionality (limited user interface, no trending etc.) but is intended to be integrated with a UMCS in accordance with the UMCS guidance (UFC 3-401-01 and UFGS 25 10 10) to provide for remote supervisory monitoring and control of the DDC system. This UFC (3-410-02) and UFGS 23 09 23 helps to ensure that the building-level control system is capable of being interconnected with a UMCS. Even in the absence of a UMCS, this UFC describes the methodology for designer selection and specification of data exchange

parameters including requirements that will facilitate subsequent non-proprietary UMCS interface.

1-3.4 **Other systems**

Although not directly addressed or specified in the UFC or UFGS the methodology, approach, and many of the requirements defined in this UFC and UFGS 23 09 23 can be used to design other (non-HVAC) Open DDC systems such as water and sanitary sewer systems, electrical systems, lighting, and other utility systems and equipment.

1-4 **APPLICABILITY**

This UFC and accompanying UFGS 25 10 10 'LonWorks Utility Monitoring and Control System' are for use on all USACE and AFCESA projects. The NAVFAC standard is to use BACnet for its DDC communication protocol and NAVFAC systems should use UFGS 23 09 23.13 20 'BACnet Direct Digital Control Systems for HVAC'. NAVFAC allows the use of LonWorks for upgrades and additions to legacy systems.

At the discretion of and with approval from the assigning government agency (such as the responsible Corps of Engineers District) the control system designer may deviate from the approach defined in this UFC. When deviating from this guidance, systems based on an Open communications protocol are recommended and systems that lead to subsequent proprietary procurement or single-vendor systems are discouraged.

1-5 **REFERENCES**

American National Standards Institute/Consumer Electronics Association:

- ANSI/CEA-709.1-B, Control Network Protocol Specification, 2002
- ANSI/CEA-709.3, Free-Topology Twisted-Pair Channel Specification, 1998.
- ANSI/CEA-852, Tunneling Component Network Protocols Over Internet Protocol Channels, 2001.

Headquarters, U.S. Army Corps of Engineers (HQUSACE)

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- UFC 3-401-01FA, LONWORKS® UTILITY MONITORING AND CONTROL SYSTEM (UMCS), 2008.

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- LonMark Interoperability Guidelines, LonMark Application-Layer Interoperability Guide version 3.4, 2005 and LonMark layer 1-6 Interoperability Guide version 3.4, 2005.
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- LonMark SNVT Master List, LonMark Standard Network Variable Type (SNVT) Master List version 12, 2003.
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CHAPTER 2

CONTROL SYSTEM NETWORK

2-1 INTRODUCTION

This chapter describes building-level Open-communications control system architecture, device functionality, and control devices for HVAC and other building-level monitoring and control applications. The communications network and devices are based on LonWorks® technology and CEA-709.1 communications protocol.

Design of an Open-communications building-level control system does not require an extensive familiarity with the CEA-709.1 protocol, but it is critical that the designer understand that the protocol can be implemented in a manner that is not Open and thus can lead to incompatible systems. Therefore, this chapter contains information pertinent to the design of an Open system that designers likely are not familiar with due to the complex nature of modern networked control systems. While many design decisions have already been made, this chapter describes concepts and selections that the designer should be familiar with when developing a project-specific design.

2-2 ARCHITECTURE

As illustrated in Figure 2-1 a basewide system consists of a UMCS (specified by UFGS 25 10 10) connected to one or more building-level DDC systems (specified by UFGS 23 09 23). The network architecture consists of a basewide IP network and one or more building-level TP/FT-10 networks. DDC UFGS 23 09 23 refers to the building-level TP/FT-10 network as the Building Control Network (BCN). A building point of connection (BPOC) provides an interface between the IP and BCN networks.

Generally, the UMCS will be a basewide system, but it may initially consist of only one (or a few) building control networks with the capability of being expanded to include additional buildings where multiple building control networks can be connected to a single UMCS via a BPOC router at each building.

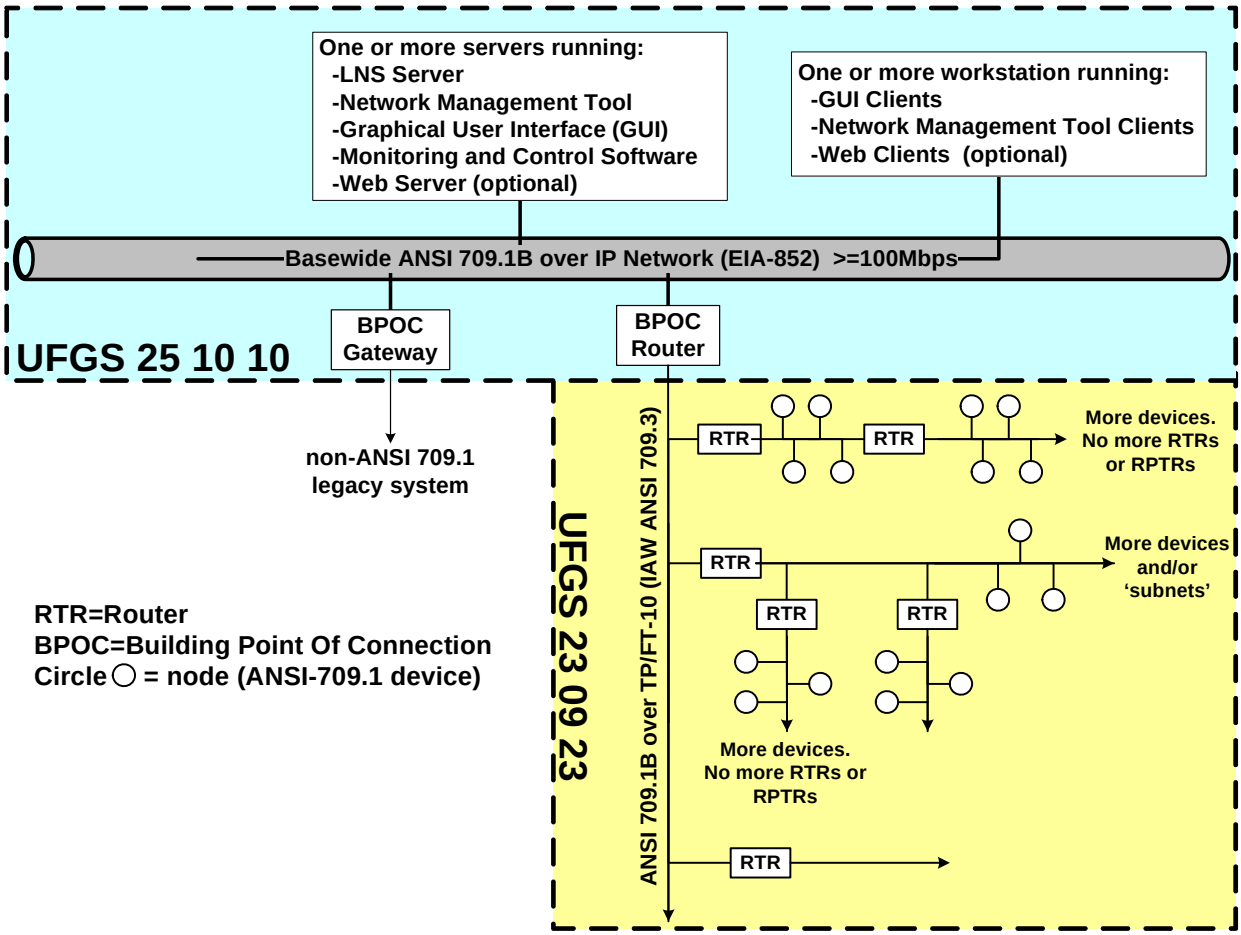


Figure 2-1. UMCS and DDC System Architecture.

2-3 BUILDING CONTROL NETWORK

2-3.1 General

As illustrated in Figure 2-1 UFGS 23 09 23 specifies the building control network (BCN) and requires the use of CEA-709.1 communications protocol over a TP/FT-10 network (in accordance with CEA-709.3) connected in a doubly-terminated topology. The BCN consists of a *backbone* with one or more *local control buses* connected to it via routers. This produces a logically flat network in the building where each node can communicate directly with any other node without the intervention of another controller.

2-3.2 TP/FT-10 media

TP/FT-10 defines a network media and transceiver type:

- The TP in TP/FT-10 stands for Twisted Pair. This is a description of the media that is used to connect the controllers. In this case, a twisted pair of wires is used. CEA-709.3 requires that this twisted pair meet the requirements of CAT-5

cable. While the protocol will work over a variety of cable types, CAT-5 (or better) cable is such a widely used standard that requiring the use of it will help avoid incompatibility problems later.

- The FT in TP/FT-10 stands for Free Topology and indicates the transceiver type that controllers on the network will use. The transceiver is responsible for actually transmitting information across the network. Note that while this allows for Free Topology, the specification further restricts the network to a doubly-terminated bus topology.

- Doubly-Terminated Bus Topology requires that the bus be daisy-chained from one device to another with no branches (stubs under 3 meters in length are allowed in accordance with CEA-709.3) with terminators at both ends of the bus. The spec requires doubly-terminated bus topology in order to maintain consistency and since this topology is the easiest to understand and work with.

The protocol communicates at 78 kbps, which translates to roughly 250 packets per second before the network begins to saturate. The specification places specific requirements on how the network is structured and how devices communicate on the network to avoid saturating the network.

For very small systems, a single network segment may be sufficient; you will not need a building network backbone. In this case, the specification may be edited manually to remove the requirements for a building backbone Note that there other reasons (explained below) why it might be advantageous to use multiple sub networks in a building.

2-3.3 **Other media types**

In addition to TP/FT-10, there are two media types that are part of the CEA-709 standard; Power Line (CEA-709.2) and Fiber Optic (CEA-709.4). Furthermore, there are many media/network types available that are not included in the CEA standard. Many of these media types should be avoided, but some such as Radio Frequency (RF) may be useful in some applications.

The IP network is not part of the BCN therefore UFGS 23 09 23 does specify IP media. IP networks are specified in UFGS 25 10 10 'Utility Monitoring and Control System'.

2-3.4 **Media selection**

UFGS 32 09 23 specifies TP/FT-10 because it the most common media and thus the most supported and Open option. Use of other media types may limit future competition by giving an advantage to the limited number of vendors whose products support the non-standard media. Therefore alternative media (with the possible exception of Power Line) should only be specified or permitted when it is used in conjunction with TP/FT-10:

- To bridge two TP/FT-10 segments

- As a local control bus connected to a TP/FT-10 backbone

The decision to specify or allow alternative media types is best made by asking “What is gained by using this media instead of TP/FT-10?” and “What Is lost by using this media instead of TP/FT-10”? Often the answer to the first question will be that it is a matter of convenience, while the answer to the second will be that the system will become less Open. In these cases, it is likely worthwhile to proceed with TP/FT-10 despite the additional cost/time, as it will prove to be more convenient in the long term.

In general, if the alternative media type requires installation of the media, then there is likely little or no benefit to using the alternative media. If the alternative media permits use of existing media such as power line (PL), radio frequency (RF) or fiber optic (FO), then it may be justified, but the impact on the Openness of the system must be considered.

Specifying or allowing an alternate media type may be warranted where it is needed to meet bandwidth requirements

2-3.5 **Building control network - backbone**

In accordance with UFGS 23 09 23 routers are the only devices to be connected to the backbone. In addition, only traffic to/from the front end (via the BPOC) is allowed on the backbone. (Note that these requirements may be relaxed for a very small building.) This helps to ensure that ample bandwidth is initially available on the backbone and also helps to accommodate bandwidth needs due to system modifications or future expansions. The backbone is available for connection to the UMCS network via BPOC router as specified by UFGS 25 10 10.

In rare cases, the available bandwidth of the building backbone will be insufficient to accommodate the required traffic between the building and the UMCS. In this case the building Contractor will provide a single TP/FT-10 backbone which the UMCS Contractor (***not*** the DDC Contractor) will later break into multiple TP/FT-10 backbones connected by an IP network. A drawback to multiple backbones is that each one requires a BPOC where the BCN is connected to the UMCS network.

Multiple buildings can share a common building-level backbone. For example, two or more adjacent buildings can be physically linked by a common TP/FT-10 backbone as long as network restrictions such as cable length and the total number of nodes as described elsewhere in this UFC and in UFGS 23 09 23 are adhered to. In this case, if the backbone is connected to a UMCS a single BPOC can then be used to connect these buildings to the UMCS. The need for a single BPOC assumes that more than one BPOC is not needed to accommodate network bandwidth usage constraints.

2-3.6 **Building control network - local control bus**

In accordance with UFGS 23 09 23 the local control bus is the only portion of the BCN where DDC Hardware such as controllers may be connected. This helps to ensure that ample bandwidth is available on the backbone.

2-4 CONNECTION TO A UMCS

The BCN will perform all necessary control functionality in a stand-alone mode but does not provide an operator interface for monitoring and control of the network. If the building is to be operated in a stand-alone mode for an extended period and monitoring and control functionality are required, the designer should use the applicable portions of UFGS 25 10 10 to obtain a local monitoring and control system. If the building is to be connected to the UMCS, the UMCS Contractor will be responsible for installation and configuration of the BPOC and integration of the building system into the UMCS.

2-5 NETWORK DESIGN AND LAYOUT

Network layout is left largely to the building-level controls Contractor as specified in UFGS 23 09 23.

2-6 NETWORK HARDWARE

In addition to media, the control network may contain the following types of hardware.

2-6.1 Repeater

A repeater is a device that has two or more input/output ports, connects two (or more) pieces of media, and performs signal regeneration. Signals showing up on an input port get cleaned up, amplified, and sent out of the repeaters output port(s). Repeaters may allow for longer cable runs in some cases, but not others.

2-6.2 Media converter

A media converter is a repeater that changes media types (i.e. TP/FT-10 to PL). Use of non-standard media will likely require the use of media converters where the non-standard media connects to another media type or to a device that supports another media type.

2-6.3 Router

A router is similar to a repeater, but performs the additional function of packet filtering based on destination address. A router can look at the destination address of an incoming packet. If the destination DDC Hardware is accessible via media connected to

a different output port, the packet will be sent out the appropriate output, otherwise the router will do nothing with the packet.

A router maintains a routing table consisting of a list of the domains and subnets that exist on its output ports. A router typically will also contain a “default” entry, which essentially says “If the destination doesn't show up in any routing table entry, forward the packet to another (specified) device (and hope that device can forward it properly).”

A router may be classified as a configured or learning router. A configured router has its routing tables assigned by the installer. A learning router will “learn” its routing tables. Initially, a learning router simply functions as a repeater and forwards all messages. As messages pass through the router, it looks at the source subnet address and learns which of its input ports connects to that subnet; it can then use that information to build a routing table entry for that subnet. While the choice of learning vs. configured router is left to the building Contractor, configured routers are generally preferred.

A router provides two very important functions in a control network:

- It greatly reduces network traffic. By placing devices that need to communicate frequently on a common subnet and isolating that section with a router, the base-wide (or UMCS) network will not be bogged down with local communications between the devices on the subnet.

- It allows devices to send messages to a “distant” controller without knowing the detailed network topology. A device that measures and communicates outside air temperature in one building and that sends this outside air temperature measurement to another device in another building only needs to forward the message to its router. The router is then responsible for knowing how to send the message on towards the destination device.

2-6.4 **Network bandwidth**

In accordance with UFGS 23 09 23 the Contractor is responsible for selecting the details of the architecture and ensuring that the proposed system (devices, network bindings, and network architecture) does not saturate the network.

While it is the Contractors responsibility to design and propose a network that does not exceed the network’s bandwidth capacity, UFGS 23 09 23 provides additional requirements to help ensure those limits are not exceeded:

- Use the UFGS 23 09 23 specified backbone and local control bus architecture

- Group devices that need to communicate often on a common local control bus

- Limit the amount of information sent to the UMCS. A modern UMCS can easily demand data from the local controls faster than the building network can deliver the data. Coordinate with the UMCS installer to limit “always-active” data requests from the UMCS such as trending to those really required by the installation.

- Ensure the Contractor is careful in selecting data transfer rates and integrity methods. Use “Send on Change” with reasonable change values to avoid sending data more often than required. Limit “Unacknowledged Send Multiple” and “Send Acknowledged” transmissions to critical data only.

Segmenting the network into local control buses and a backbone is the easiest way to manage network traffic and not overload the network. The intent is to place devices that need to communicate frequently on a common local control bus. The requirement that only routers be connected to the backbone ensures that traffic from a (potentially) congested local control bus does not clog the backbone – the router will keep local traffic on the local control bus and off the backbone. Traffic between devices and the front-end UMCS will utilize the building backbone. The specification requirement that no node has more than two routers between it and the backbone helps ensure that the installer doesn't bog down a local control bus by forcing traffic from a second local control bus to traverse the first local bus to get to the backbone.

2-6.5 **Other architecture issues**

2-6.5.1 **Multiple controllers per HVAC system versus single controller**

The LONWORKS industry supports the notion of “distributed control”. In a conventional DDC system, a single relatively powerful controller with ample inputs and outputs is often used to implement a complete sequence of operation. While there are CEA-709.1 controllers that support this approach, another possibility is the use of multiple simpler interconnected controllers. For example, instead of using a single controller to control an air handler, the mixed air dampers may be controlled by a dedicated controller (or even a so-called “smart actuator”) which obtains relevant temperatures from other sensors on the network (“smart sensors”), obtains occupancy status and other information from other devices on the network and drives the dampers. Similarly, the cooling coil valve could be driven by a simple controller whose only output would be a 4-20 mA control signal to the valve.

While this approach to HVAC control is not necessarily unique to CEA-709.1 based hardware, this approach does seem to be better supported by LONWORKS than other protocol technologies. As with any approach, distributed control has its own set of advantages and disadvantages.

Advantages:

- Simple controllers. Programmable controllers are not needed, which eliminates custom programming and programming software. A small selection of simple controllers can be used for all control schemes. This would allow an installation to standardize on a set of controllers and ease the training requirements for the O&M Staff.

- Supportable by multiple vendors. Since the devices have simple functionality it is easier to find a replacement device from a different vendor with the same functionality.

- Documentation. It is easier to document the actual controller and controller functions/settings.

- No long home-runs of wire. Controllers may be located at the sensors/actuators they interface, or the sensors/actuators may be the controllers ('smart' sensors/actuators) which reduced the wiring requirements.

Disadvantages:

- Execution of the system sequence may require communication between multiple controllers which in turn may require a functional network. One work-around to this issue is to create a local control network dedicated to the system and isolate this from the rest of the building with a router (this will protect the local network from most network failures elsewhere in the building).

- Harder to document. While the individual controllers were easier to document, the system sequence may be harder to document since it is distributed among multiple controllers.

- Controllers not in one location. The controllers for a single system may be scattered about the mechanical room, or even outside the mechanical room.

UFGS 23 09 23 places the burden on the Contractor to decide when distributed control should be used.

2-7 ADDRESSING, DATA TRANSMISSION, AND DATA INTEGRITY

2-7.1 Addressing

All network protocols, including CEA-709.1, define an addressing scheme: a method of delivering messages to a specific device on the network. CEA-709.1 defines several such methods. The Domain/Subnet/Node method is shown and used in the current UFGS/UFC criteria. While it requires more care to set up than the use of NodeIDs (another common method) the advantage of the Domain/Subnet/Node method is that the addressing scheme can and should reflect the logical organization of the control

network and is therefore more readily managed. For example, a large building may consist of subnets 105 – 110, with a large AHU controller at subnet 108, device 1 and its associated VAV boxes at subnet 108 including devices 2-35. In comparison, if NodeIDs were used, the addresses would all essentially be random numbers between 1 and 281 trillion. The specification requires the use of the Domain/Subnet/Node addressing scheme with documentation of the NodeIDs for DDC Hardware.

The installer should assign the Domain/Subnet/Node address to DDC Hardware according to installation-specific guidelines established for the UMCS. The choice of whether or not to put all devices on a single domain is complex. In concept the use of a single domain base-wide is straightforward, but in practice there are a number of issues to be considered:

- Devices that need to communicate with each other should be on the same domain, as you cannot bind network variables across domains. You can have the front end read a value from a controller on one domain and write it to a different controller on another domain, but this is discouraged. This “limitation” is seldom an issue; controllers that need to talk to each other are generally on the same subnet and almost never required to be on different domains.

- There are performance issues associated with large domains. The network configuration tool will open a 500 device domain faster than it will a 2000 device domain, so in this regard, it is better to have four 500 device domains than one 2000 device domain.

- A typical installation may have a few vendors (say four or five) who install the vast majority of building networks on the installation. While the specification is designed to allow multiple vendors to work with a single base-wide LNS database, there may be advantages to allowing each major vendor to have a separate LNS database (reduced potential for finger pointing, less potential for device renumbering, easier LNS database merging, perhaps easier for building vendors to use their own network configuration tool, etc.). This is not a problem, as the UFGS requires that the Monitoring and Control software support multiple LNS databases. This will require multiple domains, as a single domain cannot span multiple LNS databases.

As a practical matter, any single DDC project will almost certainly use a single domain; it is highly unlikely that multiple domains will be used within a single contract. The subnet address will often reflect some logical grouping within the system. A single subnet will often suffice for a smaller building; larger buildings may require several subnet addresses. At the lowest level are individual node addresses; each DDC Hardware device on a subnet must have a unique node address.

2-7.2 **Data transmission**

The CEA-709 data transmission speed is 78.1 kbps and there are 2 primary mechanisms through which data transfer data occurs; polling and binding. These data transfer aspects of the protocol along with the quantity of data transferred govern how much bandwidth is used.

Polling occurs when a receiver of data requests data from a transmitter. This is generally a periodic event with a defined period. Collection of trend data is an example of polling where every 15 minutes a UMCS front-end workstation requests data from several DDC hardware devices. Polling can occur at any time and a device can always poll another device for data.

Binding is used to create another form of data transfer where bindings between one or more devices are set up during network configuration. As a result of binding, a data source sends (on its own initiative) data to a recipient. There are several parameters that control the frequency of this transfer:

- Change of Value (COV). The transmitting device can be configured to only send the data if it changes by a minimum specified amount. For example, a controller that is measuring outside air temperature might be configured to transmit a new temperature value only if the current value changes, from the last value transmitted, by greater than 0.5 degrees. UFGS 23 09 23 requires use of COV whenever possible (some DDC Hardware, particularly ASCs, may not support use of COV in all situations).

- Minimum send time. The transmitting device can be configured not to send the data more often than once every ***X*** seconds. This is an important parameter for limiting network traffic; most HVAC control applications (except for example pressure or flow control applications) do not require “real-time” data and therefore data need not be transmitted more often than once every couple of seconds even if it is rapidly changing. UFGS 23 09 23 requires a minimum send time of 5 seconds for traffic between DDC Hardware

- Maximum send time. The transmitting device can be configured to send the data at least once every ***X*** seconds, even if the value is not changing. This is generally a good practice just in case something goes wrong. For example, if the receiving device is reset, it may not “remember” older data and therefore may not have the value until it is retransmitted. A typical maximum send time might be 20 minutes. UFGS 23 09 23 requires a maximum send time of 20 minutes for traffic between DDC Hardware

While binding is almost always preferred to polling due to better network efficiency, there are several cases where polling is recommended:

- When the data transmission is of a temporary nature, such as points on a graphic. If the points were bound to the graphic, all points on all graphics would be bound and all the devices would send all the data to the Monitoring and Control server constantly, even if the graphic was not being viewed. By

polling, the Monitoring and Control server can request only the data it needs – i.e. data for the graphics pages currently being viewed.

- When the device does not support binding. Frequently, the Monitoring and Control server and Local Display Panels will not support binding data to them. In this case, polling is the only option for data transmission.

2-7.3 **Data integrity**

There are several parameters that govern data integrity: how the protocol ensures reliable data communication with less-than-perfect hardware, noisy lines, “glitches” and other real-world events. With binding, there are several common means to send data and each has advantages and disadvantages:

- Unacknowledged send once. The data is sent one time and one time only. This requires the least network bandwidth, but does not provide any assurance that the data reaches the recipient.

- Unacknowledged send multiple. The data is sent multiple times (typically three). It is up to the recipient to deal with receiving the same data multiple times. This requires more bandwidth than the send once option but is still fairly fast because the transmitter does not wait for any acknowledgement. It simply sends the data ***X*** times and moves on.

- Acknowledged send. The data is sent once. Upon receipt of the data, the receiver must send an acknowledgement message back to the transmitter. If the transmitter does not receive the acknowledgment within a pre-determined period of time (the “timeout”), the transmitter will resend the data. This is the slowest method, but is a good trade-off between reliability and network bandwidth usage. This is typically used for alarms, where it is essential that the data gets transferred. This is the required method for traffic between DDC Hardware. (Communication between DDC Hardware is almost always part of a control sequence.)

CHAPTER 3
DIRECT DIGITAL CONTROL HARDWARE AND CONTROL DEVICES

3-1 INTRODUCTION

This chapter describes control devices and the DDC Hardware specified in UFGS 23 09 23 including the extended requirements needed to implement an Open system. It also describes the related terms and concepts pertaining to LONWORKS technology and the underlying CEA-709.1 communications protocol (more commonly known as LonTalk®). For additional technical information on LONWORKS, see:

https://eko.usace.army.mil/fa/bas/

3-1.1 SNVTs

During inter-communication, nodes share data and information by transmitting and receiving network variables (the messages exchanged between devices). Specifically, UFGS 23 09 23 requires the use of the Standard Network Variable Types (SNVTs) as defined by LonMark International. In general a SNVT is a command, a status, or a variable (such as temperature, pressure, humidity, etc.), but a SNVT can contain other types of information.

3-1.2 Functional profile

LonMark International defines Functional Profiles for LonWorks devices or nodes. A Functional Profile describes standard node communications and consists of mandatory and optional input and output SNVTs, mandatory and optional configuration properties, and finally a manufacturer specific section.

Functional profiles are useful in that they help define communication/data exchange requirements and network interfaces, but they do not go far enough to ensure that devices will interoperate with other devices in accordance with UFGS 23 09 23. At issue is that control sequences in UFGS 23 09 23 require SNVTs that are only optional in the corresponding Functional Profile. Therefore, the Functional Profile, in itself, is not sufficient to ensure that a device has the required inputs/outputs for a specific sequence of operation. Points Schedule drawings, as specified in UFGS 23 09 23, are used to define these extended requirements.

While there is a LonMark Functional Profile available for scheduling of devices, it is unsuitable for the control sequences defined in DDC UFGS 23 09 23 and should not be used.

3-2 DDC HARDWARE

Any device, other than network hardware, that communicates over the CEA-709.1 network is considered DDC Hardware. In general, the term DDC Hardware is used interchangeably with the term controller, but there are devices such as smart sensors and actuators that are considered DDC Hardware but are not traditionally called controllers even though they may in fact have control functionality (like a feedback control loop). Another term commonly used is “node”, where a LonWorks node is any device that resides on the LonWorks network and communicates via the CEA-709.1 protocol. This includes smart sensors, smart actuators, and controllers, along with a variety of other microprocessor-based devices.

There are several requirements that all DDC hardware must meet. They must:

- Be locally powered: Basically, there are two ways to provide power to a piece of DDC hardware. A link powered device receives its power from the same wire that is used for communication. A local powered device receives its power on a separate set of contacts. Note that a local powered device does not typically include it’s own transformer, the requirement is simply that the device be connected to a local power source, not one over the network. This specification requires that one method be used for consistency and ease of O&M. As the more common and more intuitive option, local power was selected.

- Communicate only using CEA-709.1B

- Meet the LonMark Interoperability guidelines. These guidelines provide a foundation for interoperability and devices meeting these guidelines are readily available.

- Use a TP/FT-10 transceiver for use on a TP/FT-10 network

- Support 78.1 kbps data transmission

- Be provided with an external interface file (XIF file). This is a text file that tells a Network Management Tool what the interface (inputs, outputs, configuration settings) of the controller is.

- Meet accuracy requirements. Requirements for I/O accuracy are not given directly; instead the requirement is that end-to-end error (i.e. accuracy at the SNVT value) be no worse than 150% of the allowed sensor error. This allows the Contractor flexibility in matching sensor ranges and controller A-to-D converters to the application.

Some of these requirements may be difficult to confirm for some devices, specifically programmable controllers. Product data sheets can provide a good indication of whether a device, particularly an application specific controller, meets LonMark Guidelines. In addition, LonMark International has a self-certification checklist that vendors can use to certify that a device meets the LonMark Guidelines.

DDC Hardware is further broken down into three categories, Application Specific Controllers, Application Generic Controllers, and General Purpose Programmable Controllers, each of which has additional requirements it must meet.

3-2.1 **Application specific controller**

An application specific controller (ASC) is supplied with a factory-installed (and fixed) application program. Example ASCs include VAV box controllers, fan coil unit controllers, 'smart' actuators and 'smart' sensors. An ASC is *configured* for the specific application in which it is used. This configuration does not change the function of the device, but changes settings within the device such as setpoints and other operational settings. The specification requires that ASCs meet several requirements in addition to the general DDC Hardware requirements. For example:

- An LNS® Plug-in must be provided to perform device configuration and all configuration needed for the device must be able to be performed either via this Plug-in or physical settings on the device itself (such as jumpers or dip-switches). The purpose of this requirement is to prevent the need for proprietary configuration tools. Note that UFGS 23 09 23 allows this requirement to be waived in cases where a device with a plug-in is not available (where there is no commercially available device that contains a plug-in) and the Government has approved the exception.

- The ASC must be LonMark Certified. Again, an exception can be made for cases where there is no certified device available for a specific application.

Depending on the needs and requirements of the project or specific applications, such as minimal cost and simplicity, the designer may choose to prohibit the use of General Purpose Programmable Controllers (GPPCs) described below and instead require the use of ASCs. In doing so, the designer should first ensure that appropriate products are commercially available for the application.

3-2.2 **Application generic controller**

An application generic controller (AGC) is similar to an ASC, but has a limited programming capability. Programming these controllers does not change the controller ProgramID, so these controllers can be (and often are) programmed through an LNS plug-in. UFGS 23 09 23 has separate requirements for AGCs which includes a mix of ASC and GPPC requirements.

While in general, these controllers are limited in power and flexibility compared to GPPCs, most of these controllers are capable of executing the sequences specified in UFGS 23 09 23. Further, since they can be re-programmed remotely and without changing the program ID, they are often preferred to GPPCs.

3-2.3 General purpose programmable controller

A general purpose programmable controller (GPPC) comes from the factory without a fixed application program (i.e. has no application program installed, or the program may be over-written). This type of controller must be *programmed* for the application in which it is used. This makes the GPPC more flexible and powerful than an ASC, but more complicated and costly as well. The specification requires the GPPC to meet several requirements in addition to the general DDC Hardware requirements:

- The programmed GPPC shall conform to the LonMark Interoperability Guide. This requirement is in lieu of the requirement (for ASCs) to be LonMark certified.

- The software that is required to program the controller must be provided. This software will be needed if it is ever necessary to reprogram the controller.

- A copy of the program that is installed in the controller must be submitted. This copy needs to be in the form of source code readable by the provided programming software. Not only can this program can be loaded into a replacement controller, it can be modified to change the functionality of an existing controller. The intent of this requirement is so that the installation can later modify the program or replace the controller without requiring assistance from the original vendor.

3-2.4 Local display panel

The local display panel (LDP) is an ASC with a small display screen and some navigational buttons used to view and/or change the value of network variables. Although the functionality of an LDP is limited as compared to an operator workstation computer, it can be a useful diagnostic tool for maintenance staff.

There is potential for conflict between the LDP and the Monitoring and Control Software when using an LDP to change (override) a network variable. The device receiving the override will be overridden to whichever source most recently "spoke" to it which may result in some confusion. The value of specifying LDP override capability may be sufficiently beneficial to compensate for the potential confusion, but this should be coordinated with the project site.

3-2.5 CEA-709.1 sensors and actuators

Sensors and actuators may communicate using the CEA-709.1 protocol over the TP/FT-10 Building Control Network. These sensors and actuators are considered to be ASCs (or possibly GPPCs as appropriate) in addition to being actuators or sensors and therefore must meet the requirements of both the sensor/actuator and of an ASC (or GPPC). A common example of this device is a variable frequency drive unit containing a TP/FT-10 network interface. The use of sensors and actuators that contain a TP/FT-10 interface, in accordance with UFGS 23 09 23, is left to the discretion of the

Contractor. Project specific requirements may dictate that the Designer require a TP/FT-10 interface.

3-2.6 Building management interface

A small scale building-level network might call for a building management interface (BMI) node. The BMI should only be used in the absence of a UMCS, and is not specified in either UFGS 23 09 23 or UFGS 25 10 10. The BMI provides web services and can also perform scheduling, logging (trending), alarming, and other supervisory interface functions. A disadvantage of the BMI is that, while it is an Open protocol device at the building level, it likely will not support Open standard communications over the IP network in accordance with UFGS 23 09 23 or UFGS 25 10 10. Specifically, the BMI does not perform routing functions. If it is later decided to connect the building to a UMCS, the BMI will need to be replaced and any functionality in the BMI will need to be accomplished in an Open manner in accordance with UFGS 23 09 23 or UFGS 25 10 10. At the very least, an EIA-852 router will need to be installed as the BPOC.

3-3 FIELD DEVICES

3-3.1 Sensors (input devices)

Many of the control sequences have, as a designer option, a safety reset button (RST-BUT). In the event that a safety input to the DDC Hardware is activated, resulting in control system shutdown, the RST-BUT is used to reset the control system. Exact requirements and function are dictated by the specific sequence of operation. When determining whether to require a button or allow reset from an operator workstation, consideration should be given to the convenience of reset from an operator workstation versus the safety of initiating a reset by a technician with “eyes-on” the system.

Night stat is the common name for the building temperature (BLDG-T) low-limit sensor. This is typically just a temperature sensor placed in a representative location that acts as a safety to turn on the heat if the building gets too cold. In a single-zone system, the night stat may simply be the zone temperature sensor (ZN-T).

3-3.2 Actuators (output devices)

Electric actuation is recommended for all new construction and for any location where a source of control-grade compressed air does not already exist. Where the installation requires pneumatic actuation, ensure that a compressor is specified.

3-3.3 Multi-function devices

Thermostat (STAT). While the technical definition of a thermostat is a self-contained controller that generates a control output, this UFC uses a more loose definition. In this UFC and in the accompanying specifications a thermostat is defined as a space

mounted device with inputs and outputs to and from a piece of DDC hardware. Ordinarily a STAT will contain a room/space temperature sensor and provide display of space temperature. Depending on the application, it might also provide for occupant (user) adjustment of the space or room setpoint. The STAT might also contain a momentary contact button (input to DDC Hardware) that permits the occupant to override the unoccupied mode so as to temporarily place the control system into the occupied mode. This is sometimes referred to as OCC Override. Alternatively, the STAT might contain an occupancy sensor to provide the OCC Override function. Some sequences have additional operator inputs (typical mode or fan controls) that require additional input(s) at the STAT. In many cases, a STAT will fall under the definition of an ASC, in which case it must meet the DDC Hardware requirements.

CHAPTER 4

TYPICAL CONTROL LOOPS

4-1 INTRODUCTION

This chapter describes typical control loops including designer selections such as control setpoints. Part of the intent is to describe preferred or definitive control loops where commonality from designer-to-designer and project-to-project will aid in the operation, maintenance, and support of the installed control systems. The development of control logic diagrams, used to define detailed control sequences, is also described.

4-2 BASIC CONTROL LOOP

A basic control loop schematic, as shown in Figure 4-1, is comprised of a sensor, a DDC, and the controlled device. A sensor is the input component of the control loop that measures the controlled variable (such as temperature, relative humidity, pressure, air flow rate, or carbon dioxide). A controller is the decision-making component of the control loop that compares the controlled variable to the setpoint and provides a corrective output signal. Controlled devices are output components of the control loop and typically include valves or dampers.

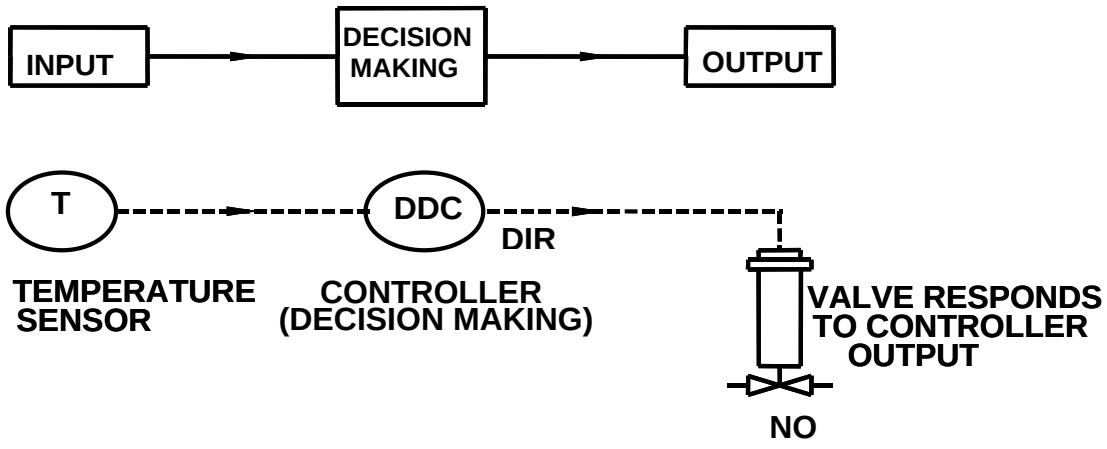


Figure 4-1. Basic Control Loop.

4-2.1 Control action and device failsafe

If the power source or control signal to an actuator (or other device) is lost or disconnected it may be desirable for the device to move to a failsafe position. The intent

is to provide for equipment protection, such as protection against freezing, and must be selected/specified by the designer. Failsafe positions can be: normally open (NO), normally closed (NC), or Fail-In-Last-Position (FILP). A NO device will move to the open position and a NC device will move to the closed position. In the case of an actuator, movement to the NO or NC position is accomplished under the power of a spring internal to the actuator. A FILP device ordinarily has no spring and as a result, upon loss of actuator power or control signal, the device remains fixed at its last position. FILP is generally not useful nor advised as a failsafe but is usually the most inexpensive option for an electric actuator and is intended for applications where a true failsafe is not needed such as terminal unit actuators. Generally, terminal units do not require NO or NC actuators; FILP is sufficient. Valve and damper failsafe positions are to be specified. When a device is specified as either NO or NC, the corresponding direct (DIR) or reverse (REV) action of the controller should also be specified such that the action pairs up with the specified failsafe position.

4-2.1.1 **Direct control action**

A controller that has been configured to provide DIR control action will generate an output that moves in the same direction as the controller input. An example control loop that uses DIR control action with a normally open valve is shown in Figure 4-1. Figure 4-2 shows how the controller output changes as the temperature input changes. As the temperature input increases, the DIR acting controller output increases, and the normally open valve will move towards the closed position.

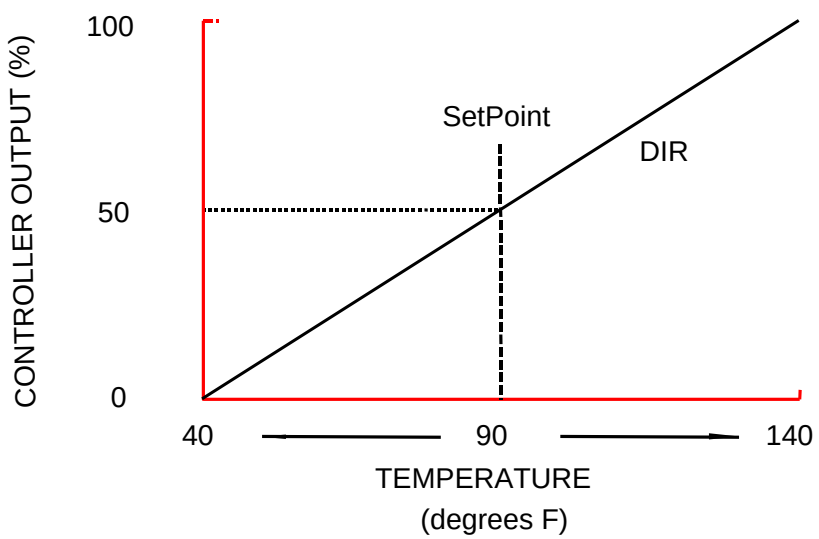


Figure 4-2. Direct Control Action

4-2.1.2 Reverse control action

A controller that has been configured to provide REV control action will generate an output that moves in the opposite direction as the controller input. Figure 4-3 shows how the controller output changes as the relative humidity input changes as a result of REV control action. An example of REV control action would be a humidifier application with a normally closed valve. As the humidity input increases, the REV acting controller output decreases, and the normally closed valve will move towards the closed position.

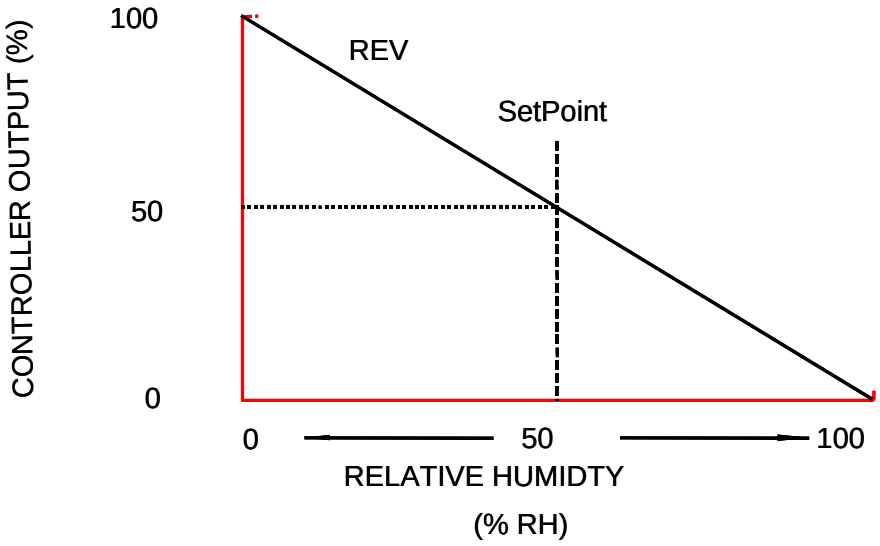


Figure 4-3. Reverse Control Action

4-3 CONTROL LOGIC DIAGRAMS

A control logic diagram (CLD) is a detailed graphical and functional representation of the control system sequence of operation. The CLD supplements the written sequence of operation. Designer use of a CLD is optional, but recommended.

Ordinarily, the CLD will consist of a basic sequence that describes a control loop. In addition it will include enabling logic used to activate the loop. The enabling logic used depends on the loop and on the requirements of the application. An example of basic enabling logic for a mixed air control loop is: 1) the economizer must be ‘on’, and 2) the air handling unit fan(s) must be running.

4-3.1 Control logic diagram basic sequence

The procedure for developing a CLD begins with a basic sequence which typically includes a proportional-integral-derivative (PID) control loop with a process variable and

a setpoint (SP) input along with a control signal output. Figure 4-4 shows an example of a basic PID block. It has two analog inputs, one analog output, one (shown) configuration property, and one binary input:

- SA-T: Supply Air Temperature, an analog (A) hardware input.

- SA-T-SP: Supply Air Temperature, an analog input from "elsewhere". This signal may be defined elsewhere on the CLD for that system, it may be an output from another system, or it may be shown as an input to the system on the Points Schedule drawing. In this case, SA-T-SP is a configured setpoint and would be shown as such on the Points Schedule drawing.

- CLG-V-C: Cooling Valve Command, a hardware analog (A) output. Note that the CLD does not distinguish between NO and NC valves nor DIR or REV control action. These details are specified/shown in the control schematic drawing. From the perspective of the CLD, a 10% signal output corresponds to the valve being 10% open, it is irrelevant whether this corresponds to 9 Volts, 8 PSI, or any other "physical" value. Similarly, the CLD does not distinguish DIR acting versus REV acting control – the CLD treats all controllers as direct acting where the output moves in the same direction as the controller input.

- CLOSED: A default value; the value assumed by the PID output when the loop is disabled. This will be a configuration property whose value will also be shown on the Points Schedule. Note that there are many other configuration properties associated with a PID loop; the others are not necessary for a basic understanding of the operation of the system and are not shown on the CLD.

- CLG-ENA: Cooling Enable, a binary input from "elsewhere". In this case, CLG-ENA will be defined/generated in the system enabling logic portion of the system CLD. When this signal is TRUE, the loop is enabled, active, and controlling CLG-V-C to maintain SA-T at SA-T-SP. When this signal is FALSE, the PID loop output will assume the (shown) default output.

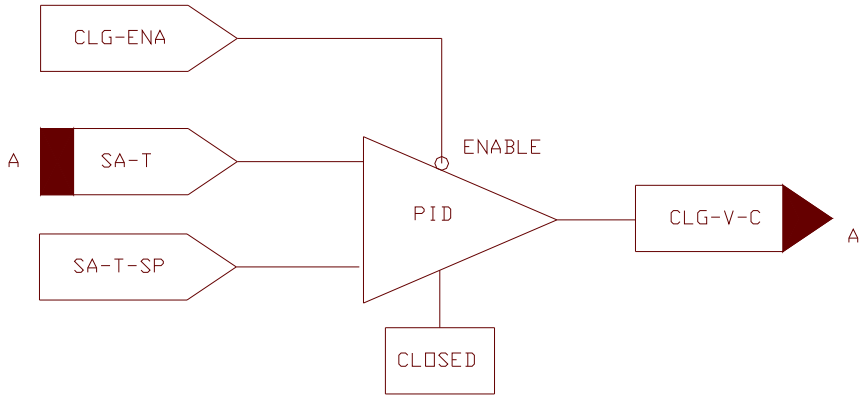


Figure 4-4. Basic Sequence for a Cooling Coil Control Loop.

4-3.2 System enabling logic

Figure 4-5 shows enabling logic at the system level, including the logic that enables the cooling loop (CLG-ENA) as shown in the lower right hand corner of Figure 4-5. This block has multiple inputs and outputs:

- SF-S: Supply Fan Status; a hardware binary (B) input proof that the supply fan is running. This can be from a current sensing relay, flow switch, or feedback from a variable frequency drive unit; the exact mechanism is unimportant.

- RF-S: Return Fan Status; a hardware binary (B) input.

- FAN-DIS: Fan Disable; a binary signal from the “Alarms and Shutdown” block; this is TRUE when an alarm occurs and the air handling unit should be shutdown.

- SYS-OCC: System Occupancy; a network binary signal from the system scheduler providing system occupancy status.

- BLDG-T-LL-SP: Building Temperature Low Limit SetPoint; a configured analog input. This is the night-setback temperature.

- BLDG-T: Building Temperature; a hardware analog (A) input from the night stat

- FAN-FAIL: A binary signal (to the “Alarms and Shutdown” block diagram) indicating a fan has failed (not running when it should be).

- SYS-ENA (and SF-SS): A binary signal indicating that the system is enabled and running. Note this same signal is also used as a hardware binary (B) output to the fan. This signal is true whenever the system is commanded to be on (either due to occupancy or night stat) and the system is not being shutdown due to an alarm condition.

- CLG-ENA (and ECO-ENA): A binary enable signal to the cooling block and economizer blocks, respectively, enabling those loops. This signal is enabled whenever the SYS-ENA is TRUE and the occupancy is OCCUPIED or WARM UP / COOL DOWN.

- MINOA-ENA: A binary enable signal to the MIN-OA control block. This signal is enabled whenever the SYS-ENA is TRUE and the occupancy is OCCUPIED.

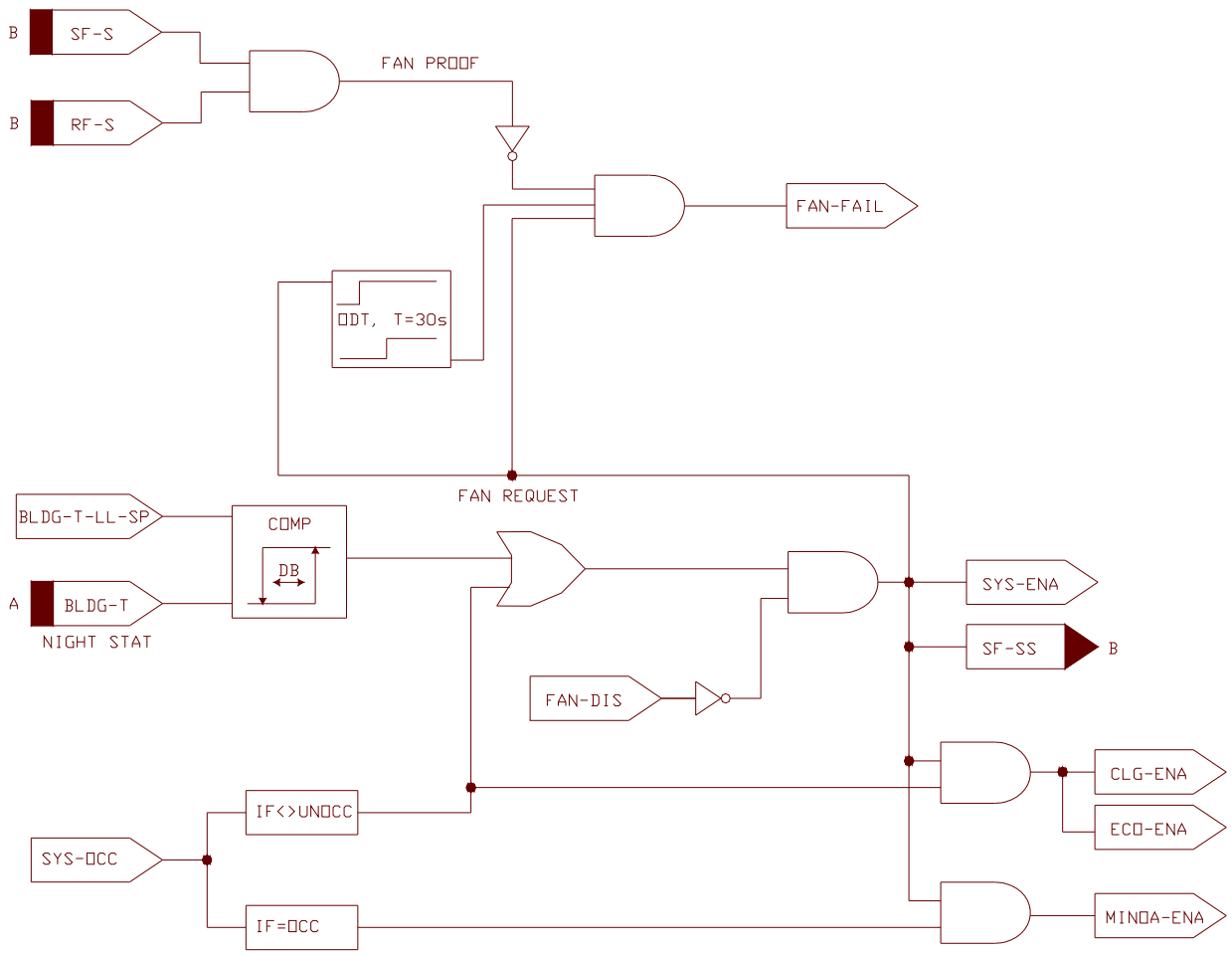


Figure 4-5. System Enabling Logic.

4-3.3 **Alarms and shutdown CLD**

Figure 4-6 shows logic used to shut the system down in case of an alarm condition. It has multiple inputs and outputs:

- PH-T-LL: Preheat Temperature Low Limit; a hardware binary (B) input from the freeze stat. This will be from a contact that closes upon a drop in temperature below the freeze stat setpoint. Therefore this signal is true when the freeze stat “trips”. Note there is an implied setpoint here: the freeze stat trip setting. This is not shown in the CLD because this as a hardware configuration setting (something that gets adjusted via setscrew at the freezestat) and is shown in the Points Schedule. Note that the example CLD shows a freeze stat for the preheat

coil. In the absence of a preheat coil the freeze stat would be in a different location (such as at the cooling coil).

- SA-P-HL: Supply Air Pressure High Limit; a hardware binary (B) input from the duct high pressure limit safety switch located at the outlet of the fan. This input is from a contact that closes upon a rise in pressure above the pressure switch setpoint. As with the PH-T-LL the SA-P-HL setpoint is implied in the CLD and its setting is shown in the Points Schedule. Note that while the example CLD shows a SA-P-HL this only applies to a VAV air handler and (ordinarily) should not be shown in a non-VAV system.

- SA-SMK and RA-SMK: Supply (Return) Air Smoke; hardware binary (B) inputs from the smoke detectors.

- FAN-FAIL: A binary signal from the System Enabling Logic indicating fan failure.

- RST-BUT: Reset Button; a hardware binary (B) input (to the DDC control logic) from a pushbutton located at the AHU (or AHU control panel). This signal clears the system failure and resulting shutdown due to any of the above alarms.

- FAN-DIS: Fan Disable: A binary (B) signal which goes to the System Enabling Logic to disable the system.

The CLD shows one other component, a set/reset (S/R) Latch used to “remember” the system failure until the failure is cleared via the RST-BUT input. The designer needs to specify the setpoints for the PH-T-LL and SA-P-HL alarms.

Note that the alarm conditions are dealt with directly by the sequence running in the DDC Hardware. As a general rule, alarm conditions must be dealt with in the control system sequence of operation. While an alarm should be sent to the M&C server, the sequence must place the system in a “safe” mode and not rely on operator intervention.

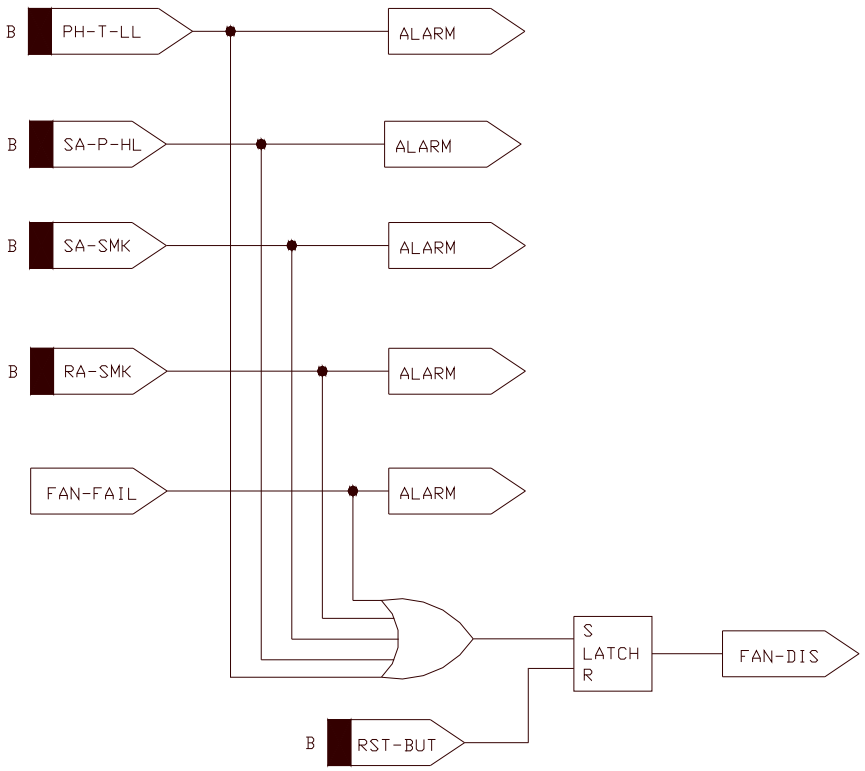


Figure 4-6. Alarms and Shutdown CLD.

4-4 CONTROL LOOPS

4-4.1 Preheat coil control loop

A minimum amount of outside air (OA) must always be used in HVAC systems. In cold climates preheating the OA avoids the freeze-up of coils and raises the temperature of the OA before using it in the system. Preheated OA is usually mixed in the return air plenum with a setpoint between 40° and 55°F depending on the application. For example, a 40°F setpoint might be used when there is a downstream coil to further condition the air while a 55°F setpoint might be used when there is no downstream coil. Figure 4-7 shows the preheat coil temperature loop schematic, and Figure 4-8 shows the CLD for preheat coil control. Designer selections for this loop include: (1) Preheat coil discharge air temperature setpoint (2) Preheat coil temperature low limit (PH-T-LL) (referred to as the Freeze stat) setpoint, (3) Valve size (C_v), (4) valve shutoff pressure/force, and (5) Control action of the controller. Note that the freeze stat is shown on the Preheat Coil Loop Control Schematic because that is **physically** where it is located and is shown on the Alarms and Shutdown CLD (not the Preheat Coil CLD) because that is where it is **logically** located.

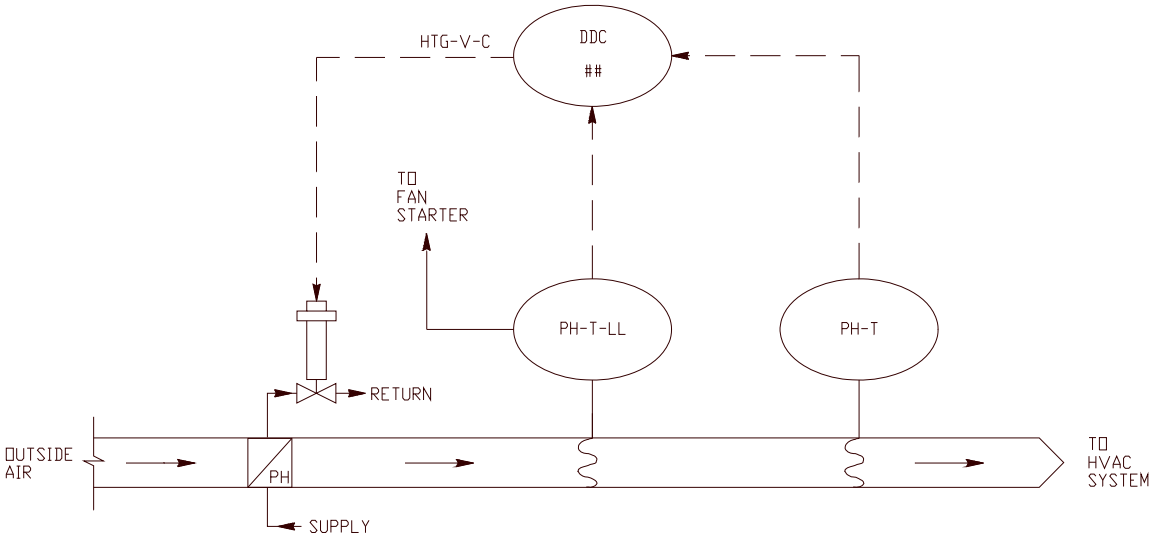


Figure 4-7. Preheat Coil Control Schematic.

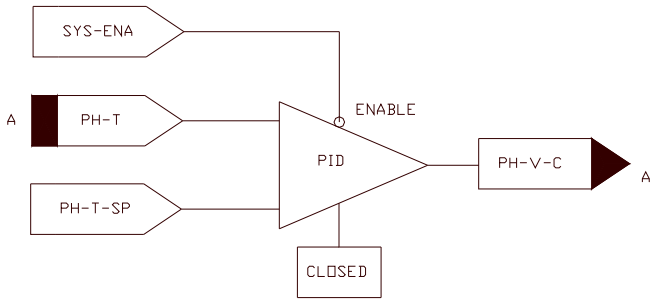


Figure 4-8. Preheat Coil CLD.

4-4.2 **Cooling coil control loop**

The cooling coil control loop is a constant-temperature control loop. The cooling coil valve is ordinarily chosen to be NC as an energy conservation measure and the corresponding control action will be DIR. As a failsafe against freezing, the designer might choose to select a NO valve with a corresponding REV control action (where if the AHU shuts down on freeze stat) since a fully open coil is less likely to freeze than a closed coil. A typical setpoint for the cooling coil control loop is 55°F, but will depend on the application requirements. In the event there is a mixed air temperature control loop, the cooling coil loop setpoint might be chosen to be slightly higher than the mixed air temperature setpoint. This slight difference in setpoints helps to keep the cooling coil valve closed while the mixed air temperature economizer is active. The cooling coil valve will open when the economizer loop does not maintain supply air temperature at or below the cooling coil loop setpoint. Figure 4-9 shows the cooling coil control loop schematic, and Figure 4-10 shows the CLD for cooling coil control. Ordinarily the control loop is enabled when: (1) the supply fan is proven to be on, and (2) the system is in the occupied mode. Note that the freeze stat is shown downstream of the cooling coil. This is to prevent false trips where upon system startup (such as at the beginning of the day) a surge of outside air is drawn into the air handler but after short amount of time becomes mixed with warmer return air. The designer my choose to locate the freeze stat upstream (such as in the mixed air section) particularly in the case where there is a heating coil upstream. In this case the cooling coil need not have a freeze stat but the heating coil should. As a rule, only one freeze stat is required per system. Designers are advised to check with local O&M staff for freeze stat location preferences. Suggested designer selections include the following: (1) Supply air temperature control setpoint (typical value of 55ºF), and freeze stat setpoint in the Points Schedule; (2) Values for valve size (C_v) and valve shutoff pressure/force in the Valve Schedule; and (3) Control action notation in the Control Schematic Drawing.

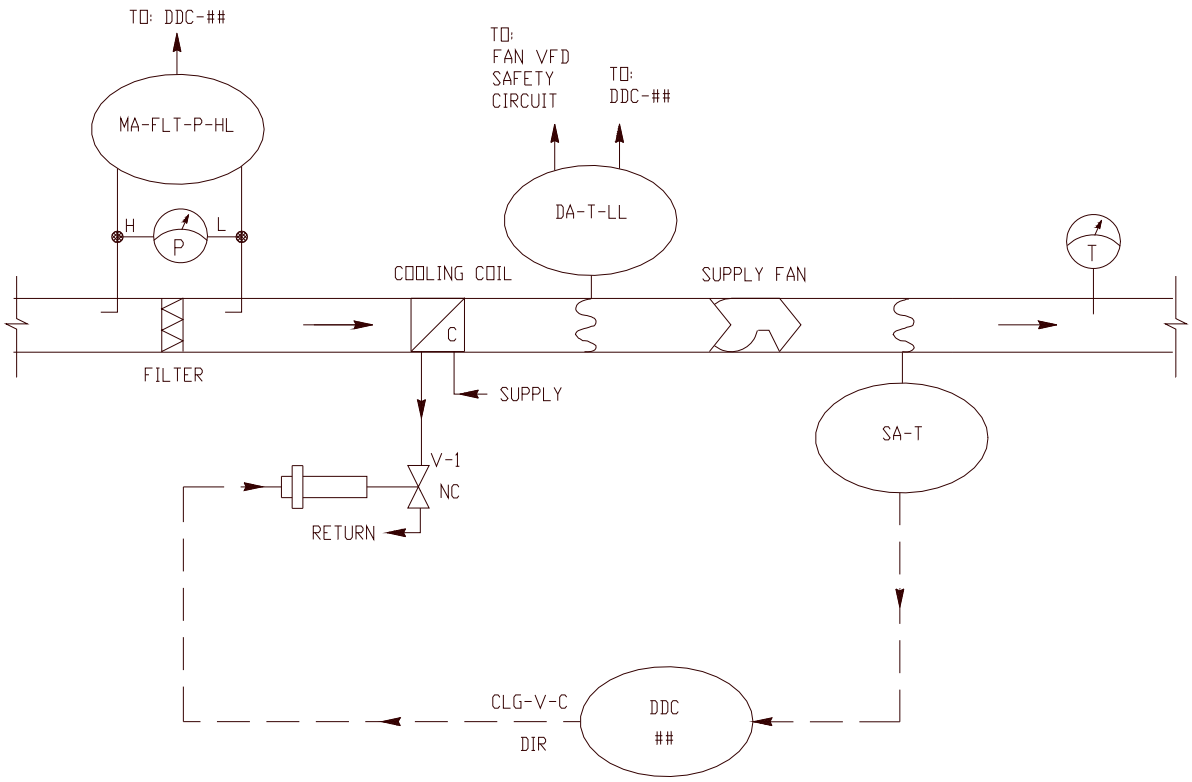


Figure 4-9. Cooling Coil Control Schematic.

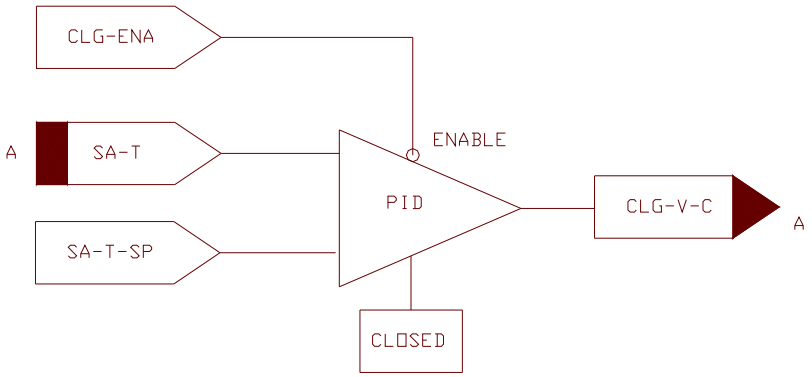


Figure 4-10. Cooling Coil CLD.

4-4.3 **Heating coil control loop with setpoint reset**

This control loop involves the control setpoint being adjusted (reset) based on a system variable (usually outside air temperature). Typical applications are (1) Heating hot water temperature (hydronic) and (2) Heating coil discharge air temperature.

A *reset schedule* defines the relationship between outside air temperature and setpoint temperature. Figure 4-11 shows an example of setpoint reset control, with the following characteristics: (1) heating coil discharge air temperatures of 120°F at 0°F outside air and below; (2) 90°F at 60°F outside air and above.

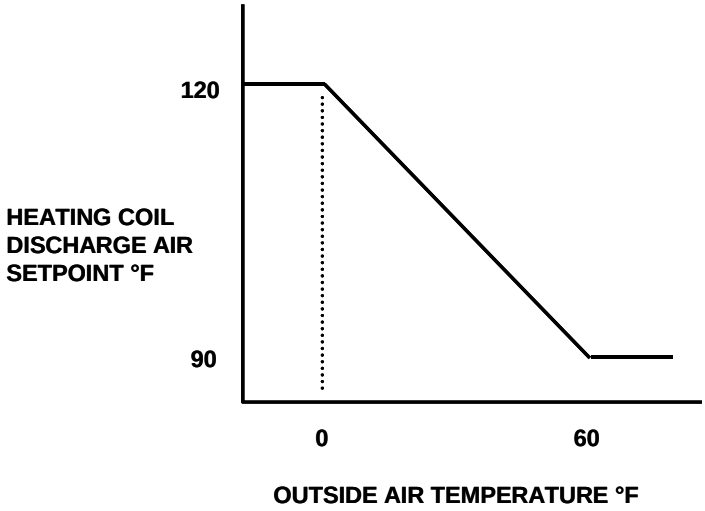


Figure 4-11. Typical Setpoint Reset Schedule for Heating Coil Air Temperature.

Figure 4-12 shows the heating coil with outside air reset control loop schematic. Suggested designer selections include the following: (1) Values for setpoint and freeze stat setpoint in the Points Schedule; (2) Reset Schedule, if setpoint reset is used; (3) Values for valve size (C_v) and valve shutoff pressure/force in the Valve Schedule; and (4) Control action notation in the Control Schematic Drawing.

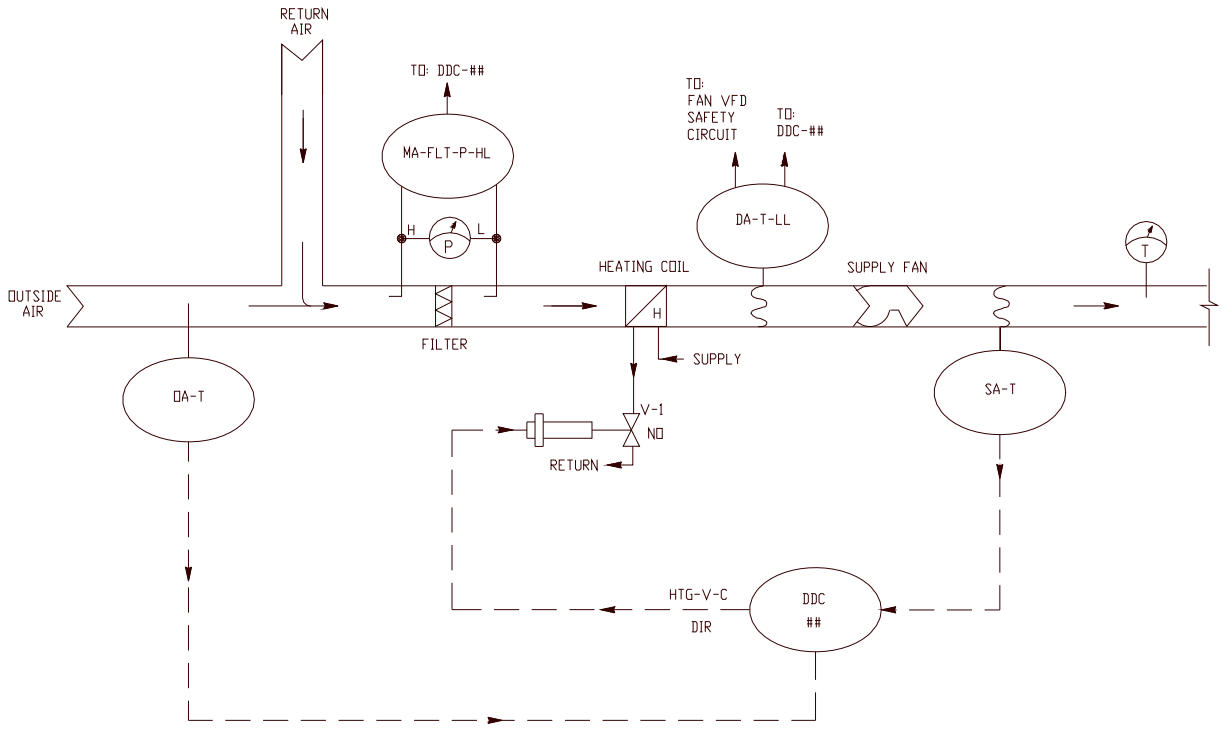


Figure 4-12. Heating Coil with Outside Air Reset Control Schematic.

4-4.4 Mixed air temperature control with economizer

An economizer functions as a switch to introduce outside air for “free cooling”. When the economizer is “on”, the mixed air temperature control loop DDC controller modulates the outside, return, and relief dampers. Modulation of the outside and return dampers regulates mixed air temperature (MA-T) to its specified setpoint while modulation of the relief damper serves to exhaust the additional outside air delivered to the building/spaces. When the economizer is “off” the economizer outside air damper is closed.

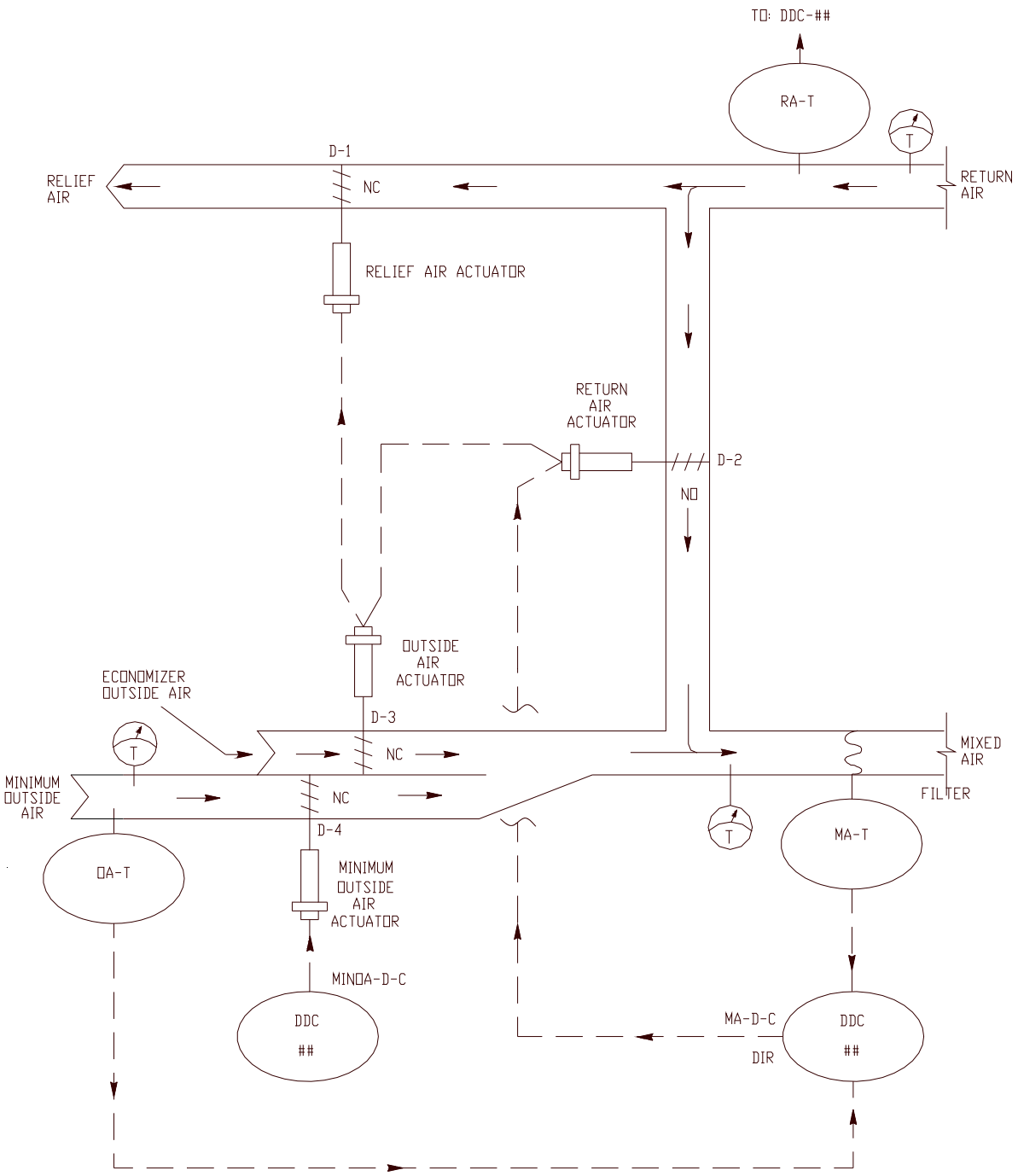


Figure 4-13. Economizer/Mixed Air Temperature Control Schematic.

4-4.4.1 OA-Only dry bulb economizer

Although there are many ways to perform the economizer on/off decision, a control system that uses only an outside air dry bulb sensor is recommended based on its simplicity and long term reliability as compared to other methods.

Figure 4-13 shows the OA-only dry bulb economizer control loop. It uses an OA dry bulb sensor and DDC controller to make the economizer on/off decision. When the Economizer is on, the controller sends a mixed air damper command (MA-D-C) to modulate the relief, return, and outside air dampers. When the economizer if off, the DDC moves the three dampers to their failsafe positions. Minimum outside air quantity is maintained by a separate control loop. The return air temperature sensor shown in figure 4-13 is optional and would be used only for temperature monitoring purposes.

Figure 4-14 shows the CLD for the OA-only dry bulb economizer. As described previously, the System Enabling Logic provides the SYS-ENA signal (based on occupied mode and fan proof). When the outside air temperature is less than the economizer high limit setpoint (ECO-HL-SP) a 'true' output is generated by the comparator (COMP). Similarly, when outside air temperature is greater than the economizer low limit setpoint (ECO-LL-SP) a true output is generated by the other comparator (COMP). When all three conditions are true the AND gate generates a true output enabling the MA-T PID loop. When the PID is not enabled the default output closes the OA economizer damper.

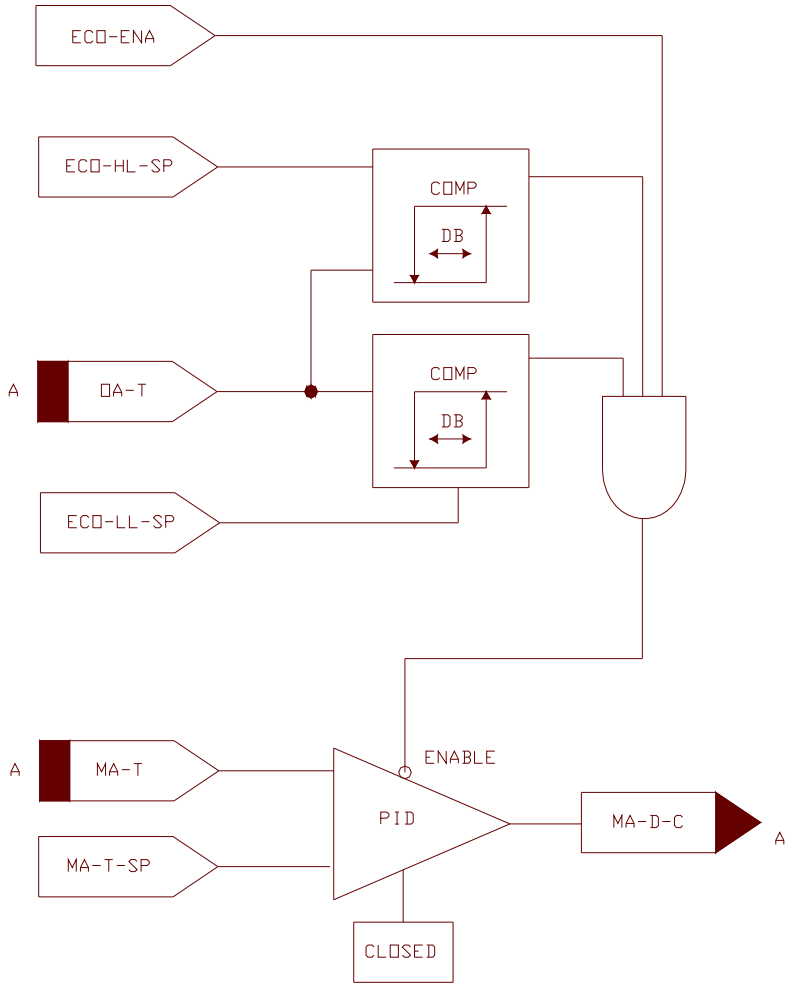


Figure 4-14. OA-Only Dry Bulb Economizer CLD.

4-4.4.2 OA-Only dry bulb economizer designer selections

The designer must select the economizer high limit setpoint (ECO-HL-SP), the low limit temperature setpoint (ECO-LL-SP), and the mixed air temperature setpoint (MA-T-SP).

4-4.4.2.1 Economizer high limit setpoint selection

Economizer high limit setpoint (**ECO-HL-SP)** is the dry bulb temperature below which the OA-only economizer turns “on”. The objective is to select it low enough so that the economizer turns on when the OA enthalpy is lower than the return air enthalpy, thus achieving free cooling. Since neither the return air enthalpy nor outside air enthalpy are being measured, assumptions must be made. Outside air enthalpy can be estimated based on the outside air dry bulb temperature using (local) average weather data. The ECO-HL-SP is then selected based on this estimation. Due to the assumptions made a margin of safety is then applied to the selection of ECO-HL-SP.

Figure 4-15 illustrates selection of the **OA-only economizer** setpoint for Greenville, NC:

1. Plot a constant enthalpy line through the return air design dry bulb temperature & relative humidity (A-B). In this example, 78°F and 50% RH. Caution: Give careful consideration to the return air condition. For example, if you follow this procedure for 78°F and 50% RH condition but the actual condition is 72°F and 50% RH, the economizer (on average) will turn on about 4°F or 5°F sooner than it should, resulting in wasted mechanical cooling energy.

2. Plot a weather line (C-D) for the worst case month, in this case July, using the midpoint of each OA dry bulb bin and corresponding mean coincident OA wet bulb. To help select the worst case month, you may choose to plot the average weather line for two or three summer months and then proceed to step 3. Wet bulb and dry bulb weather data is available through UFC 3-400-02 "Design: Engineering Weather Data" which references a data download site at **http://www.afccc.af.mil.**

3. Draw a vertical line down from the intersection of lines A-B and C-D to the dry bulb axis. This is Point E. (If you plotted multiple average weather lines, draw the vertical line down from the month that places Point E furthest to the left.)

4. For the **OA-only economizer**, the economizer high limit setpoint (ECO-HL-SP) is point E, or 67°F. Again, note the additional caution in step 1.

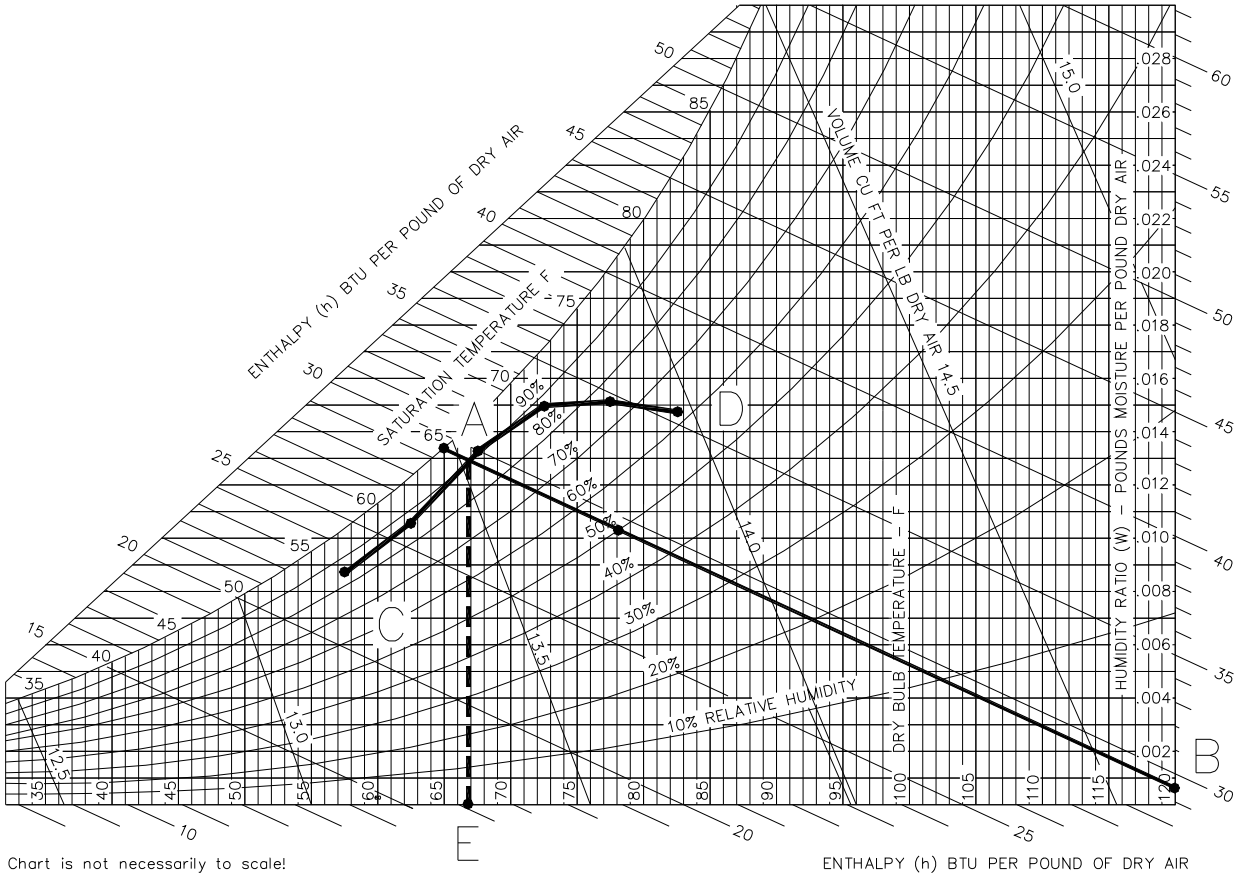


Figure 4-15. OA-Only Economizer Setpoint Selection Example for Greenville, NC.

GREENVILLE–SPARTANBURG APRT SO CAROLINA

LAT 34 54N LONG 82 13W ELEV 957 FT

MEAN FREQUENCY OF OCCURRENCE OF DRY BULB TEMPERATURE (DEGREES F) WITH MEAN COINCIDENT WET BULB TEMPERATURE (DEGREES F) FOR EACH DRY BULB TEMPERATURE RANGE

Temperature Range	MAY Obsn Hour Gp 01 to 08	MAY 09 to 16	MAY 17 to 24	MAY Total Obsn	MAY MCWB	JUNE 01 to 08	JUNE 09 to 16	JUNE 17 to 24	JUNE Total Obsn	JUNE MCWB	JULY 01 to 08	JULY 09 to 16	JULY 17 to 24	JULY Total Obsn	JULY MCWB
100/104															
95/99		0		0	69		3	1	4	74		2	1	3	74
90/94		7	2	9	69		21	6	27	74		27	7	34	74
85/89		33	12	45	68	0	49	21	70	72		75	28	103	73
80/84	0	49	25	74	67	4	64	41	109	70	3	79	53	135	72
75/79	4	50	41	95	65	19	53	55	127	68	34	47	82	163	71
70/74	25	43	62	130	64	74	31	67	172	67	152	17	66	235	69
65/69	83	31	52	166	62	97	16	38	151	64	52	2	11	65	65
60/64	70	23	33	126	58	37	4	8	49	59	6		0	6	59
55/59	37	9	15	61	53	9	0	1	10	54	1			1	55
50/54	17	3	6	26	48	1	0	0	1	50					
45/49	10		1	11	43										
40/44	2			2	39										
35/39	0			2	35										
30/34															

Temperature Range	AUGUST Obsn Hour Gp 01 to 08	AUGUST 09 to 16	AUGUST 17 to 24	AUGUST Total Obsn	AUGUST MCWB	SEPTEMBER 01 to 08	SEPTEMBER 09 to 16	SEPTEMBER 17 to 24	SEPTEMBER Total Obsn	SEPTEMBER MCWB	OCTOBER 01 to 08	OCTOBER 09 to 16	OCTOBER 17 to 24	OCTOBER Total Obsn	OCTOBER MCWB
100/104		0		0	75										
95/99		3	1	4	74		1		1	73					
90/94		32	8	40	74		9	2	11	71					
85/89	0	73	30	103	74		34	10	44	72		1		1	70
80/84	3	70	57	130	72		51	27	78	70		17	2	19	66
75/79	35	45	77	157	71	4	53	51	108	68		36	10	46	64
70/74	134	19	57	210	69	70	44	66	180	67	4	44	27	75	62
65/69	63	5	16	84	65	72	29	46	147	63	20	52	44	116	60
60/64	12	1	2	15	60	48	12	23	83	58	44	50	61	155	56
55/59	1			1	55	30	5	10	45	54	59	27	46	132	52
50/54						13	1	3	17	50	45	15	36	96	48
45/49						3	1	1	5	46	44	6	16	66	44
40/44											23	1	5	29	39
35/39											8	0	1	9	34
30/34											2		0	2	30

Figure 4-16. Greenville SC Weather Data for OA-Only Economizer Setpoint Selection Example.

4-4.4.2.2 **Low limit temperature setpoint selection**

Economizer low limit setpoint (**ECO-LL-SP**) is the dry bulb temperature below which the OA-only economizer turns ‘off’ when the OA temperature is cool/cold (e.g. 50ºF). As a practical matter, while the economizer is ‘on’, the mixed air control loop will modulate the dampers to maintain the mixed air setpoint. Therefore this low limit function is theoretically not needed, but it can help prevent nuisance tripping of the freeze stat and can also help stabilize the minimum outside air flow control loop by eliminating interaction between these two competing airflow paths. Selection of the ideal setpoint selection would require modeling to identify the heat/cool *balance point* of the building where, below the balance point, the building only needs heating. Modeling can be expensive and therefore not practical. An estimate of the ECO-LL-SP (balance point) is acceptable, usually 50ºF. Applications with high internal cooling loads may benefit from a lower setting.

4-4.4.2.3 **Mixed air temperature setpoint selection**

The mixed air temperature setpoint (MA-T-SP) should be selected to be the same as the cooling coil control loop discharge air setpoint (CC-DA-T-SP), typically 55°F, or 1°F to 2°F less than CC-DT-SP. A lesser setpoint helps to reduce or eliminate mechanical cooling while the economizer is ‘on’.

4-4.4.3 **OA/RA dry bulb economizer**

The OA/RA dry bulb economizer is a refinement of the OA-only economizer in that it takes into account the return air condition by sensing return air dry bulb. This economizer should be used with caution but can be beneficial where the return air condition is not constant such as in variable load and/or variable occupancy applications. More importantly, proper operation is highly dependent upon seasonal changes in space temperature setpoints in that heating mode space setpoints must be lower than cooling mode space setpoints. This is further discussed as part of the Condition 2 setpoint selection.

Figure 4-13 and Figure 4-17 illustrate the OA/RA dry bulb economizer. Unlike the OA-only economizer the OA/RA economizer uses both the outside and return air temperature sensor measurements. It operates when *both* of two temperature conditions are met:

1. Condition 1: The difference between return and outdoor air temperatures (RA-T and OA-T, respectively) is sufficient to use OA for free cooling. Specifically, RA-T minus OA-T is greater than the economizer differential setpoint (ECO-DIFF-SP)

2. Condition 2: RA-T indicates that there is a cooling load. Specifically, RA-T is greater than the ECO-HL-SP. Note that RA-T is not the only mechanism by which the economizer can determine if there is a cooling load. The designer may choose an alternate mechanism such as the status of the cooling coil valve position (where if it is not closed, Condition 2 is met).

In addition, as described previously, the economizer enable (ECO-ENA) signal must be ‘true’. This signal is generated by the System Enabling Logic (when the system is in occupied mode and supply fan proven ‘on’).

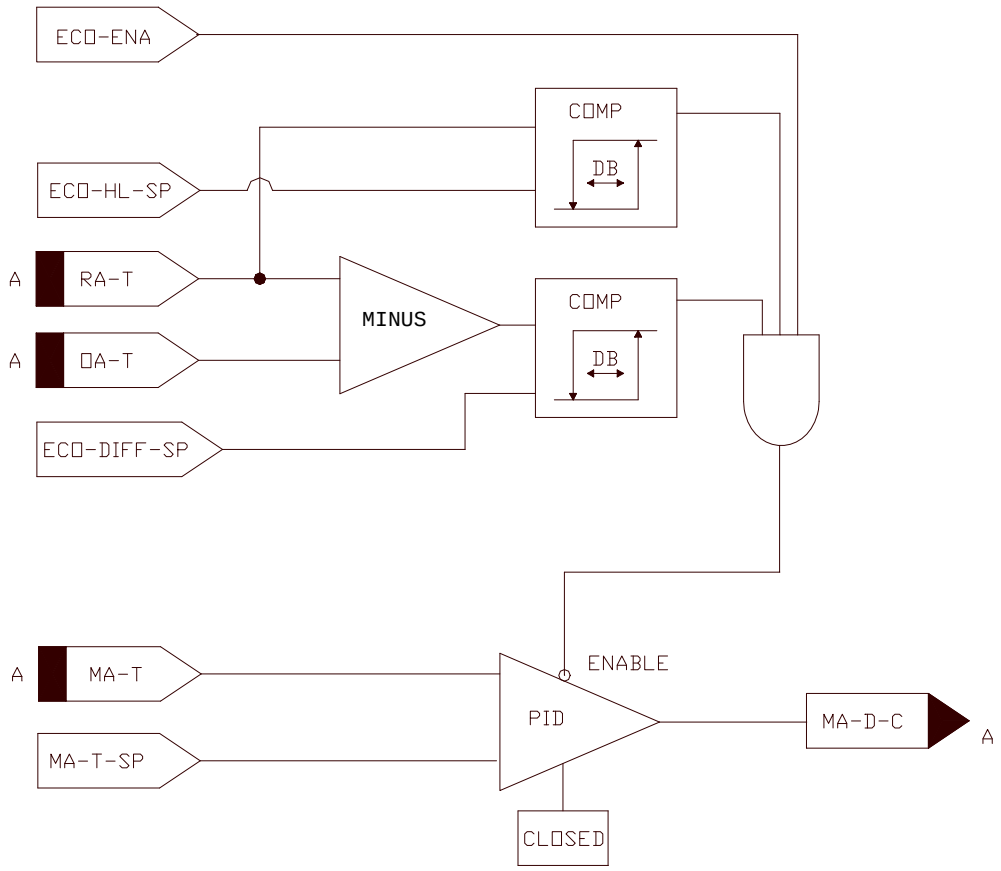


Figure 4-17. Mixed Air Temperature Control with RA/OA Activated Economizer CLD.

4-4.4.4 OA/RA dry bulb economizer designer selections

The designer must select the ECO-DIFF-SP and the ECO-HL-SP.

4-4.4.4.1 OA/RA economizer differential setpoint selection

Selection of the switching ‘Condition 1’ ECO-DIFF-SP is based on annual average (wet bulb) weather data which takes enthalpy into account, thereby optimizing the dry bulb economizer’s on/off decision. In summary, the designer uses a psychrometric chart and BIN weather data to correlate OA enthalpy to OA dry bulb along with an assumed RA condition (%RH and dry bulb) to correlate RA enthalpy to RA dry bulb. This results in a measure of OA and RA *dry bulb* temperatures that, in effect, provides for an enthalpy-based economizer decision.

Figure 4-18 illustrates selection of the OA/RA economizer Condition 1 setpoint (ECO-DIFF-SP) for Greenville, NC using weather data shown in Figure 4-16:

1. Plot a constant enthalpy line through the return air design temperature & relative humidity (A-B). In this example, 78°F and 50% RH.

2. Plot the average weather line (C-D). Use the midpoint of each OA dry bulb bin and corresponding mean coincident OA wet bulb from TM-5-785.

3. Draw a vertical line down from the intersection of lines A-B and C-D. This is point E.

4. Draw vertical line (G) down from constant enthalpy line return air condition to dry bulb temperature.

5. The **OA/RA economizer** ECO-DIFF-SP is the difference between point E and point G.

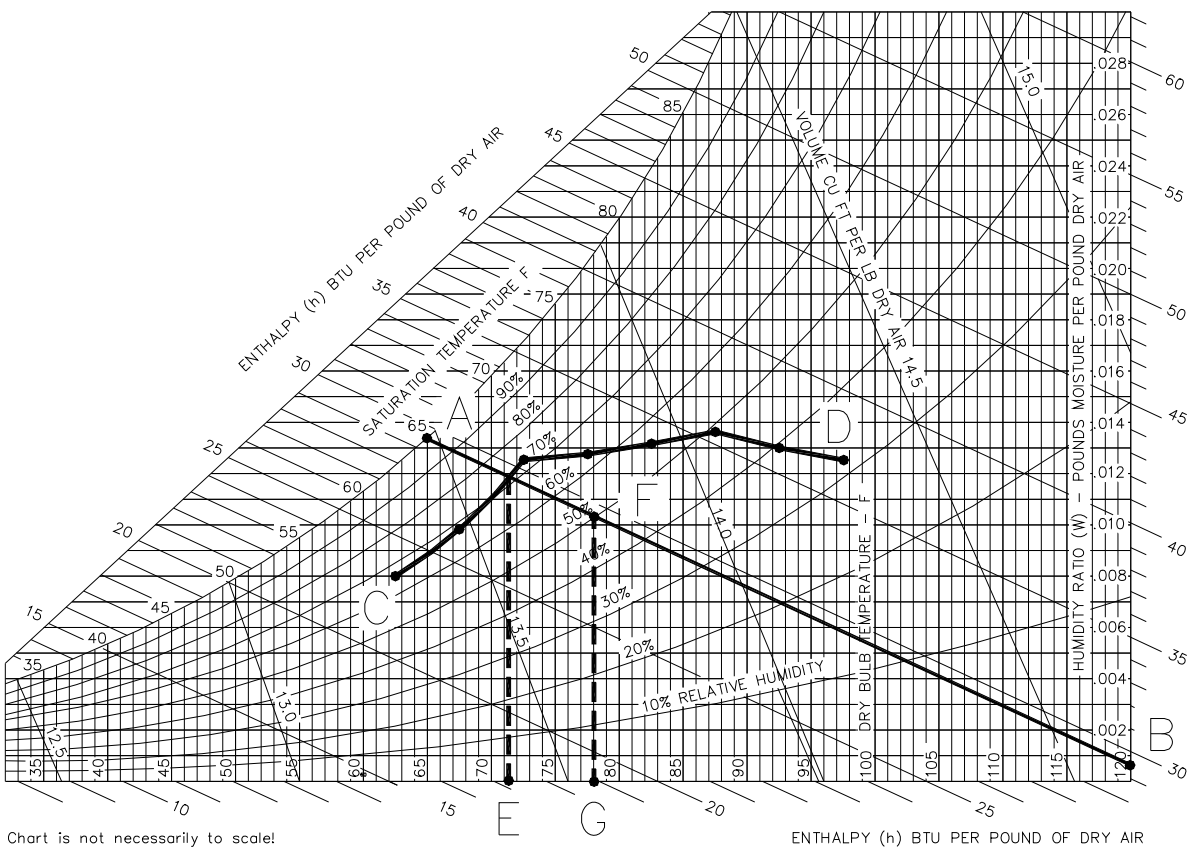


Figure 4-18. OA/RA Economizer Differential Setpoint Selection.

GREENVILLE–SPARTANBURG APRT SO CAROLINA

Temperature Range	NOVEMBER Obsn Hour Gp 01 to 08	09 to 16	17 to 24	Total Obsn	MCWB	DECEMBER Obsn Hour Gp 01 to 08	09 to 16	17 to 24	Total Obsn	MCWB	JANUARY Obsn Hour Gp 01 to 08	09 to 16	17 to 24	Total Obsn	MCWB
100/104															
95/99															
90/94															
85/89															
80/84		2	0	2	66										
75/79		2	1	10	64		1		1	62					
70/74		21	6	27	60		4	0	4	58		2	0	2	62
65/69	4	36	19	59	58	1	12	2	15	57	1	6	2	9	57
60/64	23	46	32	101	56	5	22	12	39	56	4	14	7	25	55
55/59	27	39	46	112	50	12	26	22	60	51	7	24	14	45	50
50/54	41	34	46	121	46	16	33	32	81	46	9	32	25	66	45
45/49	43	27	40	110	42	25	41	37	103	42	24	42	39	105	41
40/44	43	16	27	86	37	37	45	45	127	37	32	46	50	128	37
35/39	34	6	16	56	33	44	33	45	122	33	51	39	50	140	33
30/34	18	2	6	26	28	49	21	34	104	29	52	27	36	115	29
25/29	6	1	2	9	24	36	7	14	57	24	38	11	18	67	24
20/24	3	0	0	3	20	16	2	4	22	19	20	4	6	30	19
15/19	0			0	18	5	1	1	7	15	8	2	2	12	14
10/14						2	0	1	3	10	2	0		2	10
5/9						1			1	6	0			0	6
0/4															

Temperature Range	FEBRUARY Obsn Hour Gp 01 to 08	09 to 16	17 to 24	Total Obsn	MCWB	MARCH Obsn Hour Gp 01 to 08	09 to 16	17 to 24	Total Obsn	MCWB	APRIL Obsn Hour Gp 01 to 08	09 to 16	17 to 24	Total Obsn	MCWB	ANNUAL TOTAL Obsn Hour Gp 01 to 08	09 to 16	17 to 24	Total Obsn	MCWB
100/104																	0		0	75
95/99												0		0	72		9	3	12	74
90/94												0		0	65		96	25	121	73
85/89												8	2	10	67	0	273	103	376	72
80/84							2	1	3	60		22	9	31	65	10	356	215	581	70
75/79		0		0	66		7	2	9	62		28	17	45	62	96	329	336	761	68
70/74		4	1	5	59	0	16	8	24	59	3	36	29	68	60	462	281	389	1132	66
65/69	0	10	5	15	56	2	23	16	41	56	20	39	44	103	58	415	261	295	971	61
60/64	3	18	11	32	54	12	36	27	75	53	48	40	49	137	55	312	266	265	843	56
55/59	13	31	28	72	51	18	44	41	103	49	52	34	39	125	51	266	239	262	767	51
50/54	18	33	30	81	46	33	39	46	118	46	44	20	25	89	46	237	210	249	696	46
45/49	25	37	41	103	42	46	35	43	124	42	38	10	18	66	42	258	199	236	693	42
40/44	36	37	41	114	37	54	26	32	112	38	23	3	7	33	38	250	174	207	631	37
35/39	50	29	34	113	33	46	10	20	76	33	12	0	1	13	33	245	117	167	529	33
30/34	39	15	20	74	28	24	6	7	37	28	1			1	29	185	71	103	359	29
25/29	22	5	8	35	24	40	3	3	14	24						110	27	45	182	24
20/24	10	2	3	15	19	4	1	2	7	21						53	9	15	77	19
15/19	5	1	1	7	14	1	0	0	1	16						19	4	4	27	15
10/14	1	0	1	2	10	1			1	12						6	0	2	8	10
5/9	1	0		1	5											2		26	2	6
0/4	0			0	3											0			0	3

Figure 4-19. Greenville SC Weather Data for OA/RA Economizer Setpoint Selection Example.

4-4.4.4.2 **OA/RA economizer high limit setpoint selection**

Selection of the switching ‘Condition 2’ ECO-DIFF-SP, and thus proper operation of this economizer, is premised on the **assumption** that the return air temperature will vary based on the need for heating or cooling and, to a lesser extent, based on load changes. In other words, there must be a seasonal swing in the return air temperature. This swing can be achieved by defining and implementing zone/space heating and cooling thermostat setpoints (i.e. 68°F heating and 78°F cooling). If this is not desirable or achievable, the OA/RA dry bulb economizer is not recommended. With a heating mode setpoint of 68°F and and a cooling mode setpoint of 78°F, the midpoint is 73°F. To account for return air heat pickup from lights and other sources, add 2°F to this midpoint. The ECO-HL-SP setpoint is then 75°F.

4-4.4.4.3 **Mixed air temperature setpoint selection**

The mixed air temperature setpoint (MA-T-SP) should be selected to be the same as the cooling coil control loop discharge air setpoint (CC-DA-T-SP) (typically 55°F) or 1°F to 2°F less than CC-DA-T-SP. This lower setpoint helps to reduce or eliminate mechanical cooling while the economizer is ‘on’.

4-4.5 **Outside air flow control**

This section describes the three preferred methods that may be used to accomplish outside air flow control:

1) Two-Position Damper
2) Flow Control
3) Demand Controlled Ventilation

In each case, a separate/dedicated ventilation outside air duct should be specified. A dedicated duct provides for a more accurate setting and better control of the outside air flow. 100% outside air systems and systems that do not contain an economizer do not require this separate/dedicated duct.

The control system design must be accomplished in accordance with ASHRAE Standard 62, “Ventilation for Acceptable Indoor Air Quality”, which describes how to provide indoor air quality that will be acceptable to human occupants and is intended to minimize the potential for adverse health effects. Standard 62 also contains guidance on managing sources of contamination, controlling indoor humidity, and filtration of the building air.

4-4.5.1 **Ventilation air versus make-up air**

Design of the outside air flow control loop and the specified minimum outside air (MINOA) flow quantity must take into account two basic considerations;

1) Ventilation air for building occupants, and
2) Make-up air required to offset building exhaust and to provide pressurization for exfiltration flow

The MINOA quantity selected by the designer must be sufficient to meet the ventilation air flow requirements as defined in ASHRAE Standard 62. In addition, the minimum outside air quantity must be sufficient to provide make-up air for all sources of exhaust flow (Exh Flow) from the areas served by the air handler and to provide for a degree of building pressurization by creating exfiltration flow (Exf Flow). The larger of these two outside air quantities should be selected and specified as the MINOA quantity. In summary:

If Ventilation Air Flow > (Exh Flow + Exf Flow), then: MINOA = Ventilation Air Flow
If Ventilation Air Flow < (Exh Flow + Exf Flow), then MINOA = Exh Flow + Exf Flow

The exfiltration flow component is intended to help ensure that that the MINOA flow exceeds the building exhaust flow. This in turn helps to create a positive pressure in the zones/spaces served by the air handler. Exact calculation of the exfiltration flow that is required to create positive building pressure is a non-exact science due to uncertainty in inter-zonal flows and year round variations in wind-induced pressure on the external

surfaces of the building. It can be estimated using special computer programs, the ASHRAE crack method, or ASHRAE air exchange method. Alternatively, the exfiltration flow can be estimated to be a small fraction (5 to 10%) of the total design flow.

4-4.5.2 **Two-position damper**

This scheme applies to constant volume systems such as multizone and single zone air handlers. It can also be used in 100% outside air systems where there is only a single OA duct. Figure 4-20 shows a CLD for minimum OA damper control using a two-position damper.

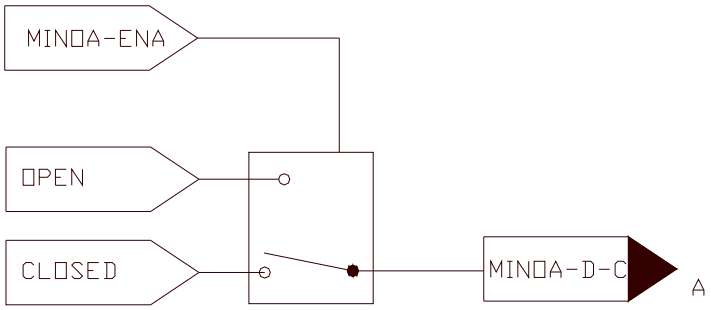


Figure 4-20. Minimum OA Using Two-Position Damper CLD.

4-4.5.3 **Flow control**

This scheme applies to variable air volume systems. This approach helps to ensure that the specified outside air quantity is supplied to the system/zones as supply fan capacity modulates with changes in VAV terminal unit flows. A minimum outside air flow (MINOA-F) sensor senses flow in the MINOA duct and is controlled to the specified setpoint through modulation of the MINOA damper using a PID controller. Figure 4-21 shows a CLD for MINOA flow control using fixed OA flow.

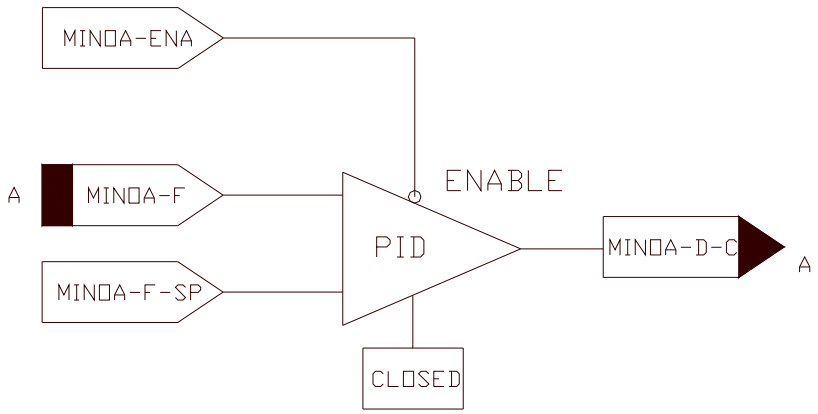


Figure 4-21. Minimum OA Flow CLD.

4-4.5.4 **Demand controlled ventilation**

A demand controlled ventilation (DCV) strategy adjusts ventilation air to a building or zone to meet occupant needs and to provide for odor control. It can also save energy by minimizing ventilation loads.

ASHRAE Standard 62.1-2004 describes adjustment of the HVAC system to “reset the design outdoor air intake flow and/or space or zone airflow as operating conditions change.” Standard 62.1-2004 lists examples of dynamic reset strategies including reset based on occupancy such as an occupancy schedule, occupancy sensors, or carbon dioxide (CO2) sensors.

CO2 based DCV uses CO2 sensor(s) to predict the demand where contaminant levels result primarily from people and occupancy varies significantly (barracks, mess halls, conference facilities, gyms, and auditoriums). Leadership in Energy and Environmental Design (LEED) points can be awarded for use of a demand control strategy.

4-4.5.4.1 **Demand controlled ventilation design**

The design of a CO2-based DCV control strategy should be in accordance with the standards and procedures described in ASHRAE Standard 62.1. Standard 62.1-2004 requires that spaces with a design occupancy density greater than 100 people per 1000 ft2 incorporate DCV in the HVAC design (i.e. lecture halls, auditoriums, lobbies). Standard 62.1-2004 also includes guidance on maintenance that the designer should consider and include in the project specifications.

The DCV strategy should adjust the outside air (OA) flow quantity based on the sensed CO2 concentration while also limiting the outside air flow quantity (to a minimum and maximum quantity). The DCV control loop must be designed and specified such that the system modulates between the upper limit of “minimum OA” and lower limit of “minimum OA.” The HVAC system must be sized to accommodate the ventilation load. The use of a DCV strategy applies to variable air and constant volume systems.

The OA flow damper should be located in a dedicated minimum OA flow duct and modulated to control the OA flow quantity. Flow control is accomplished by simple damper positioning in a constant volume system and by an air flow measurement station (AFMS) in a VAV system. Two-position dampers are unacceptable in a VAV system.

4-4.6 **Variable air volume control loops**

A variable air volume (VAV) system has the following unique characteristics:

- The air-handling unit (AHU) serves multiple zones with a single duct that delivers cool air. Sometimes the AHU will have a small preheat coil.
- Each zone has a VAV box (terminal unit) for temperature control. Each VAV box has a thermostat. VAV box dampers modulate for cooling. Heating may be provided by a reheat coil or electric resistance heating element inside the VAV box with the dampers at a minimum airflow position.
- VAV boxes open and close causing total air volume to vary.
- The AHU fan capacity varies to the keep the duct pressure constant.

4-4.6.1 **Supply duct static pressure control loop**

In a supply duct static pressure control loop, the supply fan capacity modulates to maintain a constant duct static pressure while the VAV boxes are opening and closing. Each VAV box needs a minimum amount of static pressure to operate properly and to deliver the required amount of air to its zone. There are two methods of supply fan capacity control: (1) using a variable speed fan (recommended) and (2) inlet guide vanes. Figure 4-22 shows the supply duct static pressure control loop schematic while Figure 4-23 shows the CLD for supply duct static pressure control.

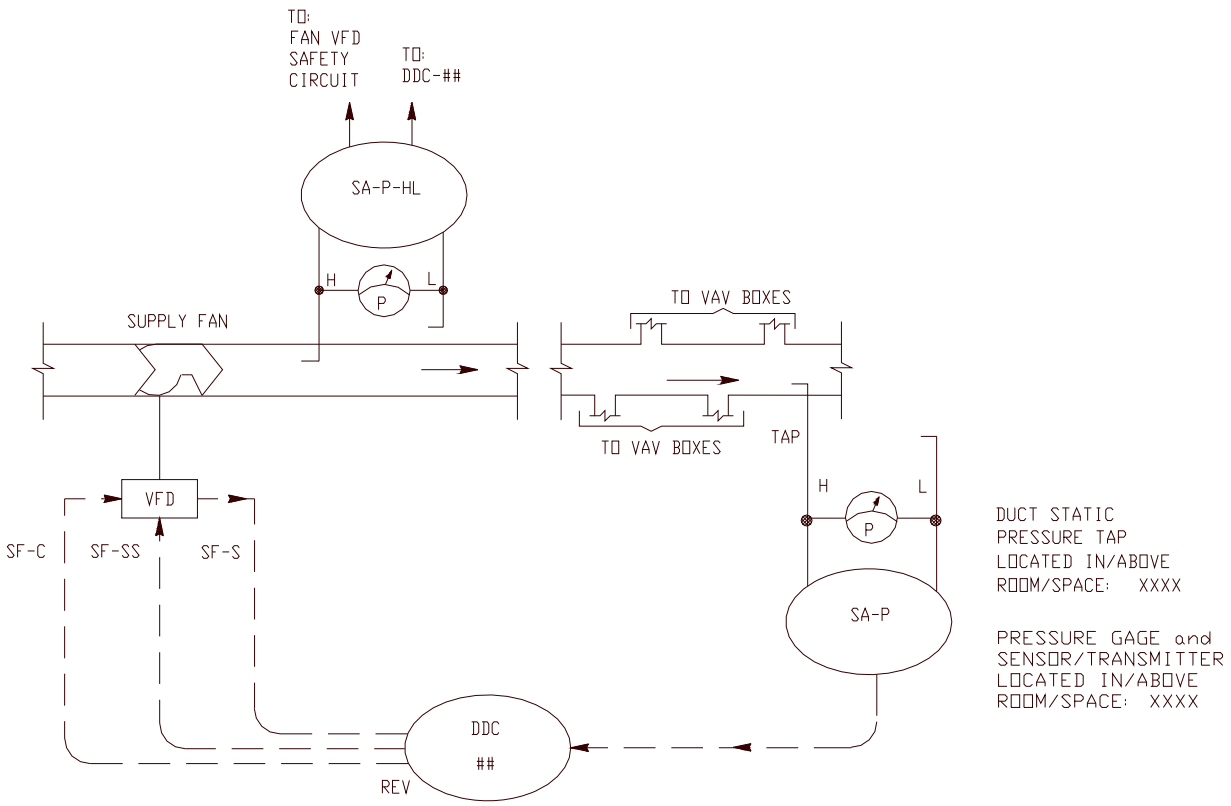


Figure 4-22. Supply Duct Static Pressure Control Schematic.

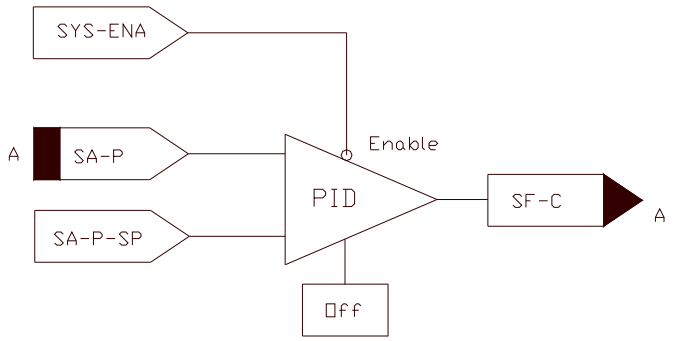


Figure 4-23. Supply Duct Static Pressure CLD.

Suggested designer selections include the following: (1) Value for supply duct static pressure setpoint (SA-P-SP) in the Points Schedule (typically 1 inch of water column (iwc)); (2) Value for duct static (differential) pressure sensor range (typically 0 to 2.5 iwc); (3) Value for duct static high-limit setpoint based on duct pressure class; and (4) Control action notation in the Control Schematic Drawing.

4-4.6.2 Supply duct static pressure control loop with setpoint reset

In accordance with ASHRAE standard 90.1, a variation on the basic supply duct static pressure loop is where the setpoint is adjusted based on VAV box demand. The commanded position of each VAV box damper is used to determine demand.

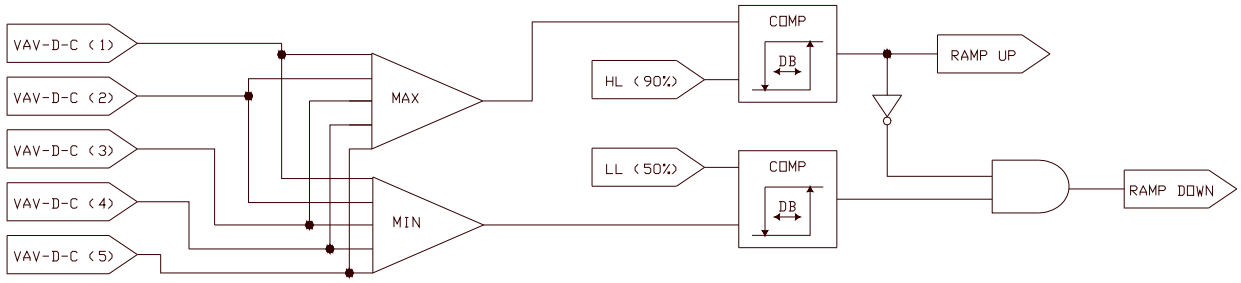


Figure 4-24. Supply Duct Static Pressure Setpoint Reset.

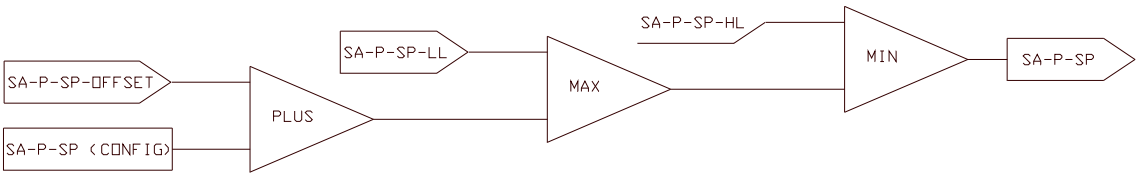


Figure 4-25. Supply Duct Static Pressure Setpoint Reset, Setpoint Calculation.

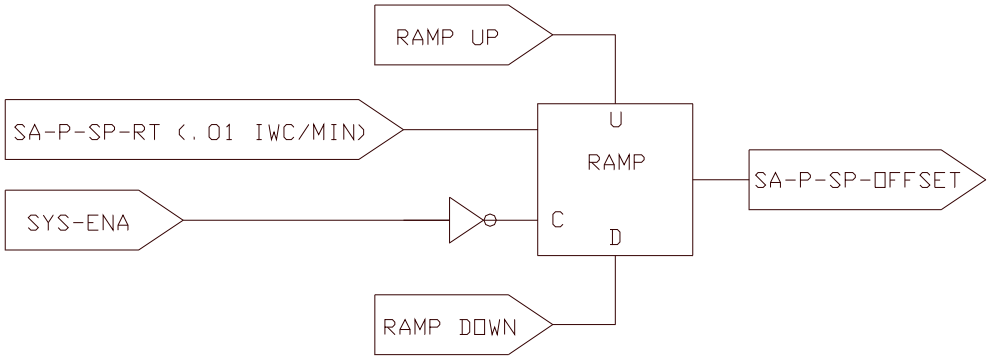


Figure 4-26. Supply Duct Static Pressure Setpoint Reset, Ramp-up / Ramp-down.

4-4.6.3 VAV box control

4-4.6.3.1 VAV box categories

VAV boxes must be of the pressure independent variety. The four basic types include; cooling only, cooling with reheat, series fan-powered, and parallel fan-powered.

4-4.6.3.2 Occupancy mode control

The sequence of operation will describe the control-related functions of each VAV box including Occupied and Unoccupied modes. Control of the occupancy mode is based on a System Scheduler or an occupancy input device:

- System Scheduler. The SNVT input from a System Scheduler (DDC Hardware) commands the VAV box to operate in either the occupied or unoccupied mode. Note that VAV boxes do not operate in a warmup or cooldown mode. Instead, they are commanded to operate in the Occupied Mode when their servicing AHU has been instructed by the System Scheduler to operate in warmup/cooldown mode. System Scheduling is described elsewhere in this UFC.

- Occupancy input device. The space/zone occupancy input from either an occupant accessible pushbutton or space mounted occupancy sensor indicates that the space is occupied. This occupancy input is used to override the system into occupied mode (usually during a scheduled unoccupied time period). When the pushbutton override input is used, the designer should decide/select how long the override will last (because this is a software feature) whereas the sensor override input is dependent upon the occupancy sensor hardware. This too can be selected/specified but requires editing of the sensor specification in the UFGS.

In Occupied Mode the zone temperature setpoint (ZN-T-SP) operates at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat where the configured setpoint is a fixed setting that resides in memory of the DDC hardware and is shown by the designer in the Points Schedule. Ordinarily the zone (occupied) temperature setpoint (ZN-T-SP) will come from an occupant-adjustable wall-mounted thermostat (via a slidey bar or knob at the thermostat). However there are some cases (computer room, museum, etc.) where the setpoint should be configured and not adjustable via a thermostat. The designer edits the sequence of operation to select the occupied mode condition(s) based on the application and project specific requirements.

In the Unoccupied Mode the zone temperature setpoint (ZN-T-SP) is at the configured unoccupied mode setpoint (instead of the thermostat setpoint). Note that a cooling-only VAV box does not have an Unoccupied Mode ZN-T-SP. It simply moves its damper to minimum position.

Sequencing diagrams should be included to illustrate the zone temperatures at which VAV box devices such as valves, dampers, fans, and heating elements turn on and off and/or open and close.

4-4.6.3.3 **VAV box control - designer selections**

Most designer selections will be shown in the Thermostat and Occupancy Sensor Schedule drawing as shown in Figure 5-3. Some settings will be shown in the Points Schedule drawing. Designer selections for VAV box control include the following:

(1) Thermostat location (particularly room number) to be shown in the schedule,
(2) Whether or not the temperature setpoint is to be adjustable at the thermostat,
(3) Occupied and unoccupied mode setpoints,
(4) Unoccupied mode override (occupant accessible push button),
(5) Unoccupied mode override (occupancy sensor),
(6) Valve size (Cv) in the case of a box containing a coil, and
(7) VAV box sequencing including a deadband between heating and cooling modes and the minimum and maximum airflow setpoints. Ordinarily, the minimum and maximum flow setpoint quantities are shown in a separate mechanical system drawing, not a control drawing.

4-4.6.4 **Return fan control loop**

A return fan in a VAV system is inherently difficult to control. Therefore, designers should avoid them where possible by using short or large return ducts and plenum instead of ducted returns. A return fan helps to ensure proper air distribution and may be required if the return air duct section pressure drop (between the zone and the relief damper) is excessive or if the supply fan inlet head will prevent positive pressure from being created at the air handler relief. Excessive return duct pressure drop can result in the following: (1) Over-pressurization of zone and excessive exfiltration as the supply air seeks an exit path out of the zone; (2) Inadequate supply air flow at the design condition due to zone and return duct flow resistance; (3) Air being drawn in through the AHU relief duct (not exhausted); or (4) The need for a return fan.

4-4.6.4.1 **Return fan control techniques**

4-5.8.3.1.1 **Flow matching**

Flow matching is accomplished by measuring the supply and return air duct flow rates using airflow measurement devices/arrays and controlling the return duct flow by modulating the return fan capacity.

4-5.8.3.1.2 **Direct building pressurization**

Direct building pressurization is accomplished by measuring the building/space pressure using a differential pressure sensor (referenced to outdoors) and modulating the capacity of the return fan.

4-5.8.3.1.3 **Fan matching**

Fan matching is accomplished by sending a control signal to the return fan identical to that used to modulate the capacity of the supply fan. Ordinarily, the signal sent to the return fan is offset or characterized in some fashion so that the return duct flow is less than the supply duct flow.

4-4.6.4.2 **Flow matching return fan control loop**

Of the three primary techniques for controlling a return fan in a VAV system, flow matching is recommended. Flow matching uses air flow measurement devices in the supply and return air ducts and the control loop maintains a constant flow difference between the supply and return air ducts. When more air is supplied than returned, this tends to pressurize the building or zones. Matching air flows also helps ensure proper air distribution through the air handler outside air intake and relief. Figure 4-27 shows a return fan flow control loop schematic, and Figure 4-28 shows the CLD.

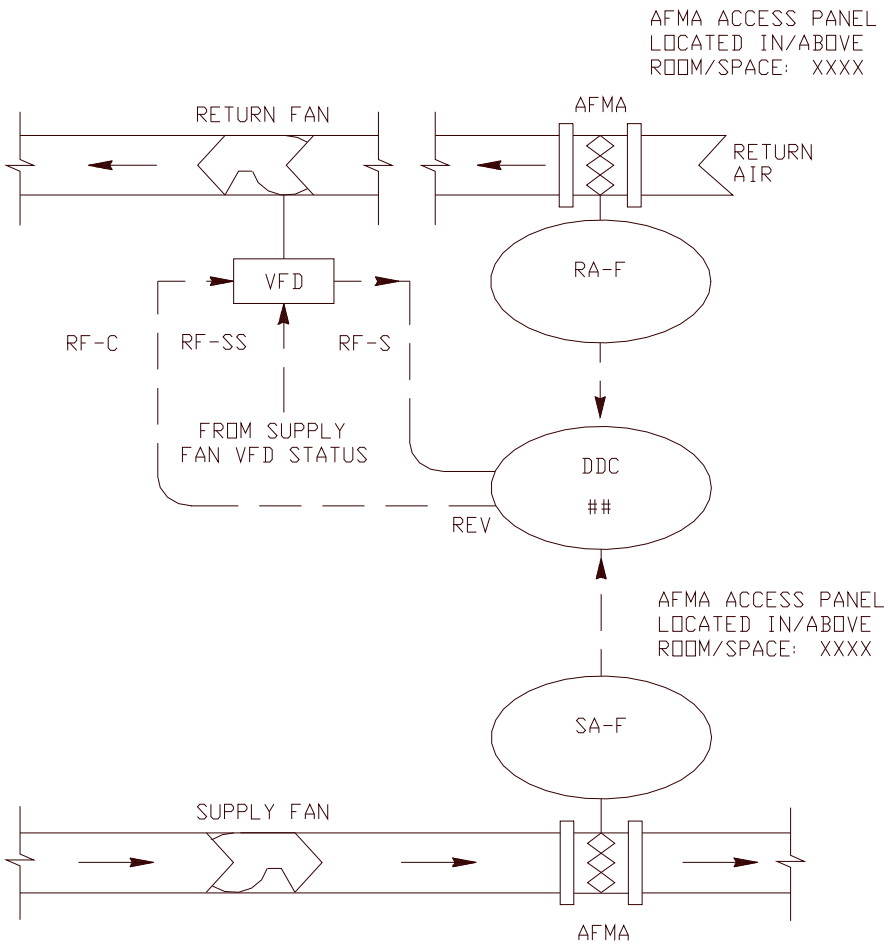


Figure 4-27. Return Fan Flow Control Schematic.

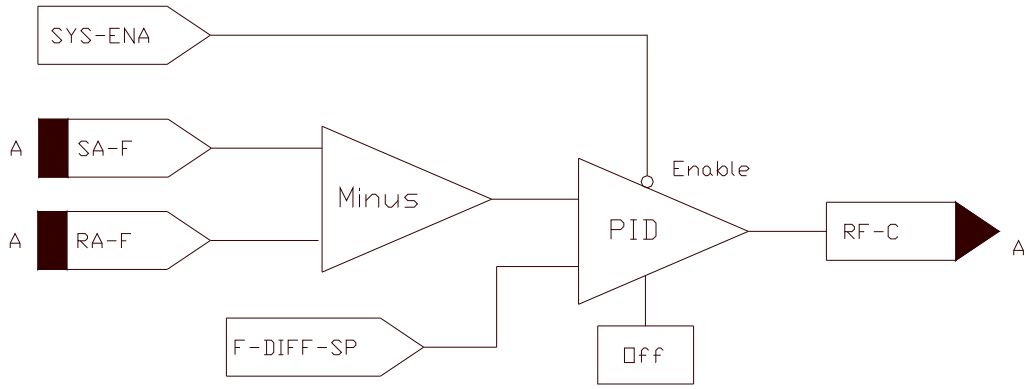


Figure 4-28. Return Fan Flow CLD.

4-4.6.4.3 **Flow difference setpoint (F-DIFF-SP) selection**

The designer must select the Flow Difference Setpoint (F-DIFF-SP) for the flow matching control loop:

$$\text{F-DIFF-SP} = \text{Flow}_{exh} + \text{Flow}_{exf} \qquad \textbf{Eq. 4-1}$$

Where:
Flow_{exh} = Zone exhaust flow, cfm or L/s
Flow_{exf} = Zone exfiltration flow, cfm or L/s

Figure 4-29 illustrates these flows.

Flow_{exh} is the total of all zone exhaust fan flows.

Flow_{exf} is selected to create a degree of pressurization in the zone by forcing air to exfiltrate from the zone. Theoretically, zone pressurization will occur with only the slightest amount of exfiltration flow but, due to limitations in flow sensor and controller accuracy, Flow_{exf} should be selected as 7 to 10 percent of the design supply flow. This helps ensure that supply flow will be greater than return flow. In addition, depending on the need in the application to ensure pressurization, the designer might chose to increase Flow_{exf}. As rules of thumb: Flow_{exf} = 10% of design flow (for **tight** buildings) and 20% of design flow (for **drafty** buildings). The following cautions apply to these "rules of thumb":

1. The zone(s) on the windward side of the building may be overcome by external wind pressure on the building surface. A 17 mph wind induces an external velocity pressure on the face of the building of approximately 0.1 in. wc (25 Pa) and can result in air infiltration. A larger bias flow may not counteract external wind pressure (i.e. the excess bias flow may exfiltrate out of the downwind side of building or be exhausted by exhaust fans or migrate to other zones/air handlers).

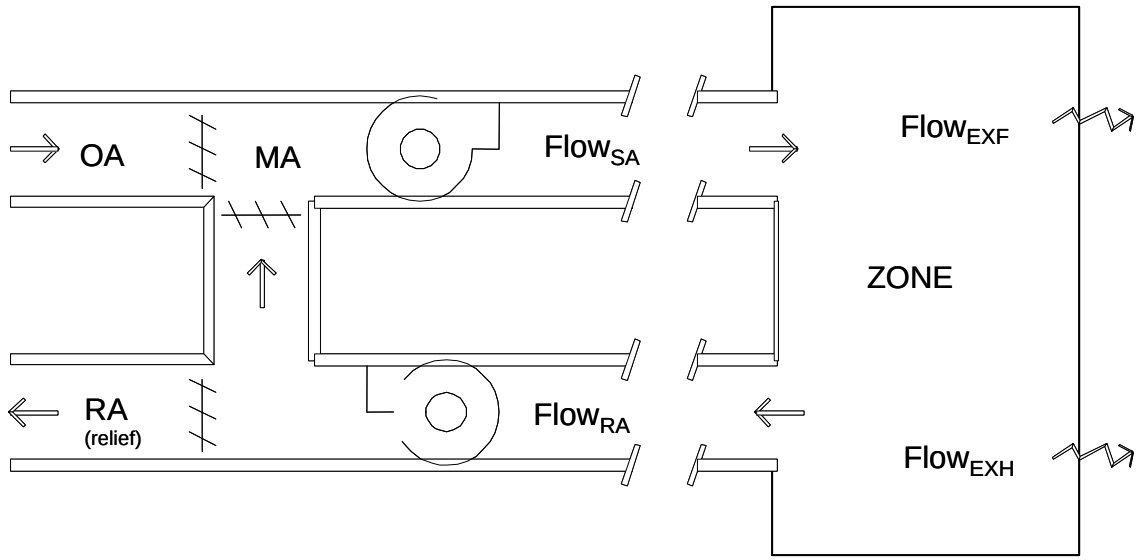


Figure 4-29. Air Flows in a Return Fan System.

4-4.6.4.4 **Minimum OA (MINOA) quantity selection**

The designer should coordinate the return fan Flow Difference Setpoint (**F-DIFF-SP**) with the minimum outside air flow selection.

The minimum outside air quantity (MINOA) used in conjunction with the **F-DIFF-SP** setting is determined by one of the following:

MINOA = $Flow_{vent}$	<u>if</u> $Flow_{vent} > (Flow_{exf} + Flow_{exh})$	**Eq. 4-2**
MINOA = $Flow_{exf+exh}$	<u>if</u> $Flow_{vent} < (Flow_{exf} + Flow_{exh})$	**Eq. 4-3**

Where:

$Flow_{vent}$ = Ventilation air flow (based on ASHRAE Standard 62, "*Ventilation for Acceptable Indoor Air Quality*").
$Flow_{exh}$ = Zone exhaust flow, cfm or L/s (total of all exhaust fans in the zone)
$Flow_{exf}$ = Zone exfiltration flow, cfm or L/s

(<u>Note</u>: If a CO2-based demand controlled ventilation control strategy is to be used the F-DIFF-SP and MINOA flow selections must be coordinated.

The correct MINOA selection helps to ensure proper air distribution thru AHU by complementing the **F-DIFF-SP** value. The MINOA selection also applies to non-return fan systems.

Suggested designer selections, all to be shown in the Points Schedule, include the following: (1) Value of F-DIFF-SP, in L/s (cfm); (2) Value of return air duct airflow measurement array (AFMA) range, from 0 to a defined maximum value in L/s (cfm); (3) Value of supply air duct AFMA range, from 0 to a defined maximum value in L/s (cfm); and (4) Value of the minimum OA quantity in L/s (cfm).

4-4.7 **Variable speed pump control**

4-5.7.1 Variable speed pump control system design

A variable frequency drive (VFD) can provide significant energy savings realized from reduced pump horsepower as flow rate is decreased to match decreased load. Energy is saved at a cubed rate where even a small reduction in the pump's speed (such as 20%) can translate into a large energy savings (such as 50%). The greater the average annual load variation from maximum design conditions, the greater the energy savings potential with variable speed pumping. Variable frequency drives can also reduce maintenance (in the pump seals).

Figure 4-30 shows an example control schematic for a primary/secondary piping system where the secondary pump VFD is modulated by the direct digital controller (DDC) based on the piping system differential pressure in the downstream secondary piping loop.

Figure 4-30 shows that the piping system should have at least one 3-way valve or a bypass pipe. Locating the valve or bypass at or near the end of the piping run is not critical but helps to keep the chilled water loop cool and thus avoids a warm water surge at the chiller. A balancing valve in the 3-way valve bypass, set equal to the head loss across the coil circuit, can help with temperature control performance of the 3-way valve and can be used to provide adjustment of the minimum system flow. Adjustment of minimum system flow is not important in the secondary of a primary/secondary system but may be necessary where the variable speed pump loop consists of only a primary (no secondary) and the chiller (or boiler) has a minimum flow rating that must be observed. The chilled water pressure sensor (CWS-P) must be at or near the end of the piping run for sensing the differential between the supply and return mains.

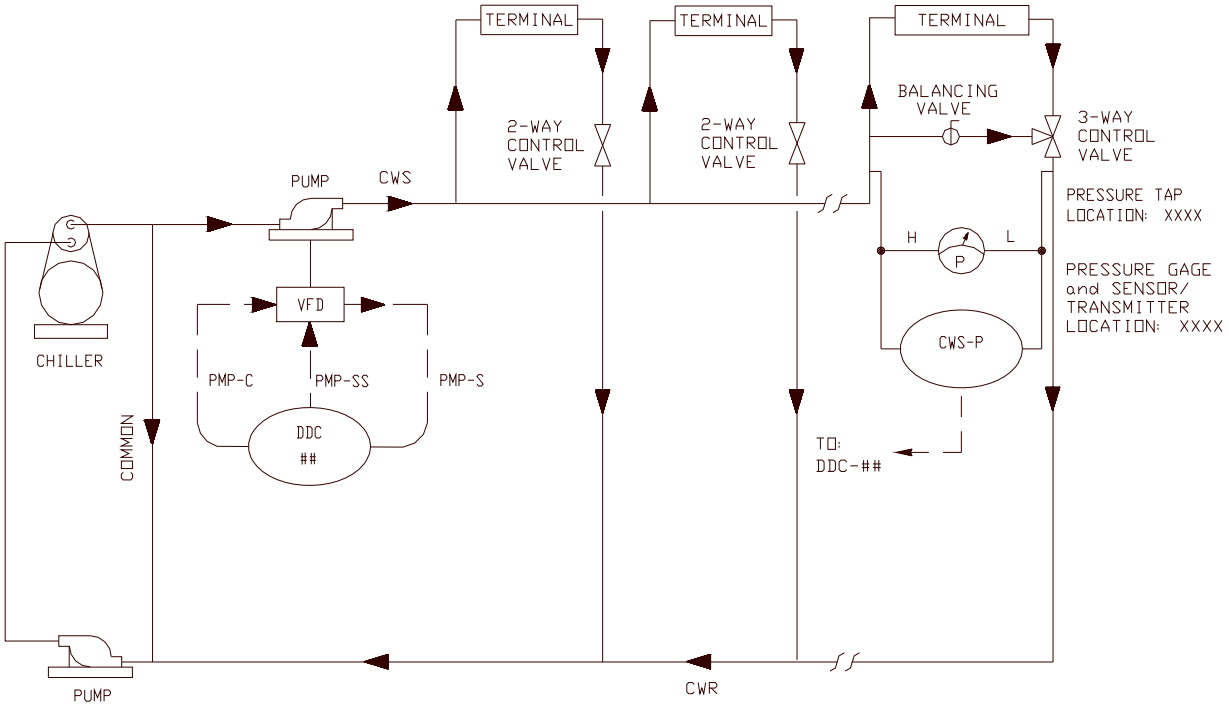


Figure 4-30. Primary/Secondary Pumping Control Schematic.

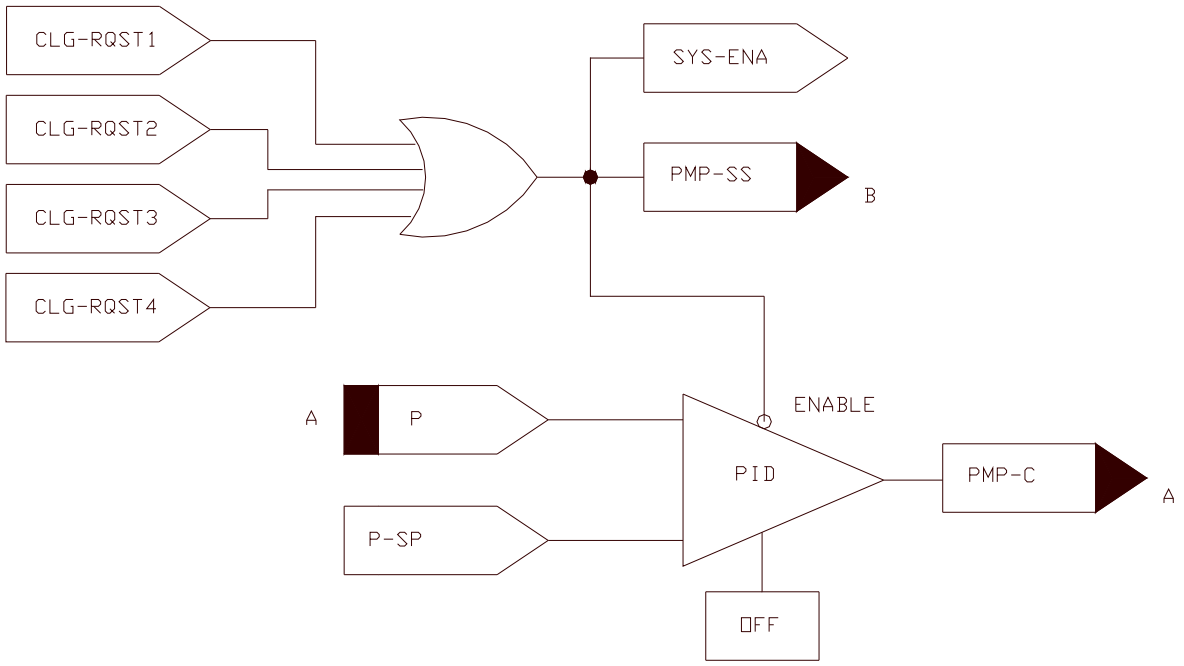


Figure 4-31. Variable Speed (Secondary) Pump CLD.

Figure 4-31 shows the CLD for this system. This system can monitor the enabled status (CLG-RQST) of all systems served by the variable speed pump system. If one or more of these systems are enabled, the VFD start/stop (SS) is 'started' and the variable speed PID control loop is enabled at minimum speed (typically 20%) and with a long ramp duration during initial start-up (typically 0.8 percent per second). The SYS-ENA signal is available to other systems as needed, such as activation of the chiller. The VFD pump command (PMP-C) signal modulates the VFD. As shown in Figure 4-32, when the VFD is placed in HAND mode it can be used to manually control the speed of the pump. A similar sequence is used in a heating application. When all enable requests stop, the DDC system ramps down the VFD to minimum speed, then shuts it off. While Figure 4-32 is shown with hardwired inputs/outputs, at the discretion of the installing Contractor, it may instead be provided with a TP/FT-10 network interface.

Once enabled, the variable speed pump increases or decreases speed in order to maintain a differential pressure between the supply and return water lines (typically at the worst case location in the facility) thus ensuring required pressure is available at all control valves in the system.

In some instances, a second pump is required to meet building demand. This is commonly referred to as a Lead/Lag system. In this scenario, the second (lag) pump is enabled whenever the first (lead) pump fails to provide "proof" that it is running (usually by means of a current sensing device) or if the first (lead) pump is operating at maximum capacity and the differential pressure set point is still not met. In this

condition, the second (lag) pump is energized and it runs in tandem at the same speed as the first (lead) pump in order to maintain differential pressure set point. Once both pumps decrease in speed below the tandem pump low speed set point the second (lag) pump will be turned off. The first (lead) pump will continue to run after the second (lag) pump has turned off. These pumps need to swap lead/lag designation periodically based on run time to ensure equal run time on each pump.

Variable speed control of hydronic systems can be difficult using PI or PID control because the speed of reaction of the system (i.e. the fluid) is very fast as compared to the ability of the DDC system to measure the change, transmit the new value to the controller, calculate a new output, and change the output to the VFD. The pressure transmitter hardwired directly to the pump controller will yield best performance.

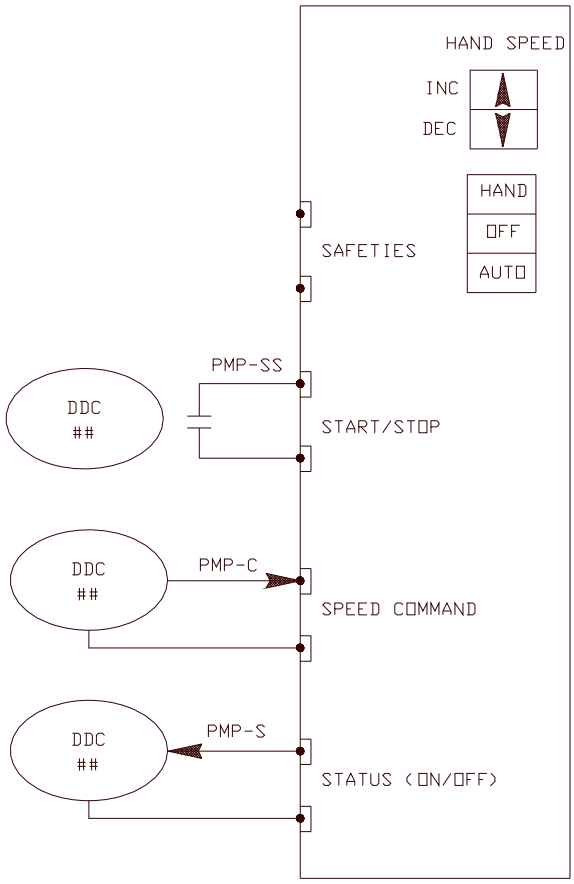


Figure 4-32. Variable Speed (Secondary) Pump Control - Ladder Diagram.

4-5.7.2 Designer selections

Designer selections for this loop include:

(1) Differential pressure control setpoint (show in the Points Schedule). The designer must select the ***initial*** value based on piping system design. It should be equal to the value of the pressure drop across the terminal unit at or near the end of the piping loop. Note that the balancing Contractor must identify and set the ***final*** value of the control setpoint at design flow in coordination with the controls Contractor.
(2) Differential pressure sensor/transducer range (show in the Points Schedule). The designer must select this value based on differential pressure control setpoint. The high end of the sensor range must exceed the control setpoint. Showing a high end range of no less than 150% is recommended. The guide specifications require that the Contractor not exceed this high end range by more than 50%.
(3) Minimum VFD speed for safe pump/motor operation.

4-4.8 **Humidity control loop**

The humidity control loop, as shown in Figure 4-33, controls a humidifier to maintain the relative humidity setpoint. The loop consists of a space humidity controller and a high limit humidity controller. The valve opens to humidify when three conditions are met: (1) The fan is on; (2) The system is in occupied mode; and (3) The ventilation delay period has expired. Typical controller setpoints are 50% relative humidity (RH) for the space and 80% RH for the high limit.

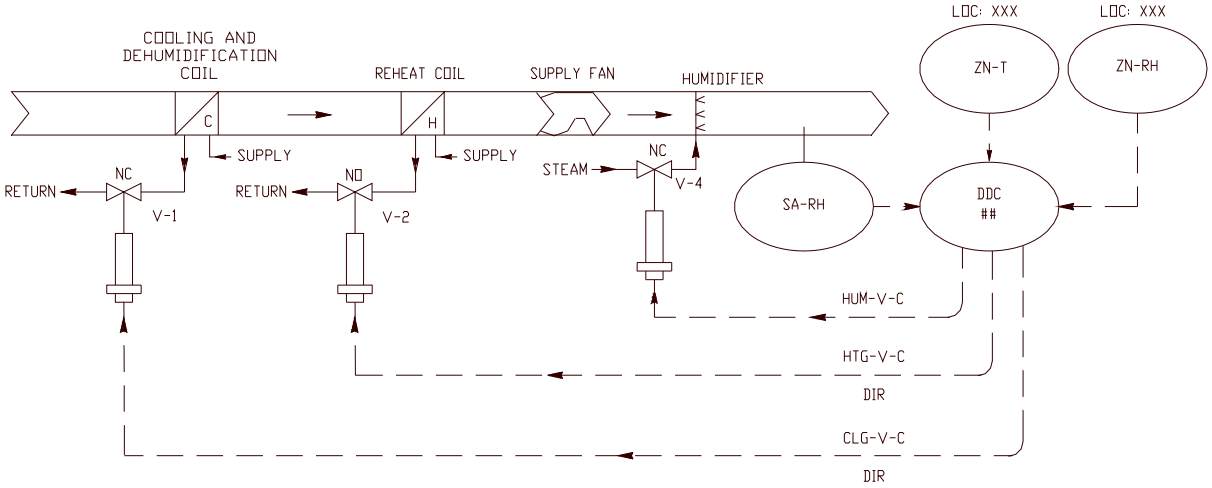


Figure 4-33. Humidity Control System Schematic.

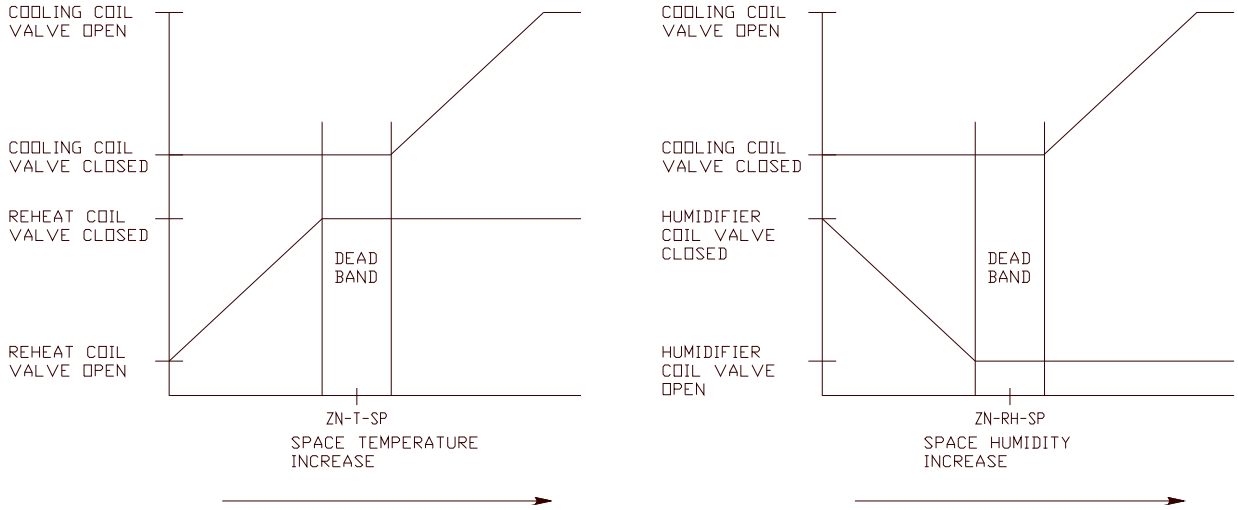


Figure 4-34. Humidity Control Sequencing Diagrams.

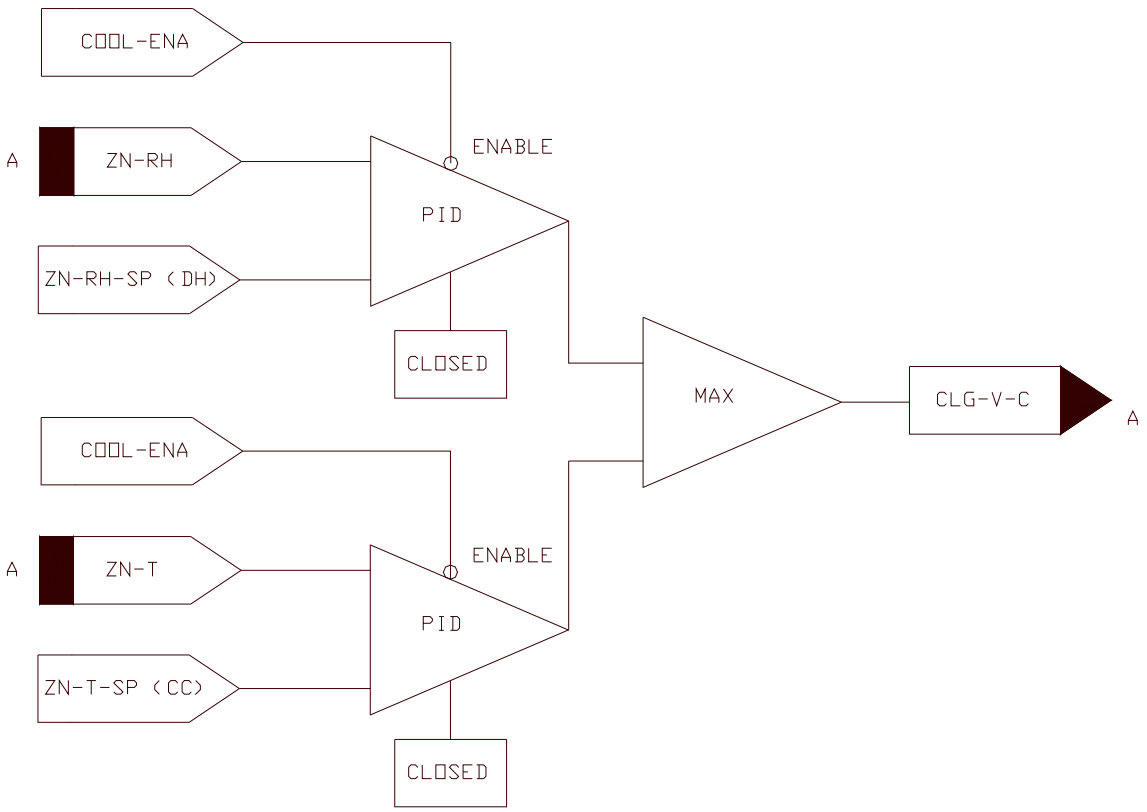


Figure 4-35. Cooling and Dehumidification CLD.

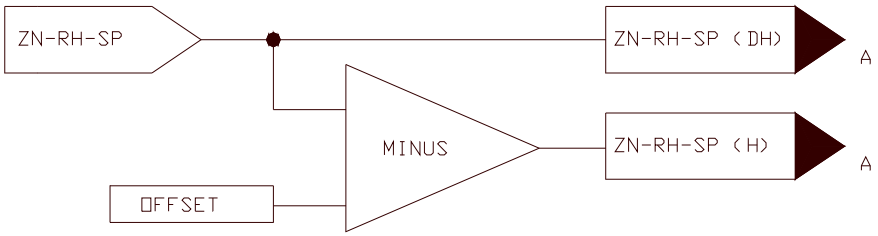


Figure 4-36. Dehumidification / Humidification Sequencing CLD.

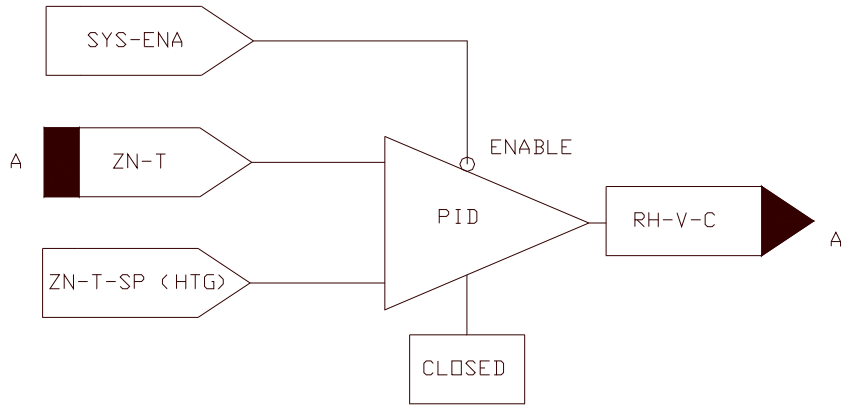


Figure 4-37. Reheat Coil CLD.

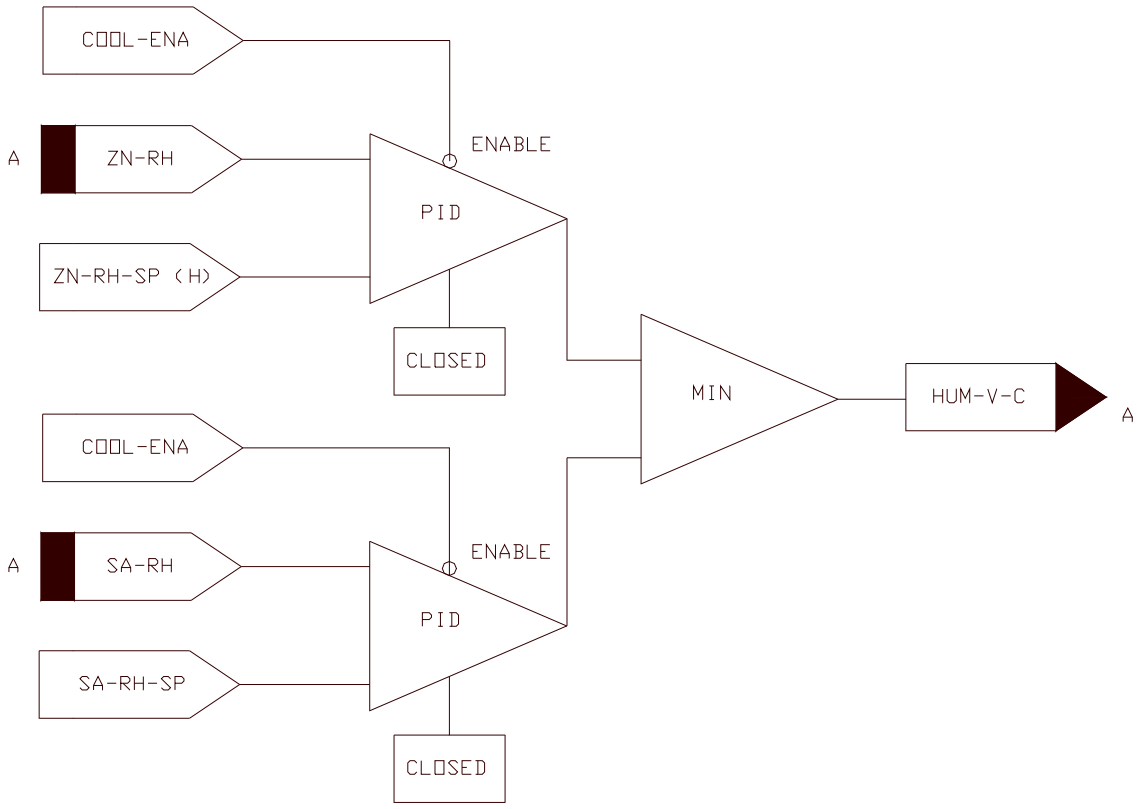


Figure 4-38. Humidifier CLD.

4-4.9 **Alarms**

4-4.9.1 **UMCS Alarms**

DDC system points (via their associated SNVTs) can be monitored by a UMCS which, in turn, determines when a point is in an alarm condition. The UMCS performs alarm generation, notification, and routing functions. The DDC system designer must specify the alarm points by showing them in the Points Schedule where the DDC Contractor is then responsible for providing a SNVT for each point that has an alarm condition assigned to it.

4-4.9.2 **System Scheduler**

Although LonMark International has developed “scheduler” and “calendar” Functional Profiles, there is not an industry-standard way to perform scheduling in an Open manner. For this reason, DDC UFGS 23 09 23 includes detailed requirements for a System Scheduler to perform scheduling.

There are four things that can affect the occupancy status of a piece of equipment. In order from lowest to highest priority:

- Scheduled Occupancy
- Occupancy Sensors (turn on only)
- Occupancy overrides from M&C (demand limiting, operator overrides, etc.)
- Night Stat (turn on only)

The System Scheduler has inputs from the M&C software as well as from local occupancy sensors and turns equipment on or off depending on these inputs.

4-4.9.3 **System scheduler inputs**

DDC UFGS 23 09 23 standardizes the input to the system scheduler as a SNVT of type SNVT_Occupancy. Therefore, all system schedulers, regardless of who installed them, communicate with the UMCS in a standard fashion. The guide specification doesn’t require a specific SNVT type between the system scheduler and the equipment it schedules but this communication must be documented by the Contractor on the Points Schedule.

Depending on the Air Handler, the Occupancy Sensor input may or may not be directly from an occupancy sensor. For air handlers with terminal units (i.e. VAV boxes), the occupancy sensor is used to turn the terminal unit (VAV box) on and the occupancy mode of the terminal unit is used by the system scheduler to determine what the air handler should be doing. If the air handler doesn’t have terminal units it will use inputs directly from the occupancy sensors.

4-4.9.4 **Warm-Up Cool-Down mode**

The only difference between Warm-Up Cool-Down (WUCD) and occupied (OCC) mode is that in WUCD mode the outside air loop is disabled so the air handler does not

condition outside air. Since Terminal Units don't condition outside air, they can just run in OCC mode when the air handler is in WUCD.

4-4.9.5 **Default schedule**

The System Scheduler contains a backup (default) schedule that becomes active in the event that the UMCS Monitoring and Control software is not present (either because the UMCS is 'down' or because it doesn't exist). If the System Scheduler hasn't received a scheduled occupancy input for more than 95 minutes it will use the default schedule. Note that occupancy sensors (if specified to do so) can still place the system (hardware) in the occupied mode.

CHAPTER 5

CONTROL SYSTEM DRAWINGS

5-1 CONTROL SYSTEM DRAWINGS OVERVIEW

This chapter describes typical control system drawings and how to edit them to be project-specific. CHAPTER 6 PROJECT IMPLEMENTATION provides an overview of the project-specific drawing requirements detailed in this chapter. Example drawings are available from:

https://eko.usace.army.mil/fa/bas/

The drawings were originally developed using AutoCAD® and every effort was made to ensure compliance with A/E/C CADD Standard Release 2.0.

5-2 CONTRACT DRAWING SET

A set of Contract drawings will ordinarily consist of:

- Index (title sheet)
- Symbols and Legend drawing
- Points Schedule - Contactor Instructions
- System Scheduling Sequence
- Alarm Generator and Alarm Handling Sequence
- System specific drawing set

A system specific drawing set consists of (as applicable):

- Control Schematic
- Ladder Diagram
- Control Logic Diagram
- Sequence of Operation
- Points Schedule
- Other Schedules:
    - Thermostat and Occupancy Sensor Schedule
    - Occupancy Schedule
    - Redundant Alarm Handling Schedule
    - Control Damper Schedule
    - Control Valve Schedule

As part of the editing process to make the sample drawings project-specific, the sample drawings use the following conventions:

- Entries required of the designer are shown bracketed as: [___]

- Entries required of the Contractor are shown bracketed as: < ___ >
- Spaces where no entry is ordinarily required contains a tilde: “ ~ “ (equivalent to an “n/a” or null value)

The bracketed [___] designer entries in the sample drawings are shown/provided as a guide to the designer. These entries must be verified or changed by the designer. When editing the drawings, delete the brackets after verifying/providing the entry. Contract drawings should contain no designer brackets [___]. Do not leave cells blank. Instead show the tilde ("~") to indicate a null value or that no further entry is required.

5-3 SYMBOLS AND UNIQUE IDENTIFIERS

The control drawing symbols and identifiers adhere to a convention that is intended to uniquely identify each control system device and signal and to make interpretation of the control drawings as simple and as self-evident as possible. This includes the use of a defined set of symbols along with a naming convention for these symbols and their associated input and output signals.

5-3.1.1 Symbols

Control schematic symbols: The generic symbol for a device used in a control schematic drawing is an oval bubble as shown in Figure 5-1. Devices can be shown with multiple input or output signals or additional I/O detail as shown in illustrations (B) and (C). The identifying letters and numbers associated with the symbols and signals are described in paragraph 5-3.1.2. Although not shown in Figure 5-1, most instrumentation symbol bubbles will show additional instrumentation detail such as a connected temperature probe or airflow measurement array.

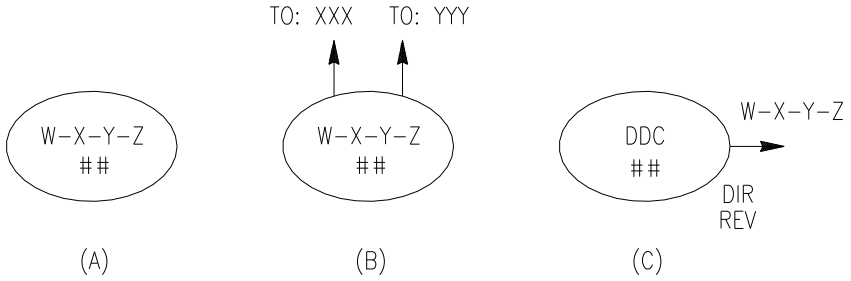


Figure 5-1. Generic Device Symbols.

Control logic diagram symbols: There are a variety of symbols used to construct control logic diagrams. They have identifying letters and numbers associated with the symbols and input/output signals as described in paragraph 5-3.1.2.

5-3.1.2 Unique identifiers

Device symbols and their associated input/output signals use a naming convention consisting of abbreviations and acronyms (W-X-Y-Z and ##), as shown in Figure 5-1, that describe the device or signal. Note that a signal can be a hardwired input or output to or from a device as shown in a control schematic or can be a logical constant or variable as shown in a control logic diagram:

- **W** - Device descriptor; Describes the device, physical location of the device, source of the signal, destination of the signal, or the apparatus/function being controlled. In some cases, a two-part device descriptor is used. For example, MA-FLT is used to describe the mixed air filter.
- **X** - Measured variable or controlled device; In the case of a sensor or measurement instrument, it is temperature (T), relative humidity (RH), pressure (P), etc. In the case of an output, it can describe the actuated device such as a valve (V) or damper (D).
- **Y** - Modifier; In some cases, a modifier is required, such as indicating that a signal is a low-limit (LL) or high-limit (HL) input. Alternatively, the modifier may be used to describe the type of control signal such as a modulating command (C), start/stop (SS), enable (ENA), or disable (DIS) signal.
- **Z** - In some cases, an additional modifier is required, such as indicating that a signal is a setpoint (SP).
- ## - Device or signal number; When there are multiple identical control devices or signals, sequential numbering is used to avoid duplicate unique identifiers. All DDC controllers are numbered (by the Contractor), even if there is only one. The intent is to be able to show a single (common) DDC controller multiple times on a drawing. This can help simplify the control drawings by showing fewer signal lines connected to several DDC controllers instead of showing numerous signal lines connect to a single DDC controller. It also provides leeway to the Contractor to use multiple controllers where project application requirements dictate the need.

Some example device symbol and signal names include:

- MA-T: Mixed air temperature
- MA-D-C: Mixed air damper command
- MA-T-LL: Mixed air temperature low limit
- ECO-ENA: Economizer enable
- ECO-HL-SP: Economizer high-limit setpoint
- ECO-LL-SP: Economizer low-limit setpoint
- SA-T: Supply air temperature
- SA-T-SP: Supply air temperature setpoint
- CLG-V-C: Cooling coil valve command
- SF-C: Supply fan command (modulating control signal)
- SF-SS: Supply fan start/stop
- SF-S: Supply fan status

5-4 POINTS SCHEDULE

5-4.1 Overview

The Points Schedule drawing conveys a great deal of information critical to the design, installation, and subsequent performance of the control system. It includes hardware input/output information, device ranges and settings, and CEA-709.1 communications protocol data. It also includes information about data that is to be accessible at the operator workstation by the UMCS UFGS 25 10 10 Monitoring and Control software.

The Points Schedule Instructions drawing describes Contractor requirements for control system implementation including how to use, complete, and submit the Points Schedule drawing.

5-4.2 Responsibilities

The designer is responsible for the initial set of Points Schedule entries. The UFGS 23 09 23 Contractor is responsible for the bulk of the entries and submits the Points Schedule as a Design Drawing for government approval and then finalizes it as an as-built submittal. The as-built is then used as a contract drawing by the UMCS Contractor. Contractor responsibilities are described in the specifications and in the Points Schedule drawing notes.

5-4.3 UMCS content shown on UFGS 25 10 10 points schedules

Some columns in the Points Schedule (labeled “M&C”) pertain to functionality provided by the Monitoring and Control (M&C) Software specified in UFGS 25 10 10. These columns include SNVT names that the building DDC system (UFGS 23 09 23) must provide for present or future use by the UMCS. Then, as stated in the Points Schedule Instructions drawing, when the building control system is integrated into a UMCS, these columns tell the UMCS Contractor what functionality to configure in the M&C Software. If the building will be ‘stand-alone’ and M&C functionality is required at the building level (to be provided by the DDC UFGS 23 09 23 Contractor), certain requirements from UMCS UFGS 25 10 10 must be added to the DDC UFGS 23 09 23 specification or an edited version of UMCS UFGS 25 10 10 must be used in conjunction with the DDC UFGS 23 09 23 specification. *Note that in the absence of adequate documentation on the Points Schedule by the DDC Contractor, the UMCS Contractor will be unable to integrate the building into the UMCS.*

5-4.4 Points schedule description and instructions

Points Schedule columns and entries are described below along with any designer responsibilities. The responsibilities of the installing Contractor are described on the Points Schedule Instructions drawing.

5-4.4.1 Header information

5-4.4.1.1 DDC hardware identifier

A unique identifier is used to identify the control hardware device on the Points Schedule, Control System Schematic, and other drawings and helps to maintain consistency between drawings. Note that this DDC Hardware identifier is different than the NodeID and the Node field of the address which are described below. The UFGS 23 09 23 Contractor is required to provide this information.

5-4.4.1.2 DDC hardware location

The physical location of the DDC Hardware. The UFGS 23 09 23 Contractor is required to provide this information. Minimally this includes the room number where the DDC Hardware is located.

5-4.4.1.3 Node address

The logical address of the node (DDC Hardware) on the network which consists of three fields: domain, subnet, and node. The UFGS 23 09 23 Contractor is required to record the entire device address on the Points Schedule

5-4.4.1.4 Node ID

A unique 48-bit identifier assigned (at the factory) to each CEA-709.1 device (often called the Neuron ID). The UFGS 23 09 23 Contractor is required to provide this information.

5-4.4.2 General columns: description and instructions

5-4.4.2.1 Function

Basic description of the function performed by this group of points.

5-4.4.2.2 Name

This is the point name. The UFGS 23 09 23 Contractor will provide point names as needed (for those points not already named) using the points abbreviations. The UMCS UFGS 25 10 10 Contractor will use these point names on graphic displays.

5-4.4.2.3 Description

This is a summary description of the point.

5-4.4.2.4 Setting

This shows setpoints, configured setpoints, configuration parameters, and settings related to each point. (These are values established in the controller by the UFGS 23 09 23 Contractor, either by dip switches, hardware settings, controller programming software, or LNS plug-in.) The designer should show setpoints and settings as required. Typical values are shown in the typical drawings. Include the appropriate engineering units for entries in this column.

The UFGS 23 09 23 Contractor will use these settings when configuring devices and will show the setting used where the design did not show or specify one.

5-4.4.2.5 **Range**

Shows the range of values associated with the point. For example, it could be a zone temperature setpoint adjustment range, a sensor measurement range, occupancy values for an occupancy input, or the status of a safety. The designer should edit this column as required, including the appropriate engineering units. In general, the following will need to be edited:

- Zone setpoints
- Switch settings
- Occupancy modes – Must be consistent with the sequence of operation or use "<__>" to indicate that the DDC UFGS 23 09 23 Contractor is to provide this information.

The UFGS 23 09 23 Contractor will use these ranges when configuring devices, and will document the ranges used for those that aren't shown. Note that the UFGS 23 09 23 Contractor must select ranges to meet UFGS 23 09 23 (e.g. permissible range of a temperature sensor).

5-4.4.2.6 **nci/CP name**

The name of the network configuration input (nci) or configuration parameter (CP) for this setting as specified in UFGS 23 09 23. The UFGS 23 09 23 Contractor provides this information for programmable controllers or application specific controllers that don't have LNS plug-ins.

5-4.4.2.7 **I/O type**

Shows the input/output signal type (if any) associated with the point. Point types can be either hardware I/O or network variable points:

- Hardware I/O
  - Analog Input (AI)
  - Analog Output (AO)
  - Binary Input (BI)
  - Binary Output (BO))
- Network variable points:
  - Network Variable Input (NVI)

- Network Variable Output (NVO)

The UFGS 23 09 23 Contractor will document the I/O used in this column, including any network inputs and outputs used to share information between DDC Hardware.

5-4.4.3 LDP and M&C display columns

5-4.4.3.1 LDP view req'd

An *"**X**"* entry in this column indicates that the point is to be viewable from a Local Display Panel (LDP).

5-4.4.3.2 M&C disp req'd

An *"**X**"* entry in this column indicates that the point is to be displayed on a workstation via Monitoring and Control (M&C) software.

5-4.4.3.3 M&C trend req'd

An "**X**" entry in this column indicates that the point is to be trended by the Monitoring and Control (M&C) software.

The intent of showing that a point is to be trended is to require the UMCS UFGS 25 10 10 (UMCS) Contractor to set up a trend for the indicated points. Note that points not marked with an "**X**" may still be trended at a future time.

5-4.4.3.4 SNVT type

The UFGS 23 09 23 Contractor will show the SNVT type for all network variables

5-4.4.4 Overrides columns

5-4.4.4.1 LDP ovrd req'd

An "**X**" entry in this column indicates that the point can be overridden (adjusted) from a Local Display Panel (LDP). If this column contains an "**X**", the **LDP VIEW REQ'D** column for that point should also contain an "**X**".

5-4.4.4.2 M&C ovrd req'd

An "**X**" entry in this column indicates that the point can be overridden (adjusted) from an operator workstation. The designer should place an X in this column for each point that requires override capability from the M&C Software. Note that, in general, overrides should not be needed nor specified for inputs (process variables) and should be limited to setpoints and outputs.

5-4.4.5 Alarms columns

Alarms are handled by the UMCS (as specified by UMCS UFGS 25 10 10) where the M&C software monitors the specified points (via their associated SNVTs) and performs alarm generation, notification, and routing functions. Refer to 5-4.4.5.3 for a description of UMCS alarm handling

5-4.4.5.1 Alarm condition

This column shows the condition(s) for each point at which an alarm occurs. Some alarms include time delays where the intent is to prevent nuisance alarms on equipment start up. Time delay duration is shown in the sample drawing “NOTES”. The designer should show the alarm condition(s) for each point.

5-4.4.5.2 Alarm priority

This column shows the UMCS-assigned priority for alarms as either Critical (CRIT) or Informational (INFO). As specified in UMCS UFGS 25 10 10, critical alarms remain in alarm until acknowledged by a UMCS operator and the alarm condition no longer exists. Informational alarms remain in alarm until the alarm condition no longer exists or until the alarm is acknowledged. The designer should show the alarm priority for each alarm.

5-4.4.5.3 M&C routing

This column shows the name of the alarm routing group that is to be used for each alarm to be handled by the UMCS. The routing group specifies the destinations for each alarm message and, as specified in UMCS UFGS 25 10 10, each group consists of some combination of a pop-up message on one or more workstations, an email to one or more individuals, paging of one or more individuals, or printing to one or more printers.

- If there is an existing UMCS or if this system is to be interfaced with a UMCS, coordinate with the installation and show the M&C Routing group name for each alarm.

- If there is not an existing UMCS, leave the entries in this column in brackets [___] indicating it is a future design option to be completed when the UMCS is designed.

M&C Routing is described in more detail in UMCS UFC 3-401-01.

5-4.5 Points schedule application notes

These notes describe Points Schedule entries for specific rows shown in the Schedule.

5-4.5.1 Analog and binary inputs

Any analog input (AI) or binary input (BI) can be viewed from an LDP or displayed using M&C software at a workstation but AI's and BI's should not overridden from an LDP or workstation (in addition, many application specific controllers do not support this functionality). In the event an AI or BI must be overridden, such as during start-up testing, it can be overridden using a network configuration tool.

5-4.5.2 System reset button (RST-BUT)

The activation of any safety will result in system shutdown. The system remains shutdown until devices requiring manual reset (such as a low limit switch with a reset button) are reset and the system reset button (RST-BUT) signal is activated. This could be either a binary input (BI) (pushbutton) local to the DDC controller or a network variable input (NVI) SNVT from a workstation or local display panel (LDP).

It is recommended that the designer coordinate the decision on how to perform system reset with the local O&M staff. If System Reset is to be performed from a local push button, show "BI" under the I/O TYPE column and show a tilde in all other columns. If System Reset is to be performed via a network variable from the M&C Software and/or an LDP, show an "X" in the M&C OVRD REQ'D column and/or the LDP OVRD REQ'D column. The possible combinations for the RST-BUT are summarized in Table 5-1

Table 5-1: System Reset Button Options and Points Schedule Entries

System Reset From	Entry in I/O column	Entry in M&C OVRD REQ'D Column	Entry in LDP OVRD REQ'D Column
Local Push-Button Only	BI	~	~
Local Push-Button or M&C Software	BI	X	~
Local Push-Button or LDP	BI	~	X
Local Push-Button, LDP or M&C Software	BI	X	X
M&C Software Only	~	X	~
LDP Only	~	~	X
LDP or M&C Software Only	~	X	X

In addition to showing the RST-BUT functionality in the Points Schedule, edit the Control Logic Diagram as required.

5-4.5.3 System occupancy (SYS-OCC)

Most systems will obtain their occupancy mode command (OCC, UNOCC, Warm-up/Cool-down) from a System Scheduler. The occupancy mode for the system is overridden via an override input to the System Scheduler, not to the DDC Hardware performing the specific system sequence of operations, so the system should never have an 'X' in either the M&C or LDP Override columns. Systems that do not require

scheduling will not have a SYS-OCC row shown on the Points Schedule. For example, many infrared heating systems operate according to a manual on/off or an occupancy sensor.

Show SYS-OCC (include this row) for any system that is to operate according to a schedule. Show Occupied, Unoccupied and WUCD (Warm-up/Cool-down) scheduling times (hours of operation) in the OCCUPANCY SCHEDULE Drawing.

5-4.5.4 **Zone occupancy (ZN-OCC) and effective occupancy (EFF-OCC)**

The operational mode (occupied or unoccupied) of a piece of DDC Hardware used to provide environmental control of a space or zone can be dictated by either the System Scheduler (SYS-OCC) or by a binary input (BI) occupancy signal from the zone (ZN-OCC). This BI occupancy signal (ZN-OCC) can be from either an occupancy sensor or from an occupant accessible push button.

For systems such as VAV boxes that require a servicing AHU, the EFF-OCC signal is a network variable output (NVO) from the DDC Hardware (controller) which indicates the current operational mode for the system. This output is used for monitoring the system and (for terminal units requiring air handler service) as an input to the System Scheduler to allow the System Scheduler to place the serving AHU into occupied mode.

If the design is to include either an occupancy sensor or occupancy push button, include both the ZN-OCC and EFF-OCC rows in the Points Schedule. On the Occupancy Sensor Schedule, show the quantity of ZN-OCC BI's (i.e. the number of occupied zones) required to cause the System Scheduler to turn on the AHU that serves these zones. A minimum of two BI's are recommended to help minimize inadvertent starting of the AHU due to cleaning or security staff passing through after hours.

5-4.5.5 **LDP view and override**

The designer may require that LDPs be installed in each mechanical room where the intent is to support air handlers and other primary equipment such as hydronic systems. On the other hand, the template Points Schedules for Terminal Units shows no LDP 'view' or 'override' capability in large part because these units include thermostats that ordinarily provide an adequate operator interface. The designer may choose to show LDP functionality.

5-4.5.6 **Minimum outside air flow**

The minimum outside air flow is the quantity of outside air required for fresh air or for makeup. Show the minimum outside air flow setpoint (MINOA-F-SP) when the outside air flow quantity is controlled using DDC Hardware, an air flow measurement array, and a flow control damper. Otherwise (where there is no closed loop control, such as in a constant volume system), show the minimum OA flow quantity as "Minimum Outside Air Flow Setting". In that case, it does not have a point NAME because it is not an actual signal (not measured using an installed sensor).

5-4.5.7 PID loop settings

The PID Loop Settings are all the settings required to configure PID control, including but not limited to the P, I, and D gains, deadbands, and reset schedules.

5-4.5.8 Filters

As described in the Sequence of Operation Designer Notes, delete the filter pressure high limit switches if/where they are not needed. When filter switches are used, show on the Points Schedule whether the filter status should be displayed at an LDP or UMCS, or if the filter should be routed as an Alarm.

5-4.5.9 Other points

These are points which are not associated with a control loop and are therefore included for monitoring purposes only.

5-4.5.10 Unit status

The Unit Status point indicates if the system is operating in heating/cooling mode. This status is used as a monitored point at the M&C Software and as a heating/cooling request to a chiller, boiler, or heat exchanger. For systems other than heat exchangers, a network variable of type SNVT_HVAC_STATUS is used for this point and the range shown for this point applies to the MODE Field of the SNVT. For heat exchangers, a network variable of type SNVT_SWITCH is used instead.

5-4.5.11 Heating request and cooling request

DDC Hardware controlling chillers, boilers and heat exchangers receive Unit Status inputs from their serviced equipment in the form of heating/cooling requests. The DDC hardware will use these Unit Status inputs to determine whether to start/stop their controlled equipment (e.g. the DDC hardware controlling the chiller may require that three AHUs are calling for cooling prior to starting the chiller). The Chiller, Boiler, or Heat Exchanger System Enable schedule shows under what conditions the equipment will be enabled.

5-5 CONTROL SYSTEM SCHEMATIC

The control system schematic provides a functional representation of the control system. It shows control loops, control system devices, their symbols, unique identifiers, and associated input and output signals. It also contains space for designer notes. Depending upon the particular system, the control system schematic might also show Sequencing Diagrams. It is used to complement the sequence of operation, along with the other control system drawings, and must be coordinated with the sequence of operation and the devices and signals shown in the other drawings.

5-5.1 **Loops and devices**

Each control system schematic consists of one or more loops with associated control hardware and devices including DDC hardware, input devices (sensors and other instrumentation), output devices (valves/dampers/fans/pumps), and multi-function devices. With few exceptions, such as valves, dampers, fans, and pumps, all control devices and signals shown in the Control Schematic should also be shown in the Points Schedule. Valve and damper details are shown in their respective schedules.

The control system schematic must be edited to be project specific and consistent with the other Contract drawings:

- Edit the border as required.
- Provide/show an identifier for the 'system'.
- Add or delete loops and devices as required.
- Show other points (sensors) that will be used for monitoring purposes only and show these Other Points in the Points Schedule.
- Show pneumatic actuation if desired, including positive positioners. By default, valve and damper actuators will use electric actuation.
- Where applicable, show the locations of permanent instrumentation in coordination with other drawings (M-plates).

5-5.2 **Sequencing diagrams**

A Sequencing Diagram shows the heating, deadband, and cooling temperature ranges for controlled devices and equipment. Default Sequencing Diagrams are shown on the typical control drawings and must be edited to be project specific. Show device sequencing for primary equipment such as single-zone air handlers, multizone zone temperature controls and terminal unit equipment, such as VAV boxes and fan coil units on the Control Schematic. In most cases, the sequencing is dependent upon the mode of operation such as occupied, unoccupied, and warm-up/cool-down. Sequencing is further described in the respective written Sequence of Operation and, when used, the Control Logic Diagram.

5-5.3 **Designer notes**

The Control System Schematic has space provided for designer notes including pre-defined/default notes.

5-6 **LADDER DIAGRAM**

The ladder diagram, sometimes referred to as a fan or pump starter circuit or wiring diagram, shows control system equipment interlocks and interfaces. In most cases, these interlocks will be with fan and pump motor starters or variable frequency drive units. In the case of HVAC system equipment, the interlocks will usually include hand-off-auto switches, freeze stats, smoke detectors, fire alarm panel interface, and the

emergency shutdown switch. Default Ladder Diagrams are shown on the typical control drawings and should be edited to be project specific.

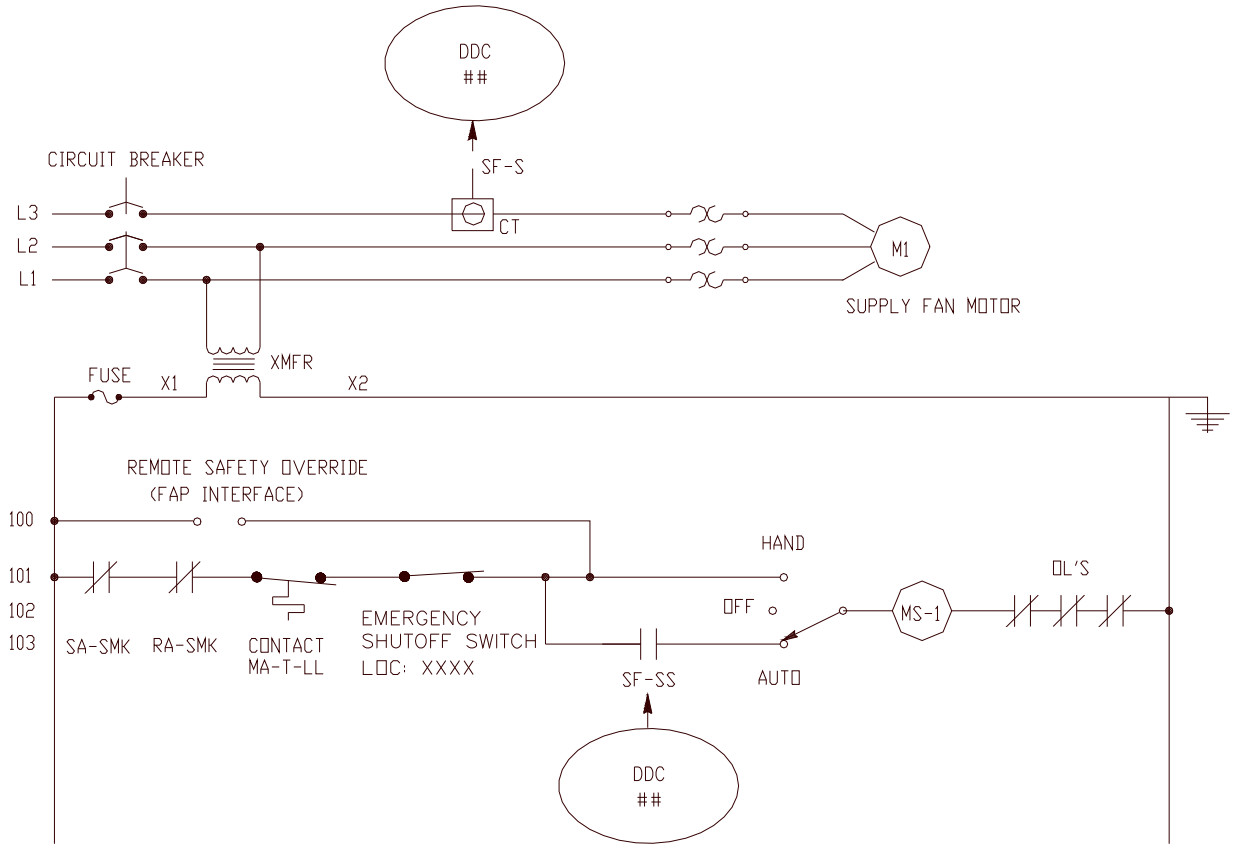


Figure 5-2. Sample Ladder Diagram.

5-7 CONTROL LOGIC DIAGRAM

The control logic diagram (CLD) drawing is intended to be an unambiguous graphical description of the control system sequence of operation. It provides detail that may not be evident in the written sequence. The focus of the CLD is on control logic, not on a particular hardware implementation. Inclusion of a CLD in the Contract drawing package is optional depending on the desired degree of specificity in the design. Use of a CLD is recommended where precise implementation of a particular control sequence is needed. It is also beneficial as part of project quality verification as it can be used as a tool to verify proper implementation of the control sequence.

The CLD must be edited to be project specific and consistent with the other Contract drawings. A control logic diagram tutorial is contained in the Appendix.

5-8 SEQUENCE OF OPERATION

The sequence of operation drawing shows a written description of the control logic. The written sequences are part of DDC UFGS 23 09 23. To avoid confusion, these sequences were not repeated on the typical control drawings. The sequence must be edited to be project specific and consistent with the other Contract drawings and be copied onto the Sequence of Operation drawing.

5-9 THERMOSTAT AND OCCUPANCY SENSOR SCHEDULE

The Thermostat and Occupancy Sensor Schedule (Figure 5-3) shows requirements for space mounted devices.

SYSTEM SERVICE (AHU)	TERMINAL UNIT IDENTIFIER	SPACES SERVED	STAT LOCATION	ZN-T	ZN-T-SP ADJUST	UNOCC OVERRIDE PUSHBUTTON	UNOCC OVERRIDE TIME	OCC SENSOR
[____]		RM-[____] RM-[____]	RM-[____]	[_]	[_]	[_]	[____]	[_]
[____]		RM-[____] RM-[____] RM-[____]	RM-[____]	[_]	[_]	[_]	[____]	[_]
[____]		RM-[____]	RM-[____]	[_]	[_]	[_]	[____]	[_]

Figure 5-3. Thermostat and Occupancy Sensor Schedule.

5-9.1 Thermostats

Note that the definition of a thermostat (STAT) is used somewhat loosely here in that (contrary to the historical definition, but in line with current usage) the thermostat does not necessarily provide a control output (to modulate or position an end device). Instead, the thermostat will contain a temperature sensor and one or more of an occupant adjustable setpoint input, an occupancy sensor, or an unoccupied mode override (manual pushbutton). The intent and application of a thermostat, along with the technical requirements, are clear in the drawings and specifications (including ‘User Input Devices’ and ‘Multifunction Devices’).

5-9.2 **Occupancy sensors**

Space occupancy input(s) may consist of an occupancy sensor and/or a local push-button. Occupancy sensor location, within the room/space, is left up to the Contractor. If ceiling mount sensors are preferred, edit the sequences and/or indicate in the Thermostat and Occupancy Sensor Schedule.

5-9.3 **Schedule entries**

Show project specific entries in the Thermostat and Occupancy Sensor Schedule columns:

- System Service: Show an identifier for the system, such as the air handler, that services/supplies the space. Ensure coordination/consistency with other mechanical system drawings.
- Terminal Unit Identifier: Show an identifier when applicable, such as in a VAV system. Ensure coordination/consistency with other mechanical system drawings.
- Spaces Served: Show the room or rooms serviced by the thermostat and/or occupancy sensor. In general, all stats and occupancy sensors for a given terminal unit should be shown on the same line. However, there may be cases where additional rows may be required. For example, if a VAV zone consists of multiple spaces, a single thermostat but multiple occupancy sensors (one in each space/room) may be desired. The designer might choose to show a separate row for each occupancy sensor. Alternatively, a comment could be added to the column entitled ‘Other’ to clarify the requirement for a single thermostat with multiple space occupancy sensors.
- STAT Location: Show the physical location of the thermostat.
- ZN-T: Thermostats should always include a temperature sensor, so there should always be an ‘X’ in this column.
- ZN-T-SP Adjust: Show an ‘X’ if the thermostat is to include an occupant adjustable setpoint (thumb wheel or sliding bar). Where a non-(occupant)-adjustable setpoint is specified, show the (configured) setpoint in the Points Schedule. When using non-adjustable setpoints, be sure to indicate on the Points Schedule that the setpoint must be capable of being overridden from the M&C Software or an LDP.
- OCC Pushbutton: Show an ‘X’ if the thermostat is to include an occupant accessible pushbutton to override the unoccupied mode and start the servicing system for a duration shown under the UNOCC Override Time.
- OCC Pushbutton Time: If an ‘X’ is shown in the UNOCC Override Pushbutton column, show the time duration that the system will remain in Occupied mode after pressing the UNOCC Override Pushbutton.
- OCC Sensor: Show an ‘X’ if the space is to include an occupancy sensor. The occupancy sensor specification requires a 15 minute off-mode delay prior to leaving the occupied mode. If a different time is desired, show it in the thermostat

schedule and ensure that it is consistent with the DDC UFGS 23 09 23 occupancy sensor product specification.

5-10 OCCUPANCY SCHEDULE

The Occupancy Schedule shows the system modes (Occupied, Unoccupied, and Warm-Up/Cool-Down) and when the system should be in each mode. Two sets of times are shown. One for the normal operating schedule set at the UMCS and one for the default schedule in the building which is active if connection to the UMCS is lost. In addition, the number of occupancy sensors that are required to be reporting as 'occupied' before the system air handler is put into occupied mode is shown on this schedule

5-10.1 System default schedule

The System Default Schedule is configured in the System Scheduler by the Section UFGS 23 09 23 Contractor. This schedule is a '7-day' schedule. In other words, the schedule can differ by day of the week but not day of the year. This schedule should be as simple as possible with one set of times for weekdays and one for weekends. An extended Occupied mode is recommended and should encompass warm-up/cool-down times. For example, if the building is normally in Warm-Up from 0700-0800 and Occupied mode from 0800-1800, a reasonable default schedule might be for the building to be in Occupied mode from 0530-1930. When choosing times for the default schedules for systems with occupancy sensors, the Occupied mode times can be shorter since the occupancy sensors (or override buttons) can still put the system into an Occupied mode.

5-10.2 Supervisory monitoring and control schedule

The Supervisory Monitoring and Control (M&C) Schedule is configured at the M&C software by the UFGS 25 10 10 Contractor. Once a building is connected to the UMCS, this is the schedule that systems in the building will use. Although this schedule can include exceptions for holidays, it is recommended that the designer coordinate with the project site before requiring the implementation of these exceptions. Since the date of most holidays needs to be adjusted year-by-year, the project site O&M staff will need to reconfigure them yearly. As with the default schedule, the presence of Occupancy Sensors should be considered when choosing Occupied mode times.

5-10.3 Number of occupancy sensors to put AHU in occupied mode

Systems with occupancy sensors (or override buttons) can be placed into the Occupied mode by the occupancy sensors when a minimum number of occupancy sensors detect that the space they serve is occupied. Indicate the required number of occupancy sensors in this column.

CHAPTER 6

PROJECT IMPLEMENTATION

6-1 INTRODUCTION

This chapter describes the planning and design of a DDC project.

6-2 PLANNING

In addition to the guidance contained in this UFC, the design should be based on site-specific planning documents. Designs must be accomplished in accordance with the customer's site specific requirements such as, in the case of a Corps of Engineers project, the Installation Design Guide (IDG), Master Planning documents, and the UMCS/DDC Implementation Plan. To help obtain maximum benefit of Open DDC systems, designers should encourage their customers to develop a UMCS/DDC Implementation Plan. Development of an Implementation Plan is recommended in Engineering Construction Bulletin (ECB) 2007-8 and is described in ERDC/CERL Technical report TR-07-16 'IMCOM LONWORKS® Building Automation Systems Implementation Strategy'. This Technical Report is available at:
http://www.cecer.army.mil/techreports/ERDC-CERL_TR-07-16/ERDC-CERL_TR-07-16.pdf

PROCUREMENT CONSIDERATIONS

6-2.1 Non-proprietary procurement

Design of an LNS-based LonWorks® system that is compatible with a UMCS as described in this UFC is the preferred approach.

6-2.2 Proprietary procurement

Other approaches may require proprietary procurement and are therefore discouraged. Where a proprietary procurement approach is deemed necessary, possible proprietary procurement options include:

- Develop a five-year requirements contract.
- Develop contract documents for an Open system but indicate in the contract that, in lieu of an Open system, the Contractor may provide a proprietary DDC system compatible with the existing base-wide system. This requires two designs and two specifications.

- Develop a contract specification for a control system that is strictly "local" with no need to interface to a supervisory system. This approach is strongly discouraged for two reasons:
    - It results in a system that cannot readily be integrated later into a basewide UMCS.
    - Except for the most trivial control systems, a system without a supervisory front end, such as UMCS, will generally not meet customer needs for monitoring and control.

6-3 DDC DESIGN

6-3.1 General

The control system designer is responsible for specifying each control system required for the project systems and will incorporate the control loops and control system sequences of operation using the symbols, abbreviations, and acronyms designated in this guidance. This design responsibility requires producing a contract package that includes a specification and a set of drawings for each control system. While many implementation details will be left to the controls Contractor, the designer will not depend on the control system Contractor or vendor for the preparation of the contract package.

Much of the needed detail was attended to during the development of the UFGS and UFC criteria. Still, project specific requirements must be defined by the designer and the specifications and drawings edited accordingly. It also includes editing control schematic diagrams and other drawings. This notably includes, but is not limited to, editing the Points Schedule drawing to show critical Open system requirements. Some applications require the designer to size and select hardware requirements such as valve sizing and the selection of electric or pneumatic actuation.

The resultant project-specific specification will require the control system Contractor to produce shop drawings, schedules, instructions, test plans, test procedures, testing procedures, and other documents showing the application of products to implement the control system design. The specification will require the Contractor to implement the building-level CEA-709.1 communications network in a manner that is consistent with performance requirements defined in the specification. The specification will further require that the Contractor perform calibration, adjustments, and testing of the control system and document the testing to show that the control system functions as designed.

6-4 SCOPE OF THE DESIGN

The designer must assess the project specific requirements and tailor the design accordingly. This includes determination of whether the design should include a UMCS. The flowchart shown in Figure 6-1 and the following questions will aid in this decision.

1) It will be connected to a UMCS
    a. Now
    b. Later
2) It will not be connected to a UMCS

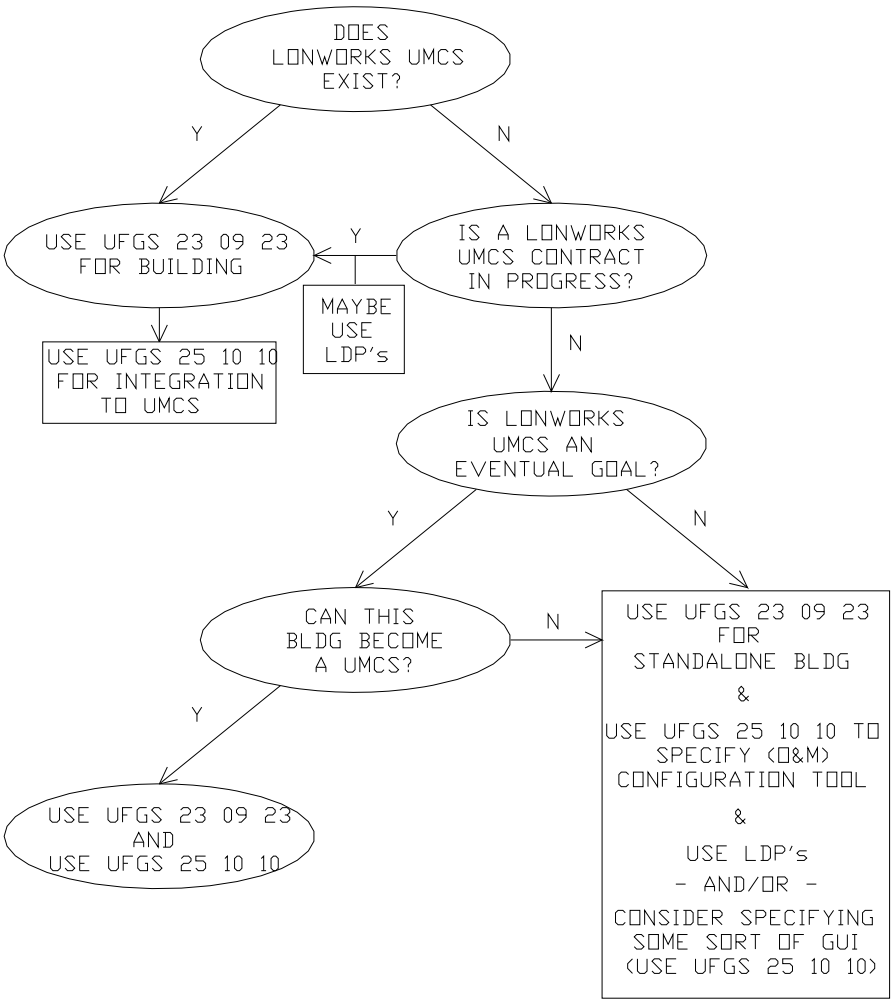


Figure 6-1. UMCS Decision Flow Chart.

Is there an existing LONWORKS UMCS?

Yes: Use DDC UFGS 23 09 23 for the present building-level project and use an edited version of UMCS UFGS 25 10 10 to specify the integration of the building system to the UMCS (UMCS UFGS 25 10 10 is designed to make this editing task straightforward).

No: Determine if there is a LONWORKS UMCS contract in-progress.

Is a LONWORKS UMCS contract in-progress?

For example, another 'in-progress' project might include a UMCS or development of an IDIQ contract for a basewide UMCS might be in 'in-progress'.

Yes: Assuming the intent is to eventually interface the present building-level (DDC UFGS 23 09 23) system with the future UMCS, the 'in-progress' building-level DDC systems (DDC UFGS 23 09 23) can later be interfaced to the UMCS (upon installation of the future UMCS) using an edited version of UMCS UFGS 25 10 10 as described above.
To provide additional interim functionality to the building until the UMCS integration can occur, the designer might choose to include local display panels (LDPs) in the present project to serve as an O&M tool until the UMCS contract provides Monitoring and Control software and a network configuration tool. Alternatively, the designer might choose to include a network configuration tool (from UMCS UFGS 25 10 10) in the present DDC UFGS 23 09 23 contract specification along with the accompanying workstation (laptop computer) required to run the (software) tool while bearing in mind that the UMCS will also include a configuration tool.

No: Decide if a LONWORKS UMCS is an eventual goal.

Is a LONWORKS UMCS an eventual goal?

If Yes, **Can this building become 'a UMCS'**? Essentially any building system project can become a UMCS by including UMCS UFGS 25 10 10 in the project specification with only an incremental investment over a single-building standalone system. In this case, use both DDC UFGS 23 09 23 and UMCS UFGS 25 10 10 in its entirety to obtain a UMCS (but see the discussion of contracting options below).
At its most basic level, the creation of a UMCS consists of adding: a UMCS workstation, M&C software, a network configuration tool, a BPOC, and an Ethernet backbone for connection to the UMCS workstation. In addition, it is wise to pre-plan a contractual support mechanism, such as an IDIQ or Services contract, to support expansion of the UMCS as new buildings are added to the UMCS (see discussion of contracting options below).
Some additional planning and/or design may be required such as providing space for the UMCS workstation, server, and printers. Consideration might need to be given to identifying desirable added functionality that might otherwise not be included in the absence of a UMCS such as the inclusion of workstation graphical displays or the addition of client workstations. Many of these things are ordinarily addressed as part of a UMCS/DDC Master Plan. In summary, adding UMCS requirements as part of a single-building system provides a single-building system that may serve as the basis for all future system expansions where subsequent buildings and systems can be integrated with this first system. This is the first step towards a basewide UMCS.

No: If **this building <u>cannot</u> become a UMCS**, use DDC UFGS 23 09 23 to specify a standalone building by using applicable portions of UMCS UFGS 25 10 10 to specify

M&C software and O&M tool requirements. For the operator interface, use LDPs as specified in DDC UFGS 23 09 23 and/or consider specifying some sort of graphical user interface (GUI), such as that specified under Monitoring and Control software in UFGS 25 10 10. You must also specify a configuration tool such as that specified in UMCS UFGS 25 10 10. The LDPs, GUI/M&C software, and configuration tool are necessary for O&M of the stand alone DDC system. While UMCS UFGS 25 10 10 is primarily intended for implementing a basewide UMCS, it also pertains to smaller scale applications including a single system or single building. In this case, UMCS UFGS 25 10 10 is necessary to obtain operator workstation (desktop or laptop) interface tools required by the O&M support staff. Edit UMCS UFGS 25 10 10 to provide the required functionality and tools. Using only DDC UFGS 23 09 23 is unadvisable. DDC UFGS 23 09 23 does not contain operator interface requirements/devices except for a local display panel which is not sufficient to adequately support O&M activities. Tools necessary to support O&M activities such as an operator workstation (laptop) will not be provided.

6-5 CONTRACTING MECHANISMS

While procurement of building level controls is relatively straightforward, procurement of a UMCS is more complex. There are two main issues to be considered:

- UMCS work is an ongoing process. While the UMCS is procured once, building integration to the UMCS is a process that can span many years. The question of how to accomplish future integration work should be addressed prior to initial procurement. As an extreme example, there are “mom-and-pop” shops that can install a custom UMCS that they have developed themselves. However, use of such a UMCS pretty much guarantees that future integration work will have to be performed by the “mom-and-pop” shop.

- Contractually, it might be easiest to procure the initial UMCS from a building level DDC Contractor as part of a building level DDC controls project. The danger in this approach is that allowing the same Contractor to install both requires extra vigilance on the part of the government to ensure that the interface between the UMCS and the building is fully compliant with UMCS UFGS 25 10 10. As an extreme case, the Contractor might install a UMCS that works fine with the Contractor’s controls, but will not work with other building control systems that are compliant with DDC UFGS 23 09 23.

There are a number of contracting mechanisms that can be used, including:

- IDIQ or services contract.

- As part of a building level DDC contract.

- As a separate contract for either UMCS procurement or integration services.

A detailed discussion of contracting methods and the pros and cons of each can be found in ERDC/CERL Technical Report TR-07-16 'IMCOM LONWORKS® Building Automation Systems Implementation Strategy' at https://eko.usace.army.mil/fa/bas/.

6-6 COORDINATION

6-6.1 IT (DOIM) Coordination

- Coordinate with the project site's Internet Technology (IT) group such as the Directorate of Information Management (DOIM) and with the UMCS UFGS 25 10 10 designer as applicable. The designer must specify the Building Point of Connection (BPOC) location, where the intent is to obtain UFGS 23 09 32 Contractor-provided TP/FT-10 building control network wiring that extends to the location of the BPOC. Ordinarily, in accordance with UMCS UFGS 25 10 10, the BPOC will be provided by the UMCS Contractor.

- A major issue for installation of a UMCS will be DIACAP and Networthiness certifications. Current Army regulations require that any Army information system be covered by DIACAP and that any system residing on the basewide IP network have a certificate of Networthiness. Fortunately, except in the infrequent case of a DDC IP network in the building, DIACAP and Networthiness do not impact installation of building-level DDC controls since they reside on a TP/FT-10 network, not IP. DIACAP and Networthiness are discussed in further detail in UFC 3-401-01, UTILITY MONITORING AND CONTROL SYSTEM (UMCS).

6-6.2 Mechanical design coordination

- Coordinate mechanical systems design with control system requirements.

- Coordinate outside air (OA) ducts. Most air systems will require a minimum OA duct/damper (for ventilation or make-up air) separate from the economizer OA duct.

- Coordinate/show outside air temperature location(s) on the M-plates.

- Coordinate/show room sensor locations on M-plates.

- Coordinate duct and pipe mount sensor locations and show on M-plates. The primary goal is to help ensure that the mechanical design accommodates control instrumentation space, distance, and access needs. A secondary goal is to ensure that the M-plates document instrument locations and other details to help ensure proper installation and to provide O&M documentation. This includes air flow measurement arrays (AFMAs), static pressure sensors, and relative humidity sensors. AFMAs generally should be located at least eight straight duct diameters downstream of obstructions and three diameters upstream. Duct static

pressure sensors should be located near the end of the longest branch duct. Duct relative humidity sensors should be located three meters downstream of an injection element. Piping differential sensors should be located towards the end of the piping system. The specifications provide specific Contractor guidance.

- Coordinate air flow measurement requirements such as those for VAV systems to provide upstream air filters, airflow station access door, and clearance for O&M access.

- Coordinate air compressor and dryer locations with mechanical designer.

- Make sure mechanical designer is providing clearance/access space to mechanical equipment for DDC UFGS 23 09 23 Contractor and O&M

- Coordinate interface to boilers, chillers, and other package units. Identify interface type. Edit chiller/boiler specs.

6-6.3 **Electrical design coordination**

- Make sure 120Vac power is available in all mechanical rooms and at terminal units for controls Contractor use to provide power to instrumentation and controls.

- Make sure there is power in the proper location for the air compressor based on estimated compressor size (horsepower). Provide an estimate of the air compressor size.

- Occupancy sensor interface to electrical systems. Where occupancy sensors will be interfaced with lighting systems/ballasts, identify possible concerns or issues.

- Where a variable frequency drive is required ensure that there is a VFD specification and that it meets the application requirements as defined in the sequence of operation and ladder diagram drawing. In particular, note the fire alarm panel interface and H-O-A switch requirements.

- Identify the location of the UMCS building point of connection (BPOC).

6-6.4 **Project site coordination**

Coordination details are described throughout this UFC. A short list of coordination activities includes:

- Pneumatic versus electric actuation. Decide which to use. Consider the actuation needs in both mechanical rooms and at terminal units in the zones/spaces.

- Valve type preferences.
- Need for local display panel (LDP). Decide if LDPs are desired/required.
- Wire and cable. Need for raceway/conduit.
- Default system schedule and Terminal Unit (TU) groupings. When a UMCS is used it will perform (primary) scheduling but in the absence (or loss) of a UMCS a ‘default schedule’ will be active. Identify the default system schedule to be used for each piece of scheduled equipment. In addition, determine if it is desirable to use a common schedule for multiple TUs and identify this schedule.
- Point naming conventions and device addressing conventions.
- Reset buttons. Decide how to implement DDC reset. Refer to Drawings Chapter and show selection on the Points Schedule.
- Occupancy sensors. Occupancy sensor signal is used to turn the servicing AHU ‘on’. Decide how many sensors must generate an occupied signal (from multiple spaces) to help avoid needless turning on of the servicing AHU (due to cleaning staff or security staff passing through after hours).
- Stats / space sensors: Select desired functionality including pushbutton override and occupancy sensor time delay. Show in the Schedule drawing.
- Filter pressure switches. Decide if these are required.
- Training. Identify number of students, number of hours of training, and number of copies of training material.

6-7 EDITING THE SPECIFICATION

6-7.1 UFGS 23 09 23 edits

Make selections/entries according to designer brackets “[ ]”. Notes are provided in the specification to assist with these selections.

6-7.2 Other specification editing/coordination

- Smoke detectors. Coordinate with applicable specification(s).
- Foundation/housekeeping pad specs.
- Performance verification test (PVT). Edit PVT requirements to be project specific.

- As identified in paragraphs “Electrical design coordination” and “Mechanical design coordination”.

6-8 DRAWING PACKAGE

Assemble and edit the drawing package as described in CHAPTER 5.

6-9 OTHER

Perform a biddability, constructability, operability, and environmental (BCOE) review.

APPENDIX A
GLOSSARY

10Base-T **100Base-T** **100Base-FX** **1000Base-T** **1000Base-SX** **1000Base-LX** **10GBase-T**	Ethernet media and communication speeds. The number is communication speed in Megabits per second (Mbps) or Gigabits per second (Gbps). “T” is twisted pair wire (usually Cat-5 or better), while “FX”, “SX”, and “LX” are fiber optic cable. Note that 10 Gigabit Ethernet is (as of 2006) an IEEE standard and 100 Gigabit Ethernet is in development.
AGC	Application Generic Controller. A controller that comes from the factory with a limited built-in application. It is p*rogrammed* for the application (VAV box, fan coil, etc.). It can be programmed through an LNS plug-in. It can be thought of as a cross between an ASC and GPPC. These controllers should be certified by Lon Mark. An AGC has a fixed program ID.
ASC	Application Specific Controller. A controller that has a built-in, fixed program to execute a sequence for a specific hardware system, e.g. a VAV box controller. An ASC controller has a fixed program ID.
Building Point of Connection (BPOC)	The BPOC is the point of connection between the UMCS network backbone (an IP network) and the building control network backbone. The hardware at this location that provides the connection is referred to as the BPOC Hardware. In general, the term "BPOC Location" means the place where this connection occurs, and "BPOC Hardware" means the device that provides the connection. Sometimes the term "BPOC" is used to mean either and its actual meaning (i.e. location or hardware) is determined by the context in which it is used.
Closed	The opposite of Open. A standard/protocol/specification where important details of its implementation are not available to all interested parties. Closed standards are closely controlled by the developing party and implementation of devices based on them is generally limited to a small number of vendors.
Configured Setpoint	As opposed to a user-adjustable setpoint like that provided by a thermostat, a configured setpoint is set at the DDC hardware by a configuration tool (software). Although they can be changed later through the configuration tool, these setpoints are more “permanent” than a user-adjustable setpoint.
Device	A piece of hardware. See also 'Node'.

DDC Direct Digital Control, defined as control consisting of microprocessor-based controls with the control logic performed by software.

Gateway A device (usually a combination of software and hardware) that connects networks using different communication protocols so that information can be passed from devices on one network to the other. Gateways perform protocol conversion to translate this information from one protocol to another.

GPPC General Purpose Programmable Controller. A controller that can be programmed to run any (within hardware limits) sequence and can be set up as a controller for different hardware systems. Changes to the program result in a different Program ID.

GUI Graphical User Interface. A program interface that takes advantage of the computer's graphics capabilities to make the program easier to use. A true GUI includes formats for representing text and graphics.

HMI Human-Machine Interface: The means by which an operator interacts with an automation system, often a GUI.

Interoperability The ability to integrate products from multiple vendors into flexible, functional systems without the need to develop custom hardware, software, or tools.

Interoperable This is closely related to Open standards and refers to the level of difficulty of integrating components (or systems) from multiple vendors into a single system. Interoperability needs to be considered from the perspective of hardware installation (will the parts physically fit and interconnect?), communications (do the devices “speak the same language”?), configuration and programming (is the same software tool used for different vendor components?), maintainability (do the components have similar maintenance procedures and requirements?), and operation (do the components have similar functionality/sequences and utilize the same operator interface?). Open standards enhances/encourages interoperability because it allows multiple vendors to utilize a common standard. A caveat: In many (if not all cases), when vendors use the term interoperable, they do not mean *interchangeable* (in the sense of swapping out a VAV box for an identical VAV box).

IP Internet Protocol. IP is a protocol on the Internet and is concerned with addressing and routing of data packets from their origin to the destination. Many other protocols are used in the Internet (TCP, HTTP, etc), but IP is the key protocol the others run on top of.

LAN Local Area Network, is a network for transferring data between computers or other digital devices.

LNS®	LonWorks Network Service, is the database architecture that resides on the computer attached to the LonWorks Network that is used to install and manage the Network. LNS is a database that can be accessed by any LNS-based Network Configuration Tool and by multiple users simultaneously.
LON	Local Operating Network. Also used as a shorthand reference to the term LonWorks.
LonTalk®	A networking protocol developed by Echelon Corporation and recognized by ANSI/CEA as ANSI/CEA-709.1-B. LonTalk implements layers 1-6 of the OSI reference model.
LonWorks®	A networking platform (created by Echelon Corporation) that provides solutions to numerous problems of designing, building, installing, and maintaining control networks.
LonWorks Router	A piece of equipment that allows ANSI/CEA-709.1-A communication and routing of network variables over an ANSI/CEA-709.1-A network. See “Router”.
LonWorks LON to IP Router	A piece of equipment that allows ANSI/CEA-709.1 communication and routing of network variables over IP. Also known as an ANSI/CEA 852 router. See “Router”.
Network	A group of devices (computers, controllers, or other digital units) that are connected by communication facilities, such as twisted-pair cabling, coaxial cable, fiber-optic cable, or wireless means.
Network Configuration Tool	The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).
Neuron® C	A derivative of the C programming language specifically designed for developing applications for the Neuron chip.
Neuron® chip	A chip that implements the ANSI/CEA-709.1 protocol. This chip is used by most LonWorks devices for communication on the network. Many LonWorks devices also use this chip for control functionality.
Node	A device (such as a computer or a controller) on a network that is capable of communicating with other network devices via a networking protocol such as ANSI/CEA-709.1.
Open system	An Open system is characterized by the ability for any qualified third party entity to readily modify, operate, upgrade, and perform retrofits on the system.

OWS	Operator Work Station, a type of computer-based GUI. An OWS is designed for use by an operator whereas a technician or maintenance worker might have a different computer and GUI with a different “look and feel”.
Peer-to-Peer	A type of network where each node has equivalent capabilities and responsibilities for network communication.
Plug-in	Software used to configure an ASC that is run/executed from within a Network Configuration Tool.
Program ID	All DDC controllers have a firmware-based program inside them that allows them to execute their function. For CEA-709.1 controllers, this program has a Program ID that is unique to that particular program. Changing the program results in a different Program ID. Program IDs may be used to ensure that 2 controllers have the same program.
Proprietary	Privately owned and controlled. Proprietary is the opposite of public domain.
Proprietary – Government procurement	In Government procurement regulations, a proprietary product is one that requires sole source procurement.
Router	A device that connects two or more LANs. Routers are devices that provide network-independent packet filtering and forwarding. They may also include bridge functionality.
SNVT	Standard Network Variable Type; Pronounced 'snivet'. A standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual LonWorks nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network variable itself (i.e. it can mean "a network variable of a standard network variable type"). In general, the intended meaning should be clear from the context.
Standard, De-Facto	De-Facto standards are ‘standards of fact’, that is, standards that have been adopted by an industry or a market. An example of a de-facto standard is Microsoft Word. While it has not been adopted by a recognized standards organization, its market dominance makes it the de-facto standard for word processing. Gray areas arise here over market share and industry recognition.

Standard, De-Jurie	De-Jurie standards (literally, ‘standards of law’) are those that have been adopted and approved by some recognized standards organization, such as ASHRAE, IEEE, ASTM, ISO, etc. CEA-709.1 is an example of a de-jurie standard. Gray areas can arise here over what constitutes a standards body.
Standard, Proprietary	Proprietary standards are those that are owned and controlled by an organization not generally recognized as a 'legitimate' standards body (they are often owned by a for-profit organization). They frequently are considered to be, or to contain, intellectual property of value to the owning body. Proprietary standards may be Open, closed, or somewhere in between, though they tend to be more closed. The Microsoft Word document format (.doc files) is an example of a closed proprietary standard.
Transceiver	A component or circuit that enables a hardware device to communicate on a network.

APPENDIX B

CONTROL LOGIC DIAGRAM (CLD) TUTORIAL

Planned edits:

1. fix binary vs analog line thickness problem
2. add PID loop figure
3. add IF figure
4. add set/reset figure
5. add ramp up and ramp down block
6. fix Figure B-1 Control Logic Diagram for Central Plant Hydronic with Steam/HW Converter – replace with updated

B-1 INTRODUCTION

The control logic diagram (CLD) is an unambiguous graphical description of the control system sequence of operation. The focus of the CLD is on control logic, not on a particular hardware implementation. In particular, the CLD does not distinguish between normally open or normally closed contacts, valves, or dampers; these details should instead be indicated on the appropriate wiring diagram, valve/damper schedule, or control schematic drawing. The CLD is concerned with whether a given signal is TRUE or FALSE.

For example, a typical sequence calls for a 'fan status' input (to be used in a fan-proof logic block). The actual hardware could be implemented in a variety of ways, -- a current-sensing-relay on the fan motor, a DP switch across the fan, or an air flow proof switch. The actual hardware used is irrelevant to the CLD. Any one of these possible hardware devices would be shown as a simple binary input to the sequence. Another example would be the freeze stat (CooLinG-Discharge-Air-Temp-LowLimit; CLG-DA-T-LL) which is TRUE when the freeze stat trips; whether that's from a set of NO or NC contacts is a detail for the wiring diagram. Finally, the Controller hardware implementation is not shown; while a given functional block is probably implemented in one controller, a build-up system (such as a RF VAV system with MA Economizer and Ventilation Demand control) may be in one or more controllers – the CLD does not make that distinction.

B-2 FUNCTIONAL BLOCKS USED IN CONTROL LOGIC DIAGRAMS

In the following descriptions, logical values are always referred to as TRUE or FALSE. Synonyms for these names include ON and OFF, as well as 1 and 0.

B-2.1 Signal

A line represents a signal path within the logic, either analog or binary. This line shows signal inputs and/or outputs to and from functional blocks.

B-2.2 **Actuator Output**

2-Position Actuator Output

Modulating Actuator Output

This block represent a physical output from the system, an actuator or valve. It accepts a binary (B) or analog (A) signal and drives a piece of hardware. Since the CLD shows the control logic without reference to the hardware implementation, the actual hardware is unspecified.

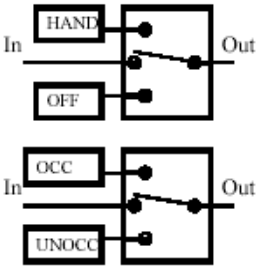
B-2.3 **Sensor Input**

Binary Sensor Input

Analog Sensor Input

This block represents a hardware sensor input to the system. It may provide either an analog (A) or binary (B) signal. Again, the exact hardware type is unspecified.

B-2.4 **Hand-Off-Auto (H-O-A) Switch**



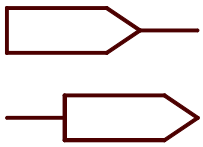
H-O-A Switch

This represents a HAND-OFF-AUTO switch. Sometimes, a H-O-A switch will be shown differently; for example where the position of the H-O-A switch would select some input to control logic. This block is generally used when the output of a control block is selected. The top block shows a normal H-O-A switch, the bottom shows a variant where the manually selected values are OCCUPIED or UNOCCUPIED.

B-2.5 **Constant Value**

This logic block represents a constant value, either analog or binary and is usually provided as an input to another logic block.

B-2.6 **Signal I/O**

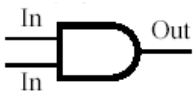


Signal Input

Signal Output

These blocks represent a named signal path within the logic. These are functionally identical to the symbols described earlier, except that this signal is given a name, which allows it to be defined or used elsewhere in the logic.

B-2.7 **Logical AND**



Logical AND Function

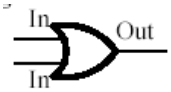
This logic block represents the logical AND function. It takes two or more binary inputs and produces a binary output. Its output is TRUE if and only if all of its inputs are TRUE. If any of its inputs are FALSE, then its output is FALSE.

B-2.8 **Logical NOT**

Logical NOT Function

This logic block represents the logical NOT function. It has one binary input and one binary output. Its output is TRUE if and only if its input is FALSE. If its input is TRUE, its output is FALSE.

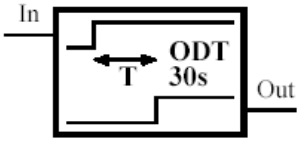
B-2.9 **Logical OR**



Logical OR Function

This logic block represents the logical OR function. It has two or more binary inputs and one binary output. Its output is TRUE if any of the inputs are true. If all the inputs are FALSE, the output is FALSE.

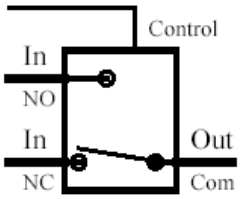
B-2.10 **On Delay Timer**



On Delay Timer

This logic block represents an On Delay Timer. It has one binary input and one binary output. In addition it has one parameter, a time (T) value. The output is always equal to the input, except when the input changes value from FALSE to TRUE. In this case, the transition of the output from FALSE to TRUE is delayed by the value of the time parameter. This time value has no effect on the transition from TRUE to FALSE, it only affects the output when the input becomes TRUE.

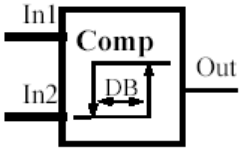
B-2.11 **Switch**



Switch

This block represents an analog switch with 2 analog inputs, one analog output, and a binary control input. When the control input is false, the output is the value of the analog signal at the Normally Closed (NC) input. When the control input is true, the output is the value of the analog signal at the NO (Normally Open) input. Note that this convention for NC and NO follows the electrical switch convention; it is opposite from that used for pneumatic switches.

B-2.12 **Comparator with Deadband**



Comparator with Deadband

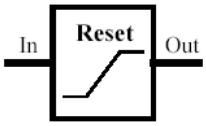
This logic block represents a comparator function with hysteresis. It takes two analog inputs and produces a binary output. It also has one parameter, deadband (DB). As shown in Comparator Table below the output value only changes if the difference between the inputs exceeds half the deadband, if the difference in inputs is less than half the deadband, the output remains at its present value.

Comparator Input and Corresponding Output

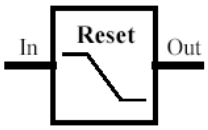
Input Conditions	Output Value
(*In1*–*In2*) < -*deadband*/2	FALSE
-*deadband*/2 ≤ (*In1*–*In2*) ≤ *deadband*/2	Output does not change; remains fixed
(*In1*–*In2*) > +*deadband*/2	TRUE

For example, if *In1*=75, *In2*=68 and the *deadband*=4, the output would be TRUE. As *In1* fell, the output would remain TRUE until *In1* went below 66 (68–66=4/2). Essentially, the output of this block is TRUE if the top value is greater than the bottom value and FALSE if the bottom value is greater than the top value (neglecting the deadband).

B-2.13 **Reset Schedule**



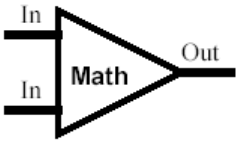
Reset Schedule
(output increases as input increases)



Reset Schedule
(output decreases as input increases)

This block represents a reset schedule. It has one analog input, one analog output, and 4 parameters: InputMin, InputMax, OutputMin, and OutputMax. For the first reset schedule shown, the output increases as the input increases; as the input ranges from InputMin to InputMax, the output varies linearly from OutputMin to OutputMax. Inputs below InputMin or above InputMax result in the output going to OutputMin or OutputMax, respectively. For the second reset schedule shown, the output decreases as the input increases. The reset schedule block can be thought of as a graph, with the input variable on the X-axis and the output variable on the Y-axis.

B-2.14 **Math Function**



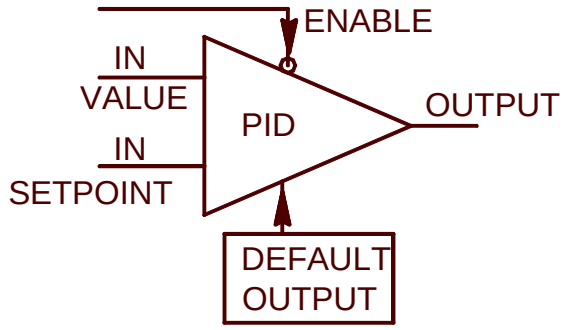
Math Function

This logic block represents a variety of mathematical functions. It takes two or more analog inputs and produces an analog output. Some common functions for this block are shown in the table below.

Common Math Block Functions

Name	Function
Minus	Subtraction
Minimum	Select the minimum value from the input values
Maximum	Select the maximum value from the input values
Plus	Addition

B-2.15 **PID Loop with Enable**



This function block represents a proportional-integral-derivative (PID) loop with an Enable input. It has 2 analog inputs (a value and a setpoint), an analog output, a binary enable input, and default output. The DEFAULT OUTPUT is the OUTPUT when the ENABLE is false.

B-2.15.1 **IF Block**

The IF Block is TRUE if the input meets the condition inside the block, otherwise the IF Block's output is FALSE.

B-2.15.2 **Set/Reset Latch**

This function block represents a latch. The latch has 2 binary inputs, a set input and a reset input, as well as a single binary output. Once set (by a TRUE value at the Set input), the latch's output remains TRUE until reset (by a TRUE value at the reset input). Likewise, once reset, the output remains FALSE until set by a TRUE value at the set input. Essentially, the latch remembers whether it was last Set or Reset.

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USACE / NAVFAC / AFCESA / NASA | UFGS-23 09 23 (December 2009)

Preparing Activity: USACE | Superseding
UFGS-23 09 23 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2009
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SECTION 23 09 23

DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS
12/09

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NOTE: This guide specification covers the requirements for direct digital control for HVAC and other local building systems.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Additional information and guidance on use of this guide specification is contained in ECB 2004-11., which may be found on the Internet on the TechInfo web site at:
http://www.hnd.usace.army.mil/techinfo/ECbull.htm
****

PART 1 GENERAL

****
NOTE: This specification covers installation of local (building-level) controls using LonWorks-based DDC. It is primarily intended for building level control systems which are to be integrated into a Utility Monitoring and Control System (UMCS) as specified in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS). For projects that require the building system to provide UMCS functionality (without connection to a UMCS), the designer must

include the necessary requirements from UFGS 25 10 10. Some requirements to include in this case are:
1) LonWorks Network Configuration Tool
2) Monitoring and Control Software
3) Computer Workstations and Servers
Further details on specifying a stand-alone building system are in UFC 3-410-02A.

The HVAC Control System design shall be in accordance with UFC 3-410-02A. This specification is based on the use of standard HVAC control systems and the designer shall coordinate the design with this specification. Additionally, the standard drawings, as delineated in UFC 3-410-02A, must be used in the preparation of the contract drawings and those drawings must be included in the completed design package. Templates for typical contract type drawings, based on the standard drawings in UFC 3-410-02A, have been developed and are available in AutoCAD and MicroStation formats on the Internet on the TECHINFO web site located at:
http://www.hnd.usace.army.mil/techinfo/index.asp
****

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 500-D	(1998) Laboratory Methods of Testing Dampers for Rating

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE FUN IP	(2009) Fundamentals Handbook, I-P Edition
ASHRAE FUN SI	(2009) Fundamentals Handbook, SI Edition

ASME INTERNATIONAL (ASME)

ASME B16.15	(2006) Cast Bronze Threaded Fittings Classes 125 and 250
ASME B16.34	(2009) Valves - Flanged, Threaded and Welding End
ASME B40.100	(2005) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2007; Addenda 2008) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

ASTM INTERNATIONAL (ASTM)

ASTM A 269	(2008) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM B 88	(2003) Standard Specification for Seamless Copper Water Tube
ASTM B 88M	(2005) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM D 1693	(2008) Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D 635	(2006) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1B	(2002) Control Network Protocol Specification
CEA-709.3	(1999) Free-Topology Twisted-Pair Channel Specification
CEA-852-A	(2004) Tunneling Component Network Protocols Over Internet Protocol Channels

FLUID CONTROLS INSTITUTE (FCI)

FCI 70-2	(2006) Control Valve Seat Leakage

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) IEEE Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE Std 142	(2007) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book (Color Book Series)

ISA - INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 7.0.01	(1996) Quality Standard for Instrument Air

LONMARK INTERNATIONAL (LonMark)

LonMark Interoperability Guide	(2002) LonMark Application-Layer Interoperability Guide; Version 3.3
LonMark SNVT List	(2002) LonMark SNVT Master List; Version 11 Revision 2
LonMark XIF Guide	(2001) LonMark External Interface File Reference Guide; Revision 4.0B

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA C12.1	(2008) Electric Meters; Code for Electricity Metering
NEMA C12.10	(2004) Physical Aspects of Watthour Meters
NEMA C12.20	(2002) Electricity Meter - 0.2 and 0.5 Accuracy Classes

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition
NFPA 90A	(2008; Errata 2009) Standard for the Installation of Air Conditioning and Ventilating Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices

UNDERWRITERS LABORATORIES (UL)

UL 5085-3	(2006e1; Rev thru Jun 2007) UL Standard for Safety Standard Low Voltage

	Transformers - Part 3: Class 2 and Class 3 Transformers
UL 555	(2006; Rev thru Feb 2009) Standard for Fire Dampers
UL 555S	(1999; Rev thru Mar 2009) Smoke Dampers
UL 916	(2007) Energy Management Equipment
UL 94	(1996; Rev thru Jun 2009) Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.2 DEFINITIONS

The following list of definitions may contain terms not found elsewhere in the Section but are included here for completeness.

a. Application Specific Controller: A device that is furnished with a pre-established built in application that is configurable but not re-programmable. An ASC has a fixed factory-installed application program (i.e Program ID) with configurable settings.

b. Binary: A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

c. Binding: The act of establishing communications between CEA-709.1B devices by associating the output of a device to the input of another.

d. Building Control Network: The CEA-709.1B control network installed under this Section, consisting of a backbone and one or more local control busses.

e. Building Point of Connection (BPOC): The BPOC is the point of connection between the UMCS network backbone (an IP network) and the building control network backbone. The hardware at this location, that provides the connection is referred to as the BPOC Hardware. In general, the term "BPOC Location" means the place where this connection occurs, and "BPOC Hardware" means the device that provides the connection. Sometimes the term "BPOC" is used to mean either and its actual meaning (i.e. location or hardware) is determined by the context in which it is used.

f. Channel: A portion of the control network consisting of one or more segments connected by repeaters. Channels are separated by routers. The device quantity limitation is dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 128 devices per channel.

g. Configuration Parameter: Controller setting usually written to EEPROM. Also see 'Standard Configuration Parameter Type (SCPT)'

h. Control Logic Diagram: A graphical representation of control logic for multiple processes that make up a system.

i. Domain: A grouping of up to 32,385 nodes that can communicate directly with each other. (Devices in different domains cannot communicate

directly with each other.) Part of the Node Addressing scheme.

j. Explicit Messaging: A method of communication between devices where each message contains a message code that identifies the type of message and the devices use these codes to determine the action to take when the message is received. These messages are non-standard and often vendor (application) dependent.

k. External Interface File (XIF): A file which documents a device's external interface, specifically the number and types of LonMark objects; the number, types, directions, and connection attributes of network variables; and the number of message tags.

l. Functional Profile: The description of one or more LonMark Objects used to classify and certify devices.

m. Gateway: A device that translates from one protocol to another. Gateways are also called Communications Bridges or Protocol Translators.

n. General Purpose Programmable Controller (GPPC): Unlike an ASC, a GPPC is not furnished with a fixed application program. A GPPC can be (re-)programmed, usually using vendor-supplied software.

o. LonMark Object: A collection of network variables, configuration parameters, and associated behavior defined by LonMark International and described by a Functional Profile. Defines how information is exchanged between devices on a network (inputs from and outputs to the network).

p. LNS Plug-in: Software which runs in an LNS compatible software tool. Device configuration plug-ins provide a 'user friendly' interface to configuration parameters.

q. LonMark: See LonMark International. Also, a certification issued by LonMark International to CEA-709.1B devices.

r. LonMark International: Standards committee consisting of numerous independent product developers and systems integrators dedicated to determining and maintaining the interoperability guidelines for the LonWorks industry. Maintains guidelines for the interoperability of CEA-709.1B devices and issues the LonMark Certification for CEA-709.1B devices.

s. LonMark Interoperability Association: See 'LonMark International'.

t. LonWorks: The overall communications technology, developed by Echelon Corporation, for control systems. The term is often used to refer to the technology in general, and may include reference to any/all of the: protocol, network management, and interoperability guidelines where the technology is based on the CEA-709.1B protocol and employs interoperable devices along with the capability to openly manage these devices (via multiple vendors) using a network configuration (or service) tool.

u. LonWorks Network Services (LNS): A network management and database standard for CEA-709.1B devices.

v. Monitoring and Control (M&C) Software: The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling

and data logging and provides a user interface for monitoring the system and configuring these functions.

w. Network Variable: See 'Standard Network Variable Type (SNVT)'.

x. Network Configuration Tool: The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).

y. Node: A device that communicates using the CEA-709.1B protocol and is connected to an CEA-709.1B network.

z. Node Address: The logical address of a node on the network. Variations in node addressing are possible, but the 'Domain, Subnet, Node' format is the established standard for this specification.

aa. Node ID: A unique 48-bit identifier assigned (at the factory) to each CEA-709.1B device, sometimes called the Neuron ID.

bb. Program ID: An identifier (number) stored in the device (usually EEPROM) that identifies the node manufacturer, functionality of device (application & sequence), transceiver used, and the intended device usage.

cc. Repeater: A device that connects two control network segments and retransmits all information received on one side onto the other.

dd. Router: A device that connects two channels and controls traffic between the channels by retransmitting signals received from one subnet onto the other based on the signal destination. Routers are used to subdivide a control network and to control bandwidth usage.

ee. Segment: A 'single' section of a control network that contains no repeaters or routers. The device quantity limitation is dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 64 devices per segment.

ff. Service Pin: A hardware push-button on a device which causes the device to broadcast a message (over the control network) containing its Node ID and Program ID. This broadcast can also be initiated via software.

gg. Standard Configuration Parameter Type (SCPT): Pronounced 'skip-it'. A standard format type (maintained by LonMark International) for Configuration Parameters.

hh. Standard Network Variable Type (SNVT): Pronounced 'snivet'. A standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network variable itself (i.e. it can mean "a network variable of a standard network variable type"). In general, the intended meaning should be clear from the context.

ii. Subnet: Consists of a logical (not physical) grouping of up to 127 nodes, where the logical grouping is defined by node addressing. Part of the Node Addressing scheme.

jj. TP/FT-10: A Free Topology Twisted Pair network defined by CEA-709.3. This is the most common media type for an ANSI-709.1 control network.

kk. UMCS Network: An IP network connecting multiple building level control networks using the CEA-852-A standard.

ll. User-defined Configuration Parameter Type (UCPT): Pronounced 'u-keep-it'. A Configuration Parameter format type that is defined by the device manufacturer.

mm. User-defined Network Variable Type (UNVT): A network variable format defined by the device manufacturer. Note that UNVTs create non-standard communications (other vendor's devices may not correctly interpret it) and may close the system and therefore are not permitted by this specification.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

The submittals included in this guide specification are critical for new projects and require Government review. Any added submittals, normally, should be for information only and reviewed through the Contractor Quality Control system.

The acquisition of all technical data, data bases

and computer software items that are identified herein will be accomplished strictly in accordance with the Federal Acquisition Regulation (FAR) and the Department of Defense Acquisition Regulation Supplement (DOD FARS). Those regulations as well as the Services implementation thereof should also be consulted to ensure that a delivery of critical items of technical data is not inadvertently lost. Specifically, the Rights in Technical Data and Computer Software Clause, DOD FARS 52.227-7013, and the Data Requirements Clause, DOD FAR 52.227-7031, as well as any requisite software licensing agreements will be made a part of the CONTRACT CLAUSES or SPECIAL CONTRACT REQUIREMENTS. In addition, the appropriate DD Form 1423 Contract Data Requirements List, will be filled out for each distinct deliverable data item and made a part of the contract. Where necessary, a DD Form 1664, Data Item Description, will be used to explain and more fully identify the data items listed on the DD Form 1423. It is to be noted that all of these clauses and forms are required to ensure the delivery of the data in question and that such data is obtained with the requisite rights to use by the Government.

Include with the request for proposals a completed DD Form 1423, Contract Data Requirements List. This form is essential to obtain delivery of all documentation. Each deliverable will be clearly specified, both description and quantity being required.

****

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.]

Technical data packages consisting of technical data and computer software (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications shall be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered 'shop drawings' under the Federal Acquisition Regulation Supplement (FARS) and shall contain no proprietary information and be delivered with unrestricted rights.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES, the CONTRACT CLAUSES and DD Form 1423 and according to the sequencing specified in paragraph PROJECT SEQUENCING:

SD-02 Shop Drawings

DDC Contractor Design Drawings[; G][; G, [_____]]

DDC Contractor Design Drawings shall be submitted in hard copy and on CDROM in [AutoCAD][Microstation] format.

Draft As-Built Drawings[; G][; G, [_____]]

Draft As-Built Drawings shall be submitted in hard copy and on CDROM in [AutoCAD][Microstation] format.

Final As-Built Drawings[; G][; G, [_____]]

Final As-Built Drawings shall be submitted in hard copy and on CDROM in [AutoCAD][Microstation] format.

SD-03 Product Data

Manufacturer's Catalog Data[; G][; G, [_____]]

Product specific catalog cuts shall be submitted for each product provided under this specification.

Programming Software[; G][; G, [_____]]

The most recent version of the Programming software for each type (manufacturer and model) of General Purpose Programmable Controller (GPPC) shall be submitted as a Technical Data Package and shall be licensed to the project site. Software shall be submitted on CD-ROM and [_____] hard copies of the software user manual shall be submitted for each piece of software provided.

GPPC Application Programs[; G][; G, [_____]]

All installed GPPC Application Programs shall be submitted on CD-ROM as a Technical Data Package. The CD-ROM shall include a list or table of contents clearly indicating which application program is associated with each device. [2][_____] copies of the GPPC Application Program's CD-ROM shall be submitted.

XIF files[; G][; G, [_____]]

External interface files (XIF files) shall be submitted as a technical data package for each model of DDC Hardware provided under this specification. XIF files shall be submitted on CD-ROM.

LNS Database[; G][; G, [_____]]

Two copies of the LNS Database for the complete control network provided under this specification shall be submitted as a Technical Data Package. Each copy shall be on CD-ROM and shall be clearly marked identifying it as the LNS Database for the work covered under this specification and with the date of the most recent database modification.

LNS Plug-in[; G][; G, [_____]]

LNS Plug-ins for each Application Specific Controller shall be submitted as a Technical Data Package. LNS Plug-ins distributed under a license shall be licensed to the project site. Plug-ins shall be submitted on CD-ROM. Hard copy manuals, if available, shall be submitted for each plug-in provided.

SD-05 Design Data

Network Bandwidth Usage Calculations[; G][; G, [_____]]

[Four][_____] copies of the Network Bandwidth Usage Calculations shall be submitted.

SD-06 Test Reports

Existing Conditions Report[; G][; G, [_____]]

[Four][_____] copies of the Existing Conditions Report shall be submitted.

Start-Up and Start-Up Testing Report[; G][; G, [_____]]

[Four][_____] copies of the Start-Up and Start-Up Testing Report shall be submitted. The Start-Up and Testing report may be submitted as a Technical Data Package.

PVT Procedures[; G][; G, [_____]]

[Four][_____] copies of the PVT Procedures shall be submitted. The PVT Procedures may be submitted as a Technical Data Package.

PVT Report[; G][; G, [_____]]

[Four][_____] copies of the PVT Phase Report shall be submitted. The PVT Phase Report may be submitted as a Technical Data Package.

Pre-Construction QC Checklist[; G][; G, [_____]]

[Four][_____] copies of the Pre-Construction QC Checklist shall be submitted.

Post-Construction QC Checklist[; G][; G, [_____]]

[Four][_____] copies of the Post-Construction QC Checklist shall be submitted.

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions[; G][; G, [_____]]

[2][_____] copies of the Operation and Maintenance Instructions, indexed and in booklet form shall be submitted. The Operation and Maintenance Instructions shall be a single volume or in separate volumes, and may be submitted as a Technical Data Package.

Training Documentation[; G][; G, [_____]]

Training manuals shall be delivered for each trainee on the Course Attendee List with [2][_____] additional copies delivered for archival at the project site. [2][_____] copies of the Course Attendee List shall be delivered with the archival copies. The Training Documentation may be submitted as a Technical Data Package.

SD-11 Closeout Submittals

Closeout QC Checklist[; G][; G, [_____]]

[Four][_____] copies of the Closeout QC Checklist shall be submitted.

1.4 SYSTEM DESCRIPTION

****
NOTE: Designer is to add location and site specific requirements.
****

The Direct Digital Control (DDC) system shall be a complete system suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and shown.

1.4.1 System Requirements

Systems installed under this guide specification shall have the following characteristics:.

a. The control system shall be an open implementation of LonWorks technology using CEA-709.1B as the communications protocol and using LonMark Standard Network Variable Types as defined in LonMark SNVT List for communication over the network.

b. LonWorks Network Services (LNS) shall be used for all network management including addressing and binding of network variables. A copy of the LNS database shall be submitted to the project site as specified.

c. The hardware shall perform the control sequences as specified and shown to provide control of the equipment as specified and shown.

d. Control sequence logic shall reside in DDC hardware in the building. The building control network shall not be dependent upon connection to a Utility Monitoring and Control System (UMCS) for performance of control sequences in this specification. The hardware shall, to the greatest extent practical, perform the sequences without reliance on the building network.

e. The hardware shall be installed such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

f. All necessary documentation, configuration information, configuration tools, programs, drivers, and other software shall be licensed to and otherwise remain with the Government such that the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor.

g. The Contractor shall provide sufficient documentation and data, including rights to documentation and data, such that the Government or their agents can execute work to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on

the Contractor.

h. Hardware shall be installed and configured such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the Contractor.

i. Control hardware shall be installed and configured to provide all input and output Standard Network Variables (SNVTs) as shown and as needed to meet the requirements of this specification.

j. All DDC devices installed under this specification shall communicate via CEA-709.1B. The control system shall be installed such that a SNVT output from any node on the network can be bound to any other node in the domain.

1.4.2 Verification of Dimensions

After becoming familiar with all details of the work, the Contractor shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

1.4.3 Drawings

The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. The Contractor shall carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, shall arrange such work accordingly, and shall provide all work necessary to meet such conditions.

1.5 PROJECT SEQUENCING

TABLE I: PROJECT SEQUENCING lists the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column) and activities as specified in PART 3: EXECUTION (denoted by an 'E' in the 'TYPE' column).

a. Sequencing for submittals: The sequencing specified for submittals is the deadline by which the submittal shall be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01 33 00 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, the Contractor shall revise the submittal and resubmit it to the Government within [14][_____] days of notification that the submittal has been rejected. Upon resubmittal there shall be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.

b. Sequencing for Activities: The sequencing specified for activities indicates the earliest the activity may begin.

c. Abbreviations: In TABLE I the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

TABLE I. PROJECT SEQUENCING

ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL)
1	S	Existing Conditions Report	
2	S	DDC Contractor Design Drawings	
3	S	Manufacturer's Catalog Data	
4	S	Network Bandwidth Usage Calculations	
5	S	Pre-construction QC Checklist	
6	E	Install Building Control System	AAO #1 thru #5
7	E	Start-Up and Start-Up Testing	ACO #6
8	S	Post-Construction QC Checklist	[_____] days ACO #7
9	S	Programming Software	[_____] days ACO #7
10	S	XIF Files	[_____] days ACO #7
11	S	LNS Plug-ins	[_____] days ACO #7
12	S	Start-Up and Start-Up Testing Report	[_____] days ACO #7
13	S	Draft As-Built Drawings	[_____] days ACO #7
14	S	PVT Procedures	[_____] days before schedule start of #15 and AAO #12
15	E	PVT	AAO #13 and #14
16	S	PVT Report	[_____] days ACO #15
17	S	GPPC Application Programs	[_____] days AAO #16
18	S	LNS Database	[_____] days AAO #16
19	S	Final As-Built Drawings	[_____] days AAO #16
20	S	O&M Instructions	AAO #19
21	S	Training Documentation	AAO #12 and [_____] days before scheduled start of #22
22	E	Training	AAO #20 and #21
23	S	Closeout QC Checklist	ACO #22

1.6 QUALITY CONTROL (QC) CHECKLISTS

The Contractor's Chief Quality Control (QC) Representative shall complete the QC Checklist in APPENDIX A and submit a Pre-Construction QC Checklist, Post-Construction QC Checklist and a Closeout QC Checklist as specified. The QC Representative shall verify each item in the Checklist and initial in the provided area to indicate that the requirement has been met. The QC Representative shall sign and date the Checklist prior to submission to the Government.

1.7 DELIVERY AND STORAGE

Products shall be stored with protection from the weather, humidity, and temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer.

1.8 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

The HVAC control System Operation and Maintenance Instructions shall include:

a. "Manufacturer Data Package 3" as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA for each piece of control equipment.

b. "Manufacturer Data Package 4" as described in Section 01 78 23 OPERATION AND MAINTENANCE DATA for all air compressors.

c. HVAC control system sequences of operation formatted as specified.

d. Procedures for the HVAC system start-up, operation and shut-down including the manufacturer's supplied procedures for each piece of equipment, and procedures for the overall HVAC system.

e. As-built HVAC control system detail drawings formatted as specified.

f. Printouts of configuration settings for all devices.

g. Routine maintenance checklist. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all installed devices, the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.

h. Qualified service organization list.

i. Start-Up and Start-Up Testing Report.

j. Performance Verification Test (PVT) Procedures and Report.

1.9 MAINTENANCE AND SERVICE

****
NOTE: The maintenance and service to be provided by the Contractor for the duration of the maintenance contract is specified in this paragraph. The Maintenance and Service may need to be a separate bid item funded by O&M funds.

Requirements should be coordinated with "WARRANTY MANAGEMENT" in Section 01 78 00 CLOSEOUT SUBMITTALS
****

Services, materials and equipment shall be provided as necessary to maintain the entire system in an operational state as specified for a period of one year after successful completion and acceptance of the Performance Verification Test. Impacts on facility operations shall be minimized.

1.9.1 Description of Work

The adjustment and repair of the system shall include the manufacturer's required sensor and actuator (including transducer) calibration, span and range adjustment.

1.9.2 Personnel

Service personnel shall be qualified to accomplish work promptly and satisfactorily. The Government shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

1.9.3 Scheduled Inspections

Two inspections shall be performed at six-month intervals and all work required shall be performed. Inspections shall be scheduled in [June and December][_____]. These inspections shall include:

a. Visual checks and operational tests of equipment.

b. Fan checks and filter changes for control system equipment.

c. Clean control system equipment including interior and exterior surfaces.

d. Check and calibrate each field device. Check and calibrate 50 percent of the total analog inputs and outputs during the first inspection. Check and calibrate the remaining 50 percent of the analog inputs and outputs during the second major inspection. Certify analog test instrumentation accuracy to be twice the specified accuracy of the device being calibrated. Randomly check at least 25 percent of all digital inputs and outputs for proper operation during the first inspection. Randomly check at least 25 percent of the remaining digital inputs and outputs during the second inspection.

e. Run system software diagnostics and correct diagnosed problems.

f. Resolve any previous outstanding problems.

1.9.4 Scheduled Work

This work shall be performed during regular working hours, Monday through Friday, excluding Federal holidays.

1.9.5 Emergency Service

The Government will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the system. A telephone number where the service supervisor can be reached at all times shall be provided. Service personnel shall be at the site within 24 hours after receiving a request for service. The control system shall be restored to proper operating condition as required per Section 01 78 00 CLOSEOUT SUBMITTALS.

1.9.6 Operation

Scheduled adjustments and repairs shall include verification of the control system operation as demonstrated by the applicable tests of the performance verification test.

1.9.7 Records and Logs

Dated records and logs shall be kept of each task, with cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain initial analog span and zero calibration values and digital points. Complete logs shall be kept and shall be available for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

1.9.8 Work Requests

Each service call request shall be recorded as received and shall include its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. A record of the work performed shall be submitted within 5 days after work is accomplished.

1.9.9 System Modifications

Recommendations for system modification shall be submitted in writing. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Government. Any modifications made to the system shall be incorporated into the Operations and Maintenance Instructions, and other documentation affected.

1.10 SURGE PROTECTION

1.10.1 Power-Line Surge Protection

Equipment connected to ac circuits shall be protected against or withstand power-line surges. Equipment protection shall meet the requirements of IEEE C62.41.1, IEEE C62.41.2. Fuses shall not be used for surge protection.

1.10.2 Surge Protection for Transmitter and Control Wiring

****
NOTE: Determine if any additional inputs or outputs require surge protection and show the requirement for them on the drawings.
****

DDC hardware shall be protected against or withstand surges induced on control and transmitter wiring installed outdoors and as shown. The equipment protection shall be protected against the following two waveforms:

a. A waveform with a 10-microsecond rise time, a 1,000-microsecond decay time and a peak current of 60 amps.

b. A waveform with an 8-microsecond rise time, a 20-microsecond decay time and a peak current of 500 amperes.

1.11 INPUT MEASUREMENT ACCURACY

****
NOTE: This paragraph is referenced elsewhere in the specification. If this paragraph is edited, removed, renamed etc make sure to verify that all references to it are updated as needed.
****

Sensors, transmitters and DDC Hardware shall be selected, installed and configured such that the maximum error of the measured value at the SNVT output of the DDC hardware is less than 150% of the maximum allowable error specified for the sensor or instrumentation.

1.12 BUILDING CONTROL NETWORK

****
NOTE: TP/FT-10 is specified as the media type for the local control network as it is an ASA Standard and the most common media type for a LonWorks network. IP can be used as a high-speed backbone when needed, and guidance on including IP is found in the designer notes of this document and in UFC 3-410-02A

TP/FT-10 (and IP if needed) will generally meet all the needs of the building control network, and the use of other media types is strongly discouraged (see guidance in UFC 3-410-02A).
****

The building control network shall consist of a backbone and one or more local control busses as specified.

1.12.1 Backbone Media

The backbone shall be a TP/FT-10 network in accordance with CEA-709.3 or an IP network as specified in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEMS (UMCS) according to the following criteria:

a. The backbone shall be an IP network as specified in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEMS (UMCS) if both of the following conditions are met:

(1) the Network Bandwidth Calculations for a heavily loaded network show that more than 70% of the 78 kbps (kilobits per second) bandwidth is used or the Network Bandwidth Calculations for a normally loaded network show that more than 30% of the 78 kbps bandwidth is used.

(2) the Government has approved the Network Bandwidth Calculations submittal.

b. The backbone shall be a TP/FT-10 network otherwise.

1.12.2 Control Network Requirements

****
NOTE: Designer must indicate Building Point of Connection (BPOC) location (See item b.).
****

The control network shall meet the following requirements:

a. The backbone shall have no control devices connected to it. Only CEA-709.1B Routers and CEA-709.1B TP/FT-10 to IP Routers may be connected to the backbone. CEA-709.1B TP/FT-10 to IP Routers are specified in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEMS (UMCS)

b. The backbone shall be installed such that a router at the Building Point of Connection (BPOC) location [as shown][_____] may be connected to the backbone.

c. The local control bus shall use CEA-709.1B over a TP/FT-10 network in doubly-terminated bus topology in accordance with CEA-709.3

d. The local control busses shall be installed such that no node (device connected to the control network) has more than two CEA-709.1B Routers and CEA-709.3 Repeaters (in any combination) between it and the backbone, including the router connected to the backbone.

e. All DDC Hardware shall connect to a local control bus.

f. All DDC Hardware shall be locally powered; link power is not acceptable.

PART 2 PRODUCTS

PART 2 of this specification covers requirements for Products (equipment). Installation requirements for these products are covered in PART 3 of this specification.

2.1 EQUIPMENT

2.1.1 General Requirements

Units of the same type of equipment shall be products of a single manufacturer. Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of these and similar products. The standard products shall have been in a satisfactory commercial or industrial use for two years prior to use on this project. The two year use shall include applications of equipment and materials under similar circumstances and of similar size. DDC Hardware not meeting the two-year field service requirement shall be acceptable provided it has been successfully used by the Contractor in a minimum of two previous projects. The equipment items shall be supported by a service organization. Items of the same type and purpose shall be identical, including equipment, assemblies, parts and components. Manufacturer's catalog data sheets documenting compliance with product specifications shall be submitted as specified for each product installed under this specification.

2.1.2 Operation Environment Requirements

All products shall be rated for continuous operation under the following conditions:

a. Pressure: Pressure conditions normally encountered in the installed location.

b. Vibration: Vibration conditions normally encountered in the installed location.

c. Temperature:

****
NOTE: Designer must decide if suggested outside air temperature range is sufficient, and provide a range if it's not.
****

(1) Products installed indoors: Ambient temperatures in the range of 0 to 50 degrees C 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.

(2) Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of [-37 to plus 66 degrees C -35 to plus 151 degrees F] [_____] and temperature conditions outside this range normally encountered at the installed location.

d. Humidity: 10% to 95% relative humidity, noncondensing and humidity conditions outside this range normally encountered at the installed location.

2.2 ENCLOSURES AND WEATHERSHIELDS

2.2.1 Enclosures

****
NOTE: In outdoor applications specify Type 3 unless hosedown of the enclosure is anticipated, in which case specify Type 4.

For retrofit projects in older mechanical rooms or where hosedown of the enclosure is anticipated specify Type 4 enclosures. Type 4 provides a greater degree of protection in dirty and wet environments than does Type 2.
****

Enclosures shall meet the following minimum requirements:

a. Outdoors: Enclosures located outdoors shall meet NEMA 250 [Type 3] [Type 4] requirements.

b. Mechanical and Electrical Rooms: Enclosures located in mechanical or electrical rooms shall meet NEMA 250 [Type 2] [Type 4] requirements.

c. Other Locations: Enclosures in other locations including but not limited to occupied spaces, above ceilings, and plenum returns shall meet NEMA 250 Type 1 requirements.

Enclosures supplied as an integral (pre-packaged) part of another product are acceptable.

2.2.2 Weathershields

Weathershields for sensors located outdoors shall prevent the sun from directly striking the sensor. The weathershield shall be provided with adequate ventilation so that the sensing element responds to the ambient conditions of the surroundings. The weathershield shall prevent rain from directly striking or dripping onto the sensor. Weathershields installed near outside air intake ducts shall be installed such that normal outside air flow does not cause rainwater to strike the sensor. Weathershields shall be constructed of galvanized steel painted white, unpainted aluminum, aluminum painted white, or white PVC.

2.3 TUBING

2.3.1 Copper

Copper tubing shall conform to ASTM B 88 and ASTM B 88M

2.3.2 Stainless Steel

Stainless steel tubing shall conform to ASTM A 269

2.3.3 Plastic

Plastic tubing shall have the burning characteristics of linear low-density polyethylene tubing, shall be self-extinguishing when tested in accordance with ASTM D 635, shall have UL 94 V-2 flammability classification or better, and shall withstand stress cracking when tested in accordance with ASTM D 1693. Plastic-tubing bundles shall be provided with Mylar barrier and flame-retardant polyethylene jacket.

2.4 NETWORK HARDWARE

2.4.1 CEA-709.1B Network Hardware

2.4.1.1 CEA-709.1B Routers

CEA-709.1B Routers (including routers configured as repeaters) shall meet the requirements of CEA-709.1B and shall provide connection between two or more CEA-709.3 TP/FT-10 channels.

2.4.1.2 CEA-709.3 Repeaters

CEA-709.3 Repeaters shall be physical layer repeaters in accordance with CEA-709.3.

2.4.2 Gateways

Gateways shall perform bi-directional protocol translation from one non-CEA-709.1B protocol to CEA-709.1B. Gateways shall incorporate exactly two network connections: one shall be for connection to a TP/FT-10 network in accordance with CEA-709.3 and the second shall be as required to communicate with the non-CEA-709.1B network.

2.5 WIRE AND CABLE

All wire and cable shall meet the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification.

2.5.1 Terminal Blocks

Terminal blocks which are not integral to other equipment shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

2.5.2 Control Wiring for Binary Signals

Control wiring for binary signals shall be 18 AWG copper and shall be rated for 300-volt service.

2.5.3 Wiring for 120-Volt Circuits

Wiring for 120-volt circuits shall be 18 AWG or thicker stranded copper and shall be rated for 600-volt service.

2.5.4 Control Wiring for Analog Signals

Control Wiring for Analog Signals shall be 18 AWG, copper, single- or multiple-twisted, minimum 50 mm 2 inch lay of twist, 100% shielded pairs, and shall have a 300-volt insulation. Each pair shall have a 20 AWG tinned-copper drain wire and individual overall pair insulation. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.5.5 Transformers

Transformers shall be UL 5085-3 approved. Transformers shall be sized so that the connected load is no greater than 80% of the transformer rated capacity.

2.6 AUTOMATIC CONTROL VALVES

****

NOTE: Ball valves are generally less expensive than globe valves, but because of potential cavitation problems should only be used in 2-position and chilled water applications. It is recommended that you coordinate their use with the local maintenance staff because unlike globe valves maintenance is more likely to require complete removal of the valve.

Show each valve's Kv (m^3/hr) and/or Cv (gal/min) on the Valve Schedule. Kv = 0.857 x Cv.

****

Valves shall have stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Valve bodies shall meet ASME B16.34 or ASME B16.15 pressure and temperature class ratings based on the design operating temperature and 150% of the system design operating pressure. Unless otherwise specified or shown, valve leakage shall meet FCI 70-2 Class IV leakage rating (0.01% of valve Kv). Unless otherwise specified or shown, valves shall have globe-style bodies. Unless otherwise specified:

a. Bodies for valves 38 mm 1.5 inches and smaller shall be brass or bronze, with threaded or union ends

b. Bodies for 50 mm 2 inch valves shall have threaded ends

c. Bodies for valves 50 to 80 mm 2 to 3 inches shall be of brass, bronze or iron.

d. Bodies for valves 65 mm 2.5 inches and larger shall be provided with flanged-end connections.

e. For modulating applications, valve Kv (Cv) shall be within 100 to 125% of the Kv (Cv) shown.

f. For two position applications (where the two positions are full open and full closed) the Kv (Cv) shall be the largest available for the valve size.

g. Valve and actuator combination shall be normally open or normally closed as shown.

2.6.1 Ball Valves

Balls shall be stainless steel or nickel plated brass. Valves shall have blow-out proof stems. In steam and high temperature hot water applications, the valve-to-actuator linkage shall provide a thermal break.

2.6.2 Butterfly Valves

Butterfly valves shall be threaded lug type suitable for dead-end service and modulation to the fully-closed position, with carbon-steel bodies and non-corrosive discs, stainless steel shafts supported by bearings, and EPDM seats suitable for temperatures from -29 to plus 121 degrees C -20 to plus 250 degrees F. The rated Kv (Cv) for butterfly valves shall be the value Kv (Cv) at 70% (60 degrees) open position. Valve leakage shall meet FCI 70-2 Class VI leakage rating.

2.6.3 Two-Way Valves

Two-way modulating valves used for liquids shall have an equal-percentage characteristic. Two-way modulating valves used for steam shall have a linear characteristic.

2.6.4 Three-Way Valves

Three-way modulating valves shall provide equal percentage flow control with constant total flow throughout full plug travel.

2.6.5 Duct-Coil and Terminal-Unit-Coil Valves

Control valves with either flare-type or solder-type ends shall be provided for duct or terminal-unit coils. Flare nuts shall be provided for each flare-type end valve.

2.6.6 Valves for Chilled-Water, Condenser-Water, and Glycol Service

Valve internal trim shall be Type 316 stainless steel. Valves 100 mm 4 inches and larger shall be butterfly valves.

2.6.7 Valves for High-Temperature Water, Hot-Water and Dual Temperature Service

Valves for hot water service between 99 and 121 degrees C 210 and 250 degrees F and dual-temperature service shall have internal trim (including seats, seat rings, modulating plugs, and springs) of Type 316 stainless steel. Internal trim for valves controlling water below 99 degrees C 210 degrees F shall be brass, bronze or Type 316 stainless steel. Nonmetallic valve parts shall be suitable for a minimum continuous operating temperature of 121 or 28 degrees C 250 or 50 degrees F above the system design temperature, whichever is higher. Valves 100 mm 4 inches and larger shall be butterfly valves.

For high-temperature hot water service above 121 degrees C 250 degrees F

valve bodies shall be carbon steel, globe type with welded ends on valves 25 mm 1 inch and larger. Valves smaller than 25 mm 1 inch shall have socket-weld ends. Packing shall be virgin polytetrafluoroethylene (PTFE). Internal valve trim shall be Type 316 stainless steel.

2.6.8 Valves for Steam Service

Bodies for valves 100 mm 4 inches and larger shall be iron or carbon steel. Internal valve trim shall be Type 316 stainless steel. If the specified Kv (Cv) is not available the valve manufacturer's next largest size shall be used.

2.7 DAMPERS

2.7.1 Damper Assembly

A single damper section shall have blades no longer than 1.2 m 48 inch and shall be no higher than 1.8 m 72 inch. Maximum damper blade width shall be 203 mm 8 inch. Larger sizes shall be made from a combination of sections. Dampers shall be steel, or other materials where shown. Flat blades shall be made rigid by folding the edges. Blade-operating linkages shall be within the frame so that blade-connecting devices within the same damper section shall not be located directly in the air stream. Damper axles shall be 13 mm 1/2 inch minimum, plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings. Pressure drop through dampers shall not exceed 10 Pa 0.04 inches water gauge at 5.1 m/s 1,000 ft/min in the wide-open position. Frames shall not be less than 50 mm 2 inch in width. Dampers shall be tested in accordance with AMCA 500-D.

2.7.2 Operating Linkages

Operating links external to dampers, such as crank arms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers, shall withstand a load equal to at least 300% of the maximum required damper-operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crank arms shall control the open and closed positions of dampers.

2.7.3 Damper Types

****

NOTE: The designer should consider the application requirements and edit the leakage ratings as needed. Show exceptions to these specifications in the Damper Schedule.

AMCA 500 leakage classifications at 4 iwc (1017 Pa) static:

Class 1: 8 cfm per square foot of (406 L/s per square meter) damper area.

Class 2: 20 cfm/sf (102 L/s per square meter).

Class 3: 40 cfm/sf (203 L/s per square meter).

Class 4: 80 cfm/sf (406 L/s per square meter).

Consider specifying very low leakage (Class 1) and/or thermally broken (barrier) frames for OA dampers in very cold climates and/or where unit runs 24/7 during unoccupied mode. Edit specification as necessary.

****

2.7.3.1 Flow Control Dampers

Outside air, return air, relief air, exhaust, face and bypass dampers shall be provided where shown and shall be parallel-blade or opposed blade type as shown on the Damper Schedule. Blades shall have interlocking edges and shall be provided with compressible seals at points of contact. The channel frames of the dampers shall be provided with jamb seals to minimize air leakage. Unless otherwise shown, dampers shall be AMCA 500-D Class 2 and shall not leak in excess of 102 L/s per square meter 20 cfm per square foot at 1017 Pa 4 inches water gauge static pressure when closed. Outside air damper seals shall be suitable for an operating temperature range of -40 to plus 75 degrees C -40 to plus 167 degrees F. Dampers shall be rated at not less than 10 m/s 2000 ft/min air velocity.

2.7.3.2 Mechanical Rooms and Other Utility Space Ventilation Dampers

Utility space ventilation dampers shall be as shown. Unless otherwise shown, dampers shall be AMCA 500-D class 4 and shall not leak in excess of 406 L/s per square meter 80 cfm per square foot at 1017 Pa 4 inches water gauge static pressure when closed. Dampers shall be rated at not less than 7.6 m/s 1500 ft/min air velocity.

2.7.3.3 Smoke Dampers

Smoke-damper and actuator assembly shall meet the current requirements of NFPA 90A, UL 555, and UL 555S. Combination fire and smoke dampers shall be rated for 121 degrees C 250 degrees F Class II leakage per UL 555S.

2.8 SENSORS AND INSTRUMENTATION

Unless otherwise specified, sensors and instrumentation shall incorporate an integral transmitter or be provided with a transmitter co-located with the sensor. Sensors and instrumentation, including their transmitters, shall meet the specified accuracy and drift requirements at the input of the connected DDC Hardware's analog-to-digital conversion. Sensors and instrumentation, including their transmitters, shall meet or exceed the specified range.

2.8.1 Transmitters

The transmitter shall match the characteristics of the sensor. Transmitters providing analog values shall produce a linear 4-20 mAdc, 0-10 Vdc or SNVT output corresponding to the required operating range and shall have zero and span adjustment. Transmitters providing binary values shall have dry contacts or SNVT output. Transmitters with SNVT output are Application Specific Controllers (ASCs) and shall meet all ASC requirements. (note: ASCs are specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE)

2.8.2 Temperature Sensors

2.8.2.1 Sensor Ranges and Accuracy

Temperature sensors may be provided without transmitters. Temperature sensors, including transmitter if used, shall have minimum operating ranges, minimum accuracy and maximum drift as specified below for the application:

a. Conditioned Space Temperature

(1) Operating Range: 10 to 30 degrees C 50 to 86 degrees F.

(2) Accuracy: +/- 0.5 degrees C 1 degree F over the operating range.

(3) Drift: Maximum 0.5 degrees C 1 degree F per year.

b. Unconditioned Space Temperature

(1) Operating Range: -7 to plus 66 degrees C 20 to 150 degrees F.

(2) Accuracy: +/- 0.5 degrees C 1 degree F over the range of -1 to plus 55 degrees C 30 to 131 degrees F and +/- 2 degrees C 4 degrees F over the rest of the operating range.

(3) Drift: Maximum 0.5 degrees C 1 degree F per year.

c. Duct Temperature

(1) Operating Range: 5 to 60 degrees C 40 to 140 degrees F.

(2) Accuracy: +/- 1 degree C 2 degrees F.

(3) Drift: Maximum 1 degree C 2 degrees F per year.

d. Outside Air Temperature

****
NOTE: Designer must choose a range for outside air sensors suitable to the environment at the project site.
****

(1) Operating Range: [_____] to [_____] degrees C degrees F.

(2) Accuracy:

(a) +/- 1 degree C 2 degrees F over the range of -35 to plus 55 degrees C -30 to plus 130 degrees F.

(b) +/- 0.5 degrees C 1 degreeF over the range of -1 to plus 40 degrees C 30 to 100 degrees F.

(3) Drift: Maximum 0.5 degrees C 1 degree F per year.

e. High Temperature Hot Water

(1) Operating Range: 65 to 232 degrees C 150 to 450 degrees F.

(2) Accuracy: +/- 2 degrees C 3.6 degrees F.

(3) Drift: Maximum +/- 1 degree C 2 degrees F per year.

f. Chilled Water

(1) Operating Range: -1 to plus 38 degrees C 30 to 100 degrees F.

(2) Accuracy: +/- 0.4 degrees C 0.8 degrees F over the range of 2 to 18 degrees C 35 to 65 degrees F and +/- 1 degree C 2 degrees F over the rest of the operating range.

(3) Drift: Maximum 0.4 degrees C 0.8 degrees F per year.

g. Dual Temperature Water

(1) Operating Range: -1 to plus 116 degrees C 30 to plus 240 degrees F.

(2) Accuracy: +/- 1 degree C 2 degrees F.

(3) Drift: Maximum 1 degree C 2 degrees F per year.

h. Heating Hot Water

(1) Operating Range: 21 to 121 degrees C 70 to 250 degrees F.

(2) Accuracy: +/- 1 degree C 2 degrees F.

(3) Drift: Maximum 1 degree C 2 degrees F per year.

i. Condenser Water

(1) Operating Range: -1 to plus 54 degrees C 30 to 130 degrees F.

(2) Accuracy: +/- 0.6 degrees C 1 degree F.

(3) Drift: Maximum 0.6 degrees C 1 degree F per year.

2.8.2.2 Point Temperature Sensors

Point Sensors shall be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper.

2.8.2.3 Averaging Temperature Sensors

Averaging sensors shall be a continuous element with a minimum length equal to 3 m/square meter 1 foot/square foot of duct cross-sectional area at the installed location. The sensing element shall have a bendable copper sheath.

2.8.2.4 Thermowells

Thermowells shall be Series 300 stainless steel with threaded brass plug and chain, 50 mm 2 inch lagging neck and extension type well. Inside diameter and insertion length shall be as required for the application.

2.8.3 Relative Humidity Sensor

Relative humidity sensors shall use bulk polymer resistive or thin film

capacitive type non-saturating sensing elements capable of withstanding a saturated condition without permanently affecting calibration or sustaining damage. The sensors shall include removable protective membrane filters. Where required for exterior installation, sensors shall be capable of surviving below freezing temperatures and direct contact with moisture without affecting sensor calibration. When used indoors, the sensor shall be capable of being exposed to a condensing air stream (100% RH) with no adverse effect to the sensor's calibration or other harm to the instrument. The sensor shall be of the wall-mounted or duct-mounted type, as required by the application, and shall be provided with any required accessories. Sensors used in duct high-limit applications shall have a bulk polymer resistive sensing element. Duct-mounted sensors shall be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage. Relative humidity (RH) sensors shall measure relative humidity over a range of 0% to 100% with an accuracy of +/- 3%. RH sensors shall function over a temperature range of -4 to plus 55 degrees C 25 to 130 degrees F and shall not drift more than 2% per year.

2.8.4 Carbon Dioxide (CO2) Sensors

Carbon dioxide (CO2) sensors shall measure CO2 concentrations between 0 to 2000 parts per million (ppm) using non-dispersive infrared (NDIR) technology with an accuracy of +/- 75 ppm and a maximum response time of 1 minute. The sensor shall be rated for operation at ambient air temperatures within the range of 0 to 50 degrees C 32 to 122 degrees F and relative humidity within the range of 0 to 95% (non-condensing). The sensor shall have a maximum drift of 2%. The sensor chamber shall be manufactured with a non-corrosive material (such as gold-plating) that does not affect carbon dioxide sample concentration. Duct mounted sensors shall be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage.

2.8.5 Differential Pressure Instrumentation

2.8.5.1 Differential Pressure Sensors

Differential Pressure Sensor range shall be as shown or as required for the application. Pressure sensor ranges shall not exceed the high end range shown on the Points Schedule by more than 50%. The over pressure rating shall be a minimum of 150% of the highest design pressure of either input to the sensor. The accuracy shall be +/- 2% of full scale.

2.8.5.2 Differential Pressure Switch

The switch shall have a user-adjustable setpoint. The setpoint shall not be in the upper or lower quarters of the range. The over pressure rating shall be a minimum of 150% of the highest design pressure of either input to the sensor. The switch shall have two sets of contacts and each contact shall have a rating greater than it's connected load. Contacts shall open or close upon rise of pressure above the setpoint or drop of pressure below the setpoint as shown.

2.8.6 Flow Sensors

2.8.6.1 Airflow Measurement Array (AFMA)

Airflow Straightener.-AFMAs shall contain an airflow straightener if required by the AFMA manufacturer's published installation instructions.

The straightener shall be contained inside a flanged sheet metal casing, with the AMFA located as specified according to the published recommendation of the AFMA manufacturer. In the absence of published documentation airflow straighteners shall be provided if there is any duct obstruction within 5 duct diameters upstream of the AFMA. Air-flow straighteners, where required, shall be constructed of 3 mm 0.125 inch aluminum honeycomb and the depth of the straightener shall not be less than 40 mm 1.5 inches.

Resistance to airflow.-The resistance to air flow through the AFMA, including the airflow straightener shall not exceed 20 Pa 0.08 inch water gauge at an airflow of 10 m/s 2,000 fpm. AFMA construction shall be suitable for operation at airflows of up to 25 m/s 5,000 fpm over a temperature range of 4 to 49 degrees C 40 to 120 degrees F.

****
NOTE: Ensure that outside air temperature range is appropriate for the environment at the project site, and provide a range if it's not.
****

Outside air temperature.-In outside air measurement or in low-temperature air delivery applications, the AFMA shall be certified by the manufacturer to be accurate as specified over a temperature range of [-29 to plus 49 degrees C -20 to plus 120 degrees F] [_____].

Pitot Tube AFMA.-Each Pitot Tube AFMA shall contain an array of velocity sensing elements. The velocity sensing elements shall be of the multiple pitot tube type with averaging manifolds. The sensing elements shall be distributed across the duct cross section in the quantity and pattern specified by the published installation instructions of the AFMA manufacturer. Pitot Tube AFMAs shall have an accuracy of +/- 3% over a range of 2.5 to 12.5 m/s 500 to 2,500 fpm.

Electronic AFMA.-Each electronic AFMA shall consist of an array of velocity sensing elements of the resistance temperature detector (RTD) or thermistor type. The sensing elements shall be distributed across the duct cross section in the quantity and pattern specified by the published application data of the AFMA manufacturer. Electronic AFMAs shall have an accuracy of +/- 3% percent over a range of 0.6 to 12.5 m/s 125 to 2,500 fpm and the output shall be temperature compensated over a range of 0 to 100 degrees C 32 to 212 degrees F.

2.8.6.2 Orifice Plate

Orifice plate shall be made of an austenitic stainless steel sheet of 3.3 mm 0.125 inch nominal thickness with an accuracy of +/- 1% of full flow. The orifice plate shall be flat within 0.1 mm 0.002 inches. The orifice surface roughness shall not exceed 0.5 micro-meters 20 micro-inches. The thickness of the cylindrical face of the orifice shall not exceed 2% of the pipe inside diameter or 12.5% of the orifice diameter, whichever is smaller. The upstream edge of the orifice shall be square and sharp. Where orifice plates are used, concentric orifice plates shall be used in all applications except steam flow measurement in horizontal pipelines.

2.8.6.3 Flow Nozzle

Flow nozzle shall be made of austenitic stainless steel with an accuracy of +/- 1% of full flow. The inlet nozzle form shall be elliptical and the

nozzle throat shall be the quadrant of an ellipse. The thickness of the nozzle wall and flange shall be such that distortion of the nozzle throat from strains caused by the pipeline temperature and pressure, flange bolting, or other methods of installing the nozzle in the pipeline shall not cause the accuracy to degrade beyond the specified limit. The outside diameter of the nozzle flange or the design of the flange facing shall be such that the nozzle throat shall be centered accurately in the pipe.

2.8.6.4 Venturi Tube

Venturi tube shall be made of cast iron or cast steel and shall have an accuracy of +/- 1% of full flow. The throat section shall be lined with austenitic stainless steel. Thermal expansion characteristics of the lining shall be the same as that of the throat casting material. The surface of the throat lining shall be machined to a +/- 1.2 micrometer 50 micro inch finish, including the short curvature leading from the converging entrance section into the throat.

2.8.6.5 Annular Pitot Tube

Annular pitot tube shall be made of austenitic stainless steel with an accuracy of +/- 2% of full flow and a repeatability of +/- 0.5% of measured value. The unit shall have at least one static port and no less than four total head pressure ports with an averaging manifold.

2.8.6.6 Insertion Turbine Flowmeter

Insertion Turbine Flowmeter accuracy shall be +/- 1% of reading for a minimum turndown ratio of 1:1 through a maximum turndown ratio of 50:1. Repeatability shall be +/- 0.25% of reading. The meter flow sensing element shall operate over a range suitable for the installed location with a pressure loss limited to 1% of operating pressure at maximum flow rate. Design of the flowmeter probe assembly shall incorporate integral flow, temperature, and pressure sensors. The turbine rotor assembly shall be constructed of Series 300 stainless steel and use Teflon seals.

2.8.6.7 Vortex Shedding Flowmeter

Vortex Shedding Flowmeter accuracy shall be within +/- 0.8% of the actual flow. The flow meter body shall be made of austenitic stainless steel. The vortex shedding flowmeter body shall not require removal from the piping in order to replace the shedding sensor.

2.8.6.8 Positive Displacement Flow Meter

The flow meter shall be a direct reading, gerotor, nutating disk or vane type displacement device rated for liquid service as shown. A counter shall be mounted on top of the meter, and shall consist of a non-resettable mechanical totalizer for local reading, and a pulse transmitter for remote reading. The totalizer shall have a six digit register to indicate the volume passed through the meter in [liters] [gallons], and a sweep-hand dial to indicate down to 1 liter 0.25 gallons. The pulse transmitter shall have a hermetically sealed reed switch which is activated by magnets fixed on gears of the counter. The meter shall have a bronze body with threaded or flanged connections as required for the application. Output accuracy shall be +/- 2% of the flow range. The maximum pressure drop at full flow shall be 34 kPa 5 psig.

2.8.6.9 Flow Meters, Paddle Type

Sensor shall be non-magnetic, with forward curved impeller blades designed for water containing debris. Sensor accuracy shall be +/- 2% of rate of flow, minimum operating flow velocity shall be 0.3 meters/second 1 foot per second. Sensor repeatability and linearity shall be +/- 1%. Materials which will be wetted shall be made from non-corrosive materials and shall not contaminate water. The sensor shall be rated for installation in pipes of 76 mm to 1 m 3 to 40 inch diameters. The transmitter housing shall be a NEMA 250 Type 4 enclosure.

2.8.6.10 Flow Switch

Flow switch shall have a repetitive accuracy of +/- 10% of actual flow setting. Switch actuation shall be adjustable over the operating flow range. The switch shall have Form C snap-action contacts, rated for the application. The flow switch shall have non flexible paddle with magnetically actuated contacts and be rated for service at a pressure greater than the installed conditions. Flow switch for use in sewage system shall be rated for use in corrosive environments encountered.

2.8.6.11 Gas Utility Flow Meter

Gas utility flow meter shall be diaphragm or bellows type (gas positive displacement meters) for flows up to 19.7 L/sec 2500 SCFH and axial flow turbine type for flows above 19.7 L/sec 2500 SCFH, designed specifically for natural gas supply metering, and rated for the pressure, temperature, and flow rates of the installation. Meter shall have a minimum turndown ratio of 10 to 1 with an accuracy of +/- 1% of actual flow rate. The meter index shall include a direct reading mechanical totalizing register and electrical impulse dry contact output for remote monitoring. For gas flows of less than 45 cubic-meters/second 1500 cubic-feet/second, the electrical impulse dry contact output shall provide not less than 1 pulse per 3 cubic meters 100 cubic feet of gas and shall not exceed 15 pulses per second for the installed application. For gas flows 45 cubic-meters/second 1500 cubic-feet/second or greater, the pulse rate shall not be the greatest pulse-rate available but not to exceed 15 pulses per second for the installed application. The electrical impulse dry contact output shall not require field adjustment or calibration.

2.8.7 Electrical Instruments

Electrical Instruments shall have an input range as shown or sized for the application. Unless otherwise specified, AC instrumentation shall be suitable for 60 Hz operation.

2.8.7.1 Watt or Watthour Transducers

Watt transducers shall measure voltage and current and shall output kW, kWh, or kW and kWh as shown. kW outputs shall have an accuracy of +/- 0.25% over a power factor range of 0.1 to 1. kWh outputs shall be a pulse output and shall have an accuracy of +/- 0.5% over a power factor range of 0.1 to 1.

2.8.7.2 Watthour Revenue Meter (with and without Demand Register)

****

NOTE: The intent of including meters in this Section is for energy monitoring as may be required

for interface to a UMCS. Meters are typically only required by this Section for retrofit applications. Coordination of meter installation and meter requirements with other specifications may be required.

Select the revenue meter accuracy as required for the application. For most applications, the 0.5 accuracy class should be suitable/sufficient. (Note the 0.5 accuracy class allows a 0.5% error, while the 0.2 class allows 0.2%).
****

All Watthour revenue meters shall measure voltage and current and shall be in accordance with NEMA C12.1 with an NEMA C12.20 Accuracy class of [0.5] [0.2] and shall have pulse initiators for remote monitoring of Watthour consumption. Pulse initiators shall consist of form C contacts with a current rating not to exceed two amperes and voltage not to exceed 500 V, with combinations of VA not to exceed 100 VA, and a life rating of one billion operations. Meter sockets shall be in accordance with NEMA C12.10. Watthour revenue meters with demand registers shall have an analog output for instantaneous demand in addition to the pulse initiators.

2.8.7.3 Current Transducers

****
NOTE: Select the required accuracy for current transducers. Note that higher accuracy transducers will be more expensive and will likely require a more expensive/better quality controller.
****

Current transducers shall accept an AC current input and shall have an accuracy of +/- [0.5] [2]% of full scale. An integral power supply shall be provided if required for the analog output signal. The device shall have a means for calibration.

2.8.7.4 Current Sensing Relays (CSRs)

Current sensing relays (CSRs) shall provide a normally-open contact with a voltage and amperage rating greater than its connected load. Current sensing relays shall be of split-core design. The CSR shall be rated for operation at 200% of the connected load. Voltage isolation shall be a minimum of 600 volts. The CSR shall auto-calibrate to the connected load.

2.8.7.5 Voltage Transducers

Voltage transducers shall accept an AC voltage input and have an accuracy of +/- 0.25% of full scale. An integral power supply shall be provided if required for the analog output signal. The device shall have a means for calibration. Line side fuses for transducer protection shall be provided.

2.8.8 pH Sensor

The sensor shall be suitable for applications and chemicals encountered in water treatment systems of boilers, chillers and condenser water systems. Construction, wiring, fittings and accessories shall be corrosion and chemical resistant with fittings for tank or suspension installation. Housing shall be polyvinylidene fluoride with O-rings made of chemical

resistant materials which do not corrode or deteriorate with extended exposure to chemicals. The sensor shall be encapsulated. Periodic replacement shall not be required for continued sensor operation. Sensors shall use a ceramic junction and pH sensitive glass membrane capable of withstanding a pressure of 689 kPa at 66 degrees C 100 psig at 150 degrees F. The reference cell shall be double junction configuration. Sensor range shall be 0 to 12 pH, stability 0.05, sensitivity 0.02, and repeatability of +/- 0.05 pH value, response of 90% of full scale in one second and a linearity of 99% of theoretical electrode output measured at 24 degrees C 76 degrees F.

2.8.9 Oxygen Analyzer

Oxygen analyzer shall consist of a zirconium oxide sensor for continuous sampling and an air-powered aspirator to draw flue gas samples. The analyzer shall be equipped with filters to remove flue air particles. Sensor probe temperature rating shall be 435 degrees C 815 degrees F. The sensor assembly shall be equipped for flue flange mounting.

2.8.10 Carbon Monoxide Analyzer

****
NOTE: Enter the range for the CO Analyzer
****

Carbon monoxide analyzer shall consist of an infrared light source in a weather proof steel enclosure for duct or stack mounting. An optical detector/analyzer in a similar enclosure, suitable for duct or stack mounting shall be provided. Both assemblies shall include internal blower systems to keep optical windows free of dust and ash at all times. The third component of the analyzer shall be the electronics cabinet. Automatic flue gas temperature compensation and manual/automatic zeroing devices shall be provided. Unit shall read parts per million (ppm) of carbon monoxide in the range of [_____] to [_____] ppm and the response time shall be less than 3 seconds to 90% value. Unit measurement range shall not exceed specified range by more that 50%. Repeatability shall be +/- 2% of full scale with an accuracy of +/- 3% of full scale.

2.8.11 Occupancy Sensors

****
NOTE: Avoid using occupancy sensors with instant start fluorescent ballasts for instant start of lamps because they shorten the lamp life. Use only rapid start fluorescent ballasts.

Show which type of occupancy sensor to use drawings: Ultrasonic sensors are best suited for spaces with partitions or dividers; Infrared sensors are best suited in line-of-sight applications.

Show occupancy sensor mounting location on drawings. Office furniture is less likely to interfere with (block) ceiling mounted sensors. In retrofit applications, occupancy sensors can be installed in place of existing light switches.

Dual-technology sensors (one sensor incorporating both types) ordinarily turn lighting ON when both

technologies sense occupancy. Then, detection by either technology will hold lighting ON.
****

Occupancy sensors shall have occupancy-sensing sensitivity adjustment and an adjustable off-delay timer with a range encompassing 30 seconds to 15 minutes. Occupancy sensors shall be rated for operation in ambient air temperatures ranging from 10 to 40 degrees C 50 to 104 degrees F or temperatures normally encountered in the installed location. Sensors integral to wall mount on-off light switches shall have an auto-off switch. Wall switch sensors shall be decorator style and shall fit behind a standard decorator type wall plate. All occupancy sensors, power packs, and slave packs shall be UL listed. In addition to any outputs required for lighting control, the occupancy sensor shall provide a contact output rated at 1A at 24 Vac or a SNVT output.

2.8.11.1 Passive Infrared (PIR) Occupancy Sensors

PIR occupancy sensors shall have a multi-level, multi-segmented viewing lens and a conical field of view with a viewing angle of 180 degrees and a detection of at least 6 meters 20 feet unless otherwise shown or specified. PIR Sensors shall provide field-adjustable background light-level adjustment with an adjustment range suitable to the light level in the sensed area, room or space. PIR sensors shall be immune to false triggering from RFI and EMI.

2.8.11.2 Ultrasonic Occupancy Sensors

Ultrasonic sensors shall operate at a minimum frequency 32 kHz and shall be designed to not interfere with hearing aids.

2.8.11.3 Dual-Technology Occupancy Sensor (PIR and Ultrasonic)

Dual-Technology Occupancy Sensors shall meet the requirements of both PIR and Ultrasonic Occupancy Sensors.

2.8.12 Vibration Switch

Vibration switch shall be solid state, enclosed in a NEMA 250 Type 4 or Type 4X housing with sealed wire entry. Unit shall have two independent sets of Form C switch contacts with one set to shutdown equipment upon excessive vibration and a second set for monitoring alarm level vibration. The vibration sensing range shall be a true rms reading, suitable for the application. The unit shall include either displacement response for low speed or velocity response for high speed application. The frequency range shall be at least 2 Hz to 200 Hz. Contact time delay shall be 3 seconds. The unit shall have independent start-up and running delay on each switch contact. Alarm limits shall be adjustable and setpoint accuracy shall be +/- 10% of setting with repeatability of plus or minus 2%.

2.8.13 Conductivity Sensor

****
NOTE: Remove the bracketed text for new construction (Contractor cannot meet this requirement). For retrofit projects, coordinate with the project site to determine need for this analysis.
****

Sensor shall include local indicating meter and shall be suitable for measurement of conductivity of water in boilers, chilled water systems, condenser water systems, distillation systems, or potable water systems as shown. Sensor shall sense from 0 to 10 microSeimens per centimeter (uS/cm) for distillation systems, 0 to 100 uS/cm for boiler, chilled water, and potable water systems and 0 to 1000 uS/cm for condenser water systems. Contractor shall field verify the ranges for particular applications and adjust the range as required.[Contractor shall submit a complete water quality analysis of a sample of the process to be monitored with the submittal of the sensor manufacturer's catalog data.] The output shall be temperature compensated over a range of 0 to 100 degrees C 32 to 212 degrees F. The accuracy shall be +/- 2% of the full scale reading. Sensor shall have automatic zeroing and shall require no periodic maintenance or recalibration.

2.8.14 Compressed Air Dew Point Sensor

Sensor shall be suitable for measurement of dew point from -40 to plus 27 degrees C -40 to plus 80 degrees F over a pressure range of 0 to 1 MPa 0 to 150 psig. The transmitter shall provide both dry bulb and dew point temperatures on separate outputs. The end to end accuracy of the dew point shall be +/- 2.8 degrees C 5 degrees F and the dry bulb shall be +/- 0.6 degrees C 1 degree F. Sensor shall be automatic zeroing and shall require no normal maintenance or periodic recalibration.

2.8.15 NOx Monitor

Monitor shall continuously monitor and give local indication of boiler stack gas for NOx content. It shall be a complete system designed to verify compliance with the Clean Air Act standards for NOx normalized to a 3% oxygen basis and shall have a range of from 0 to 100 ppm. Sensor shall be accurate to +/- 5 ppm. Sensor shall output NOx and oxygen levels and binary output that changes state when the NOx level is above a locally adjustable NOx setpoint. Sensor shall have normal, trouble and alarm lights. Sensor shall have heat traced lines if the stack pickup is remote from the sensor. Sensor shall be complete with automatic zero and span calibration using a timed calibration gas system, and shall not require periodic maintenance or recalibration.

2.8.16 Turbidity Sensor

Sensor shall include a local indicating meter and shall be suitable for measurement of turbidity of water. Sensor shall sense from 0 to 1000 Nephelometric Turbidity Units (NTU). Range shall be field-verified for the particular application and adjusted as required. The output shall be temperature compensated over a range of 0 to 100 degrees C 0 to 212 degrees F. The accuracy shall be +/- 5% of full scale reading. Sensor shall have automatic zeroing and shall not require periodic maintenance or recalibration.

2.8.17 Chlorine Detector

The detector shall measure concentrations of chlorine in water in the range 0 to 20 ppm with a repeatability of +/- 1% of full scale and an accuracy of +/- 2% of full scale. The Chlorine Detector transmitter shall be housed in a non-corrosive NEMA 250 Type 4X enclosure. Detector shall include a local panel with adjustable alarm trip level, local audio and visual alarm with silence function.

2.8.18 Floor Mounted Leak Detector

Leak detectors shall use electrodes mounted at slab level with a minimum built-in-vertical adjustment of 3 mm 0.125 inches. Detector shall have a binary output. The indicator shall be manual reset type.

2.8.19 Temperature Switch

2.8.19.1 Duct Mount Temperature Low Limit Safety Switch (Freezestat)

Duct mount temperature low limit switches (Freezestats) shall be manual reset, low temperature safety switches with a minimum element length of 3 m/square meter 1 foot/square-foot of coverage which shall respond to the coldest 450 mm 18 inch segment with an accuracy of +/- 2 degrees C 3.6 degrees F. The switch shall have a field-adjustable setpoint with a range of at least -1 to plus 10 degrees C 30 to 50 degrees F. The switch shall have two sets of contacts, and each contact shall have a rating greater than its connected load. Contacts shall open or close upon drop of temperature below setpoint as shown and shall remain in this state until reset.

2.8.19.2 Pipe Mount Temperature Limit Switch (Aquastat)

Pipe mount temperature limit switches (aquastats) shall have a field adjustable setpoint between 15 and 32 degrees C 60 and 90 degrees F, an accuracy of +/- 2 degrees C 3.6 degrees F and a 5 degrees C 10 degrees F fixed deadband. The switch shall have two sets of contacts, and each contact shall have a rating greater than its connected load. Contacts shall open or close upon change of temperature above or below setpoint as shown.

2.8.20 Damper End Switches

****
NOTE: If the HVAC system design includes smoke dampers in the return air and fan discharge, or other dampers requiring end switches, show the end switches on drawings.
****

Each end switch shall be a hermetically sealed switch with a trip lever and over-travel mechanism. The switch enclosure shall be suitable for mounting on the duct exterior and shall permit setting the position of the trip lever that actuates the switch. The trip lever shall be aligned with the damper blade.

2.9 INDICATING DEVICES

All indicating devices shall display readings in [metric (SI)][English (inch-pound)] units.

2.9.1 Thermometers

Thermometers shall not contain mercury. Unless otherwise specified, thermometers shall have an accuracy of +/- 3% of scale range. Thermometers shall have a range suitable for the application with an upper end of the range not to exceed 150% of the design upper limit.

2.9.1.1 Piping System Thermometers

Piping system thermometers shall have brass, malleable iron or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 230 mm 9 inch scale. Piping system thermometers shall have an accuracy of +/- 1% of scale range. Thermometers for piping systems shall have rigid stems with straight, angular, or inclined pattern. Thermometer stems shall have expansion heads as required to prevent breakage at extreme temperatures. On rigid-stem thermometers, the space between bulb and stem shall be filled with a heat-transfer medium.

2.9.1.2 Air-Duct Thermometers

Air-duct thermometers shall have perforated stem guards and 45-degree adjustable duct flanges with locking mechanism.

2.9.2 Pressure Gauges

Gauges shall be suitable for field or panel mounting as required, shall have black legend on white background, and shall have a pointer traveling through a 270-degree arc. Gauge range shall be suitable for the application with an upper end of the range not to exceed 150% of the design upper limit. Accuracy shall be +/- 3% of scale range. Gauges shall meet requirements of ASME B40.100.

2.9.3 Low Differential Pressure Gauges

Gauges for low differential pressure measurements shall be a minimum of 90 mm 3.5 inch (nominal) size with two sets of pressure taps, and shall have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. Gauge range shall be suitable for the application with an upper end of the range not to exceed 150% of the design upper limit. Accuracy shall be plus or minus two percent of scale range.

2.10 OUTPUT DEVICES

Output Devices with SNVT input are ASCs and shall meet all ASC requirements in addition to the output device requirements. (Note: ASCs are specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE.)

2.10.1 Actuators

****

NOTE: Include the appropriate bracketed text if pneumatic actuators are used.

Edit the control Schematic drawing to show electric and/or pneumatic actuators along with their failsafe positions (NO, NC, or fail-in-last-position (FILP)). See the UFC for design guidance on choosing actuator fail-to positions.

Include the bracketed text if using electric actuator position feedback. This should be limited to primary equipment, such as built-up air handlers. Show this feedback signal on the control schematic drawings or specifically state where this requirement applies. Add the actuator position to

the Points Schedule as a network variable available to be monitored by the UMCS (present or future).
****

Actuators shall be electric (electronic) [or pneumatic as shown]. All actuators shall be normally open (NO), normally closed (NC) or fail-in-last-position (FILP) as shown. Normally open and normally closed actuators shall be of mechanical spring return type. Electric actuators shall have an electronic cut off or other means to provide burnout protection if stalled. Actuators shall have a visible position indicator. [Electric actuators shall provide position feedback to the controller as shown.] Actuators shall smoothly open or close the devices to which they are applied. Pneumatic actuators shall have a full stroke response time matching the connected Electric to Pneumatic Transducer (EP). Electric actuators shall have a full stroke response time in both directions of 90 seconds or less at rated load. Electric actuators shall be of the foot-mounted type with an oil-immersed gear train or the direct-coupled type. Where multiple electric actuators operate from a common signal, the actuators shall provide an output signal identical to its input signal to the additional devices. [Pneumatic actuators shall be rated for 172 kPa 25 psi operating pressure except for high-pressure cylinder-type actuators.]

2.10.1.1 Valve Actuators

****
NOTE: Indicate in the Valve Schedule a close-off pressure that is 150% of the pump dead head pressure for 2-way valves and 200% of the valve differential pressure for 3-way valves, or equivalent torque values.
****

Valve actuators shall provide shutoff pressures and torques as shown on the Valve Schedule.

2.10.1.2 Damper Actuators

Damper actuators shall provide the torque necessary per damper manufacturer's instructions to modulate the dampers smoothly over its full range of operation and torque shall be at least 7 Nm/0.93 square m 6 inch-pounds/1 square foot of damper area for opposed blade dampers and 1 Nm/0.93 square m 9 inch-pounds/1 square foot of damper area for parallel blade dampers.

2.10.1.3 Positive Positioners

****
NOTE: Only larger valves and actuators or where high-speed actuation is needed may require positive positioners. Edit the drawings to show positive positioners when they are required. The typical drawings do not show/require them due to maintenance requirements for these devices. See UFC 3-410-02A for more information.
****

Positive positioners shall be a pneumatic relay with a mechanical position feedback mechanism and an adjustable operating range and starting point.

2.10.2 Solenoid-Operated Electric to Pneumatic Switch (EPS)

Solenoid-Operated Electric to Pneumatic Switches (EPS) shall accept a voltage input to actuate its air valve. Each valve shall have three-port operation: common, normally open, and normally closed. Each valve shall have an outer cast aluminum body and internal parts of brass, bronze, or stainless steel. The air connection shall be a 10 mm 0.38 inch NPT threaded connection. Valves shall be rated for 345 kPa 50 psig.

2.10.3 Electric to Pneumatic Transducers (EP)

****
NOTE: Depending on the application, the designer may choose to select an EP and actuator combination to operate over the full range in less than 90 seconds.
****

Electric to Pneumatic Transducers (EPs) shall convert either a 4-20 mAdc input signal, a 0-10 Vdc input signal, or SNVT input to a 21-103 kPa 3-15 psig pneumatic output with a conversion accuracy of +/- 2% of full scale, including linearity and hysteresis. The EP shall withstand pressures at least 150% of the system supply air pressure (main air). EPs shall include independent offset and span adjustment. Air consumption shall not be greater than 0.024 L/s 0.05 scfm. EPs shall have a manual adjustable override for the EP pneumatic output. EPs shall have sufficient output capacity to provide full range stroke of the actuated device in both directions within [90][_____] seconds.

2.10.4 Relays

Control relay contacts shall have utilization category and ratings selected for the application, with a minimum of two sets of contacts enclosed in a dust proof enclosure. Each set of contacts shall incorporate a normally open (NO), normally closed (NC) and common contact. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage.

2.11 USER INPUT DEVICES

User Input Devices, including potentiometers, switches and momentary contact push-buttons with SNVT output are Application Specific Controllers (ASCs) and shall meet all ASC requirements. (Note: ASCs are specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE). Potentiometers shall be of the thumb wheel or sliding bar type. Momentary Contact Push-Buttons may include an adjustable timer for their output. User input devices shall be labeled for their function.

2.12 MULTIFUNCTION DEVICES

Multifunction devices are products which combine the functions of multiple sensor, user input or output devices into a single product. Unless otherwise specified, the multifunction device shall meet all requirements of each component device. Where the requirements for the component devices conflict, the multifunction device shall meet the most stringent of the requirements.

2.12.1 Current Sensing Relay Command Switch

The Current Sensing Relay portion shall meet all requirements of the Current Sensing Relay input device. The Command Switch portion shall meet all requirements of the Relay output device except that it shall have at least one normally-open (NO) contact.

2.12.2 Thermostats

Thermostats shall be multifunction devices incorporating a temperature sensor and a temperature indicating device. Thermostats shall not contain mercury (Hg). In addition, the thermostat shall have the following as specified and shown:

a. A User Input Device which shall adjust a temperature setpoint output.

b. A User Input Momentary Contact Button and an output indicating zone occupancy.

c. A three position User Input Switch labeled to indicate heating, cooling and off positions ('HEAT-COOL-OFF' switch) and providing corresponding outputs.

d. A two position User Input Switch labeled with 'AUTO' and 'ON' positions and providing corresponding outputs.

e. A multi-position User Input Switch with 'OFF' and at least two fan speed positions and providing corresponding outputs.

2.13 COMPRESSED AIR STATIONS

****

NOTE: The designer will estimate the required control air consumption to calculate the required motor horsepower of the control air compressor and coordinate with the electrical designer.

For hospitals and critical installations, a standby compressor will be provided. For all other applications, the portion covering standby compressor will be deleted. For hospitals, delete the Contractor option permitting the use of polyethylene tubing in lieu of copper.

Indicate on the drawings the locations where metallic raceway or electric metallic tubing is not required for protection of nonmetallic tubing.

****

2.13.1 Air Compressor Assembly

The air compressor shall be a high pressure compressing unit with electric motor. The compressor shall be equipped with a motor with totally enclosed belt guard, an operating-pressure switch, safety relief valves, gauges, intake filter and intake silencer, and combination type magnetic starter with undervoltage protection and thermal-overload protection for each phase, and shall be supported by a steel base mounted on an air storage tank. The air compressor shall provide the compressed air required for control operation while operating not more than one-third of the time. The

air storage tank shall be fabricated for a working pressure of not less than 1380 kPa 200 psi and constructed and certified in accordance with ASME BPVC SEC VIII D1. The tank shall be of sufficient volume so that no more than six compressor starts per hour are required with the starting pressure switch differential set at 140 kPa 20 psi. The tank shall be provided with an automatic condensate drain trap with manual override feature. [A second (duplex arrangement) compressor of capacity equal to the primary compressor shall be provided, with interlocked control to provide automatic changeover upon malfunction or failure of either compressor. A manual selector switch shall be provided to index the lead compressor including the automatic changeover.]

2.13.2 Compressed Air Station Specialties

2.13.2.1 Refrigerated Dryer, Filters and, Pressure Regulator

A refrigerated dryer shall be provided in the air outlet line of the air storage tank. The dryer shall be of the size required for the full delivery capacity of the compressor. The air shall be dried at a pressure of not less than 483 kPa 70 psi to a temperature not greater than 2 degrees C 35 degrees F. The dryer shall be provided with an automatic condensate drain trap with manual override feature. The automatic drain trap shall have an adjustable cycle and drain time. The refrigerant used in the dryer shall be one of the fluorocarbon gases and have an Ozone Depletion Potential of not more than 0.05. A five micron pre-filter and coalescing-type 0.03 micron oil removal filter with shut-off valves shall be provided in the dryer discharge. Each filter bowl shall be rated for 1034 kPa 150 psi maximum working pressure. A pressure regulator, with high side and low side pressure gauges, and a safety valve shall be provided downstream of the filter. Pressure regulators of the relieving type shall not be used.

2.13.2.2 Flexible Pipe Connections

The flexible pipe connections shall be designed for 1034 kPa and 120 degrees C 150 psi and 250 degrees F service, and shall be constructed of rubber or tetrafluoroethylene resin tubing with a reinforcing protective cover of braided corrosion-resistant steel, bronze, monel, or galvanized steel. The connectors shall be suitable for the service intended and shall have threaded or soldered ends. The length of the connectors shall be as recommended by the manufacturer for the service intended.

2.13.2.3 Vibration Isolation Units

The vibration isolation units shall be standard products with published loading ratings, and shall be single rubber-in-shear, double rubber-in-shear, or spring type.

2.14 DIRECT DIGITAL CONTROL (DDC) HARDWARE

2.14.1 General Requirements

All DDC Hardware shall meet the following requirements:

a. It shall incorporate a "service pin" which, when pressed will cause the DDC Hardware to broadcast its 48-bit NodeID and its ProgramID over the network. The service pin shall be distinguishable and accessible.

b. It shall incorporate a light to indicate the device is receiving power.

c. It shall incorporate a TP/FT-10 transceiver in accordance with CEA-709.3 and connections for TP/FT-10 control network wiring. It shall not have connections to any other network media type.

d. It shall communicate on the network using only the CEA-709.1B protocol.

****
NOTE: FYI, a link powered device gets it's power from the communication cable as opposed to from a separate power source.
****

e. It shall be locally powered; link powered devices are not acceptable.

f. LonMark external interface files (XIF files), as defined in the LonMark XIF Guide, shall be submitted for each type of DDC Hardware.

g. Application programs and configuration settings shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration settings.

h. It shall have all functionality specified and required to support the application (Sequence of Operation or portion thereof) in which it is used, including but not limited to:

(1) It shall provide input and output SNVTs as specified and required to support the sequence and application in which it is used.

(2) It shall be configurable via standard or user-defined configuration parameters (SCPT or UCPT), SNVT network configuration inputs (*nci*), or hardware settings on the controller itself as specified and as required to support the sequence and application in which it is used.

i. It shall meet 47 CFR 15 requirements and have UL 916 or equivalent safety listing.

2.14.2 Hardware Input-Output (I/O) Functions

DDC Hardware incorporating hardware input-output (I/O) functions shall meet the following requirements:

a. Analog Inputs: DDC Hardware analog inputs (AIs) shall perform analog to digital (A-to-D) conversion with a minimum resolution of 8 bits plus sign or better as needed to meet the accuracy requirements specified in paragraph INPUT MEASUREMENT ACCURACY. Signal conditioning including transient rejection shall be provided for each analog input. Analog inputs shall be capable of being individually calibrated for zero and span. The AI shall incorporate common mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10,000 ohms.

b. Analog Outputs: DDC Hardware analog outputs (AOs) shall perform digital to analog (D-to-A) conversion with a minimum resolution of 8 bits plus sign, and output a signal with a range of 4-20 mAdc or 0-10 Vdc. Analog outputs shall be capable of being individually calibrated for zero and span.

c. Binary Inputs: DDC Hardware binary inputs (BIs) shall accept contact closures and shall ignore transients of less than 5 milli-second duration. Isolation and protection against an applied steady-state voltage up to 180 Vac peak shall be provided.

d. Binary Outputs: DDC Hardware binary outputs (BOs) shall provide relay contact closures or triac outputs for momentary and maintained operation of output devices.

(1) Relay Contact Closures: Closures shall have a minimum duration of 0.1 second. Relays shall provide at least 180V of isolation. Electromagnetic interference suppression shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be one ampere at 24 Vac.

(2) Triac outputs: Triac outputs shall provide at least 180 V of isolation.

e. Pulse Accumulator: DDC Hardware pulse accumulators shall have the same characteristics as the BI. In addition, a buffer shall be provided to totalize pulses. The pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero upon operator's command.

2.14.3 Application Specific Controller (ASC)

Application Specific Controllers (ASCs) have a fixed factory-installed application program (i.e. ProgramID) with configurable settings. ASCs shall meet the following requirements in addition to the General DDC Hardware and DDC Hardware Input-Output (I/O) Function requirements:

a. ASCs shall be LonMark Certified.

b. Unless otherwise approved, all necessary Configuration Parameters and network configuration inputs (*ncis*) for the sequence and application in which the ASC is used shall be fully configurable through an LNS plug-in. This plug-in shall be submitted as specified for each type of ASC (manufacturer and model). (Note: configuration accomplished via hardware settings does not require configuration via plug-in)

c. Local Display Panel (LDP): The Local Display Panel shall be an Application Specific Controller (ASC) with a display and navigation buttons. It shall provide display and adjustment of SNVT inputs and SNVT outputs as shown.

2.14.4 General Purpose Programmable Controller (GPPC)

A General Purpose Programmable Controller (GPPC) is not installed with a fixed factory-installed application program. GPPCs shall meet the following requirements in addition to the general DDC Hardware requirements and Hardware Input-Output (I/O) Function:

a. The programmed GPPC shall conform to the LonMark Interoperability Guide.

b. All programming software required to program the GPPC shall be delivered to and licensed to the project site as specified.

c. Copies of the installed GPPC application programs as source code

compatible with the supplied programming software shall be submitted as specified. The submitted GPPC application program shall be the complete application necessary for the GPPC to function as installed and be sufficient to allow replacement of the installed controller with a GPPC of the same type.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS SURVEY

****
NOTE: Use the bracketed text for retrofit projects only.
****

The Contractor shall perform a field survey, including testing and inspection of the equipment to be controlled and submit an Existing Conditions Report documenting the current status and it's impact on the Contractor's ability to meet this specification. For those items considered nonfunctional, the Contractor shall provide (with the report) specification sheets, or written functional requirements to support the findings and the estimated costs to correct the deficiencies. As part of the report, the Contractor shall define the scheduled need date for connection to existing equipment.[The Contractor shall make written requests and obtain Government approval prior to disconnecting any controls and obtaining equipment downtime. Existing devices which are not to be replaced shall be inspected, calibrated, and adjusted as necessary to place them in proper working order.]

3.2 CONTROL SYSTEM INSTALLATION

3.2.1 General Installation Requirements

3.2.1.1 HVAC Control System

The HVAC control system shall be completely installed, tested and ready for operation. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be made watertight. The HVAC control system installation shall provide clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. The control system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.2.1.2 Device Mounting Criteria

All devices shall be installed in accordance with manufacturer's recommendations and as specified and shown. Control devices to be installed in piping and ductwork shall be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements shall not be used except as specified. Spare thermowells shall be installed adjacent to each thermowell containing a sensor and as shown. Devices located outdoors shall have a weathershield.

3.2.1.3 Labels and Tags

Labels and tags shall be keyed to the unique identifiers shown on the

As-Built drawings. All Enclosures and DDC Hardware shall be labeled. All sensors and actuators in mechanical rooms shall be tagged. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient. Duct static pressure taps shall be tagged at the location of the pressure tap. Tags shall be plastic or metal and shall be mechanically attached directly to each device or attached by a metal chain or wire. Labels exterior to protective enclosures shall be engraved plastic and mechanically attached to the enclosure or DDC Hardware. Labels inside protective enclosures may attached using adhesive, but shall not be hand written.

3.2.2 DDC Hardware

****
NOTE: Coordinate with the project site for domain and subnet values. These values must be selected so that there will not be a domain or subnet conflict when the building is integrated into a UMCS. Generally this information can be obtained from whoever maintains the UMCS (whoever integrates buildings into the UMCS).
****

DDC Hardware shall be installed in an enclosure. Except for DDC Hardware used to control Terminal Units, where multiple pieces of DDC Hardware are used to execute one sequence all DDC Hardware executing that sequence shall be on a common local control bus and isolated from all other DDC Hardware via an CEA-709.1B Router or CEA-709.3 Repeater. All DDC Hardware installed shall have an CEA-709.1B domain of [_____] and a subnet between [_____] and [_____].

3.2.3 Local Display Panel (LDP)

****
NOTE: Designer must indicate on each Points Schedule which points, if any, are to be displayed or adjustable from an LDP.

Designer should coordinate with the project site to determine number and location of LDPs needed and show on them on the drawings. Due to limitations of LDPs, the project site may opt to not specify LDPs and use a laptop instead.
****

Local Display Panels shall be installed [in each mechanical room containing an air handler][_____] and shall provide SNVT inputs for display and outputs for adjusting SNVT values as shown on the Points Schedule.

3.2.4 Gateways

****
NOTE: The intent of this is to allow the use of gateways to packaged equipment controllers, not to allow the installation of a non-ANSI 709.1 network connected to a 15951 ANSI 709.1 network via a gateway.
****

Gateways may be used for communication with non-CEA-709.1B control hardware subject to all of the following limitations:

a. Each gateway shall communicate with and perform protocol translation for non-CEA-709.1B control hardware controlling one and only one package unit.

b. Non-CEA-709.1B control hardware shall not be used for controlling built-up units.

c. Non-CEA-709.1B control hardware shall not perform system scheduling functions.

3.2.5 Network Interface Jack

****
NOTE: Choose the preferred location for network interface jacks by controllers with thermostats (coordinate with the project site to determine preference of O&M Staff).

Choose the number of interface cables to be furnished by the Contractor.
****

A standard network interface jack shall be provided for each node on the control network. For terminal unit controllers with hardwired thermostats this network interface jack shall be located at the thermostat or within 3 m 10 ft of the controller. Locating the interface jack [at the thermostat][near the controller] is preferred. For all other nodes the network interface jack shall be located within 3 m 10 ft of the node. If the network interface jack is other than a 3 mm 1/8 inch phone jack, the Contractor shall provide an interface cable with a standard 3 mm 1/8 inch phone jack on one end and a connector suitable for mating with installed network interface jack on the other. No more than one type of interface cable shall be required to access all network interface jacks. Contractor shall furnish [one][_____] interface cable(s).

3.2.6 Room Instrument Mounting

****
NOTE: Wall mounted thermostats and similar control system components containing user input devices in ADA compliant facilities and spaces are required to be mounted 1.2 meters (48 inches) above the floor for forward reach and 1.3 meters (54 inches) for side reach. Note the mounting height and location for these system components on the drawings or revise the following paragraph accordingly.
****

Room instruments, including but not limited to wall mounted thermostats and sensors located in occupied spaces shall be mounted 1.5 m 60 inches above the floor unless otherwise shown. Unless otherwise shown on the Thermostat Schedule:

a. Thermostats for Fan Coil Units shall be unit mounted.

b. All other Thermostats shall be wall mounted.

3.2.7 Indication Devices Installed in Piping and Liquid Systems

Gauges in piping systems subject to pulsation shall have snubbers. Gauges for steam service shall have pigtail fittings with cock. Thermometers and temperature sensing elements installed in liquid systems shall be installed in thermowells.

3.2.8 Duct Smoke Detectors

****
NOTE: Duct Smoke Detectors are installed by the fire alarm system Contractor. Duct detectors are intended to shut down air distribution fans and close smoke dampers where applicable. Each detector must be indicated on the schematic and associated ladder diagram.

Coordinate with the applicable Section 1385x used for the fire alarm system installation, to make sure that smoke detectors are installed in the proper location and that all detectors that are to be interfaced to the DDC system have auxiliary contacts for this purpose.

In the following paragraph indicate which Section is used for the installation of the fire alarm system (and the duct smoke detectors).
****

Duct smoke detectors will be provided in supply and return air ducts in accordance with [Section 28 31 64.00 10 FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE][_____]. Contractor shall connect the DDC System to the auxiliary contacts provided on the Smoke Detector as required for system safeties and to provide alarms to the DDC system.

3.2.9 Occupancy Sensors

A sufficient quantity of occupancy sensors shall be provided to provide complete coverage of the area (room or space). Occupancy sensors shall be installed in accordance with NFPA 70 requirements and the manufacturer's instructions. Occupancy sensors shall not be located within 1.8 m 6 feet of HVAC outlets or heating ducts. PIR and dual-technology PIR/ultrasonic sensors shall not be installed where they can "see" beyond any doorway. Ultrasonic sensors shall not be installed in spaces containing ceiling fans. Sensors shall detect motion to within 0.6 m 2 feet of all room entrances and shall not trigger due to motion outside the room. The off-delay timer shall be set to [15][_____] minutes unless otherwise shown. All sensor adjustments shall be made prior to beneficial occupancy, but after installation of furniture systems, shelving, partitions, etc. Each controlled area shall have one hundred percent coverage capable of detecting small hand-motion movements, accommodating all occupancy habits of single or multiple occupants at any location within the controlled room.

3.2.10 Temperature Limit Switch

A temperature limit switch (freezestat) shall be provided to sense the temperature at the location shown. A sufficient number of temperature limit switches (freezestats) shall be installed to provide complete

coverage of the duct section. Manual reset limit switches shall be installed in approved, accessible locations where they can be reset easily. The temperature limit switch (freezestat) sensing element shall be installed in a serpentine pattern and in accordance with the manufacturer's installation instructions.

3.2.11 Averaging Temperature Sensing Elements

Sensing elements shall be installed in a serpentine pattern located as shown.

3.2.12 Air Flow Measurement Arrays (AFMA))

****
NOTE: Air filters are specified in Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION AND EXHAUST SYSTEMS and installed by the Mechanical Contractor (not by the controls Contractor under this spec).

If MinOA ducts are not used, do not permit pitot tube AFMA for OA measurement (keep bracketed text).
****

Outside Air AFMAs shall be located downstream from the Outside Air filters. Pitot Tube AFMA shall not be used if the expected velocity measurement is below 3.5 m/s 700 fpm [or for outside airflow measurements].

3.2.13 Duct Static Pressure Sensors

The duct static pressure sensing tap shall be located at 75% to 100% of the distance between the first and last air terminal units. If the transmitter is wired in a homerun configuration to an AHU controller, the transmitter shall be located in the same enclosure as the air handling unit (AHU) controller(s) for the AHU serving the terminal units.

3.2.14 Relative Humidity Sensors

Relative humidity sensors in supply air ducts shall be installed at least 3 m 10 feet downstream of humidity injection elements.

3.2.15 Flowmeters

The minimum straight unobstructed piping for the flowmeter installation shall be at least 10 pipe diameters upstream and at least 5 pipe diameters downstream and in accordance with the manufacturer's installation instructions.

3.2.16 Dampers

3.2.16.1 Damper Actuators

Actuators shall not be mounted in the air stream. Multiple actuators shall not be connected to a common drive shaft. Actuators shall be installed so that their action shall seal the damper to the extent required to maintain leakage at or below the specified rate and shall move the blades smoothly.

3.2.16.2 Damper Installation

Dampers shall be installed straight and true, level in all planes, and

square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking (parallelogramming), bowing, or other installation error. Blades shall close completely and leakage shall not exceed that specified at the rated static pressure. Structural support shall be used for multi-section dampers. Acceptable methods include but are not limited to U-channel, angle iron, corner angles and bolts, bent galvanized steel stiffeners, sleeve attachments, braces, and building structure. Where multi-section dampers are installed in ducts or sleeves, they shall not sag due to lack of support. Jackshafts shall not be used to link more than three damper sections. Blade to blade linkages shall not be used. Outside and return air dampers shall be installed such that their blades direct their respective air streams towards each other to provide for maximum mixing of air streams.

3.2.17 Valves

3.2.17.1 Ball Valves

Two-position (open/closed) ball valves may only be used on chilled water, condenser water, hot water, or steam applications. Modulating ball valves may only be used for chilled water and condenser water applications (modulating ball valves shall not be used on steam or hot water applications). In modulating applications a characterizing equal-percentage disc shall be used.

3.2.17.2 Butterfly Valves

In two-way control applications, valve travel shall be limited to 70% (60 degrees) open position.

3.2.18 Local Gauges for Actuators

Pneumatic actuators shall have an accessible and visible pressure gauge installed in the tubing lines at the actuator as shown.

3.2.19 Wire and Cable

****
NOTE: Coordinate with the project site and indicate whether all wiring needs to be in raceways or whether low-voltage wiring can be run without raceways.

Note that requiring all wiring to be run in raceways will increase the project cost.
****

Wire and Cable shall be installed without splices between control devices and in accordance with NFPA 70 and NFPA 90A. Instrumentation grounding shall be installed per the device manufacturer's instructions and as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system. Ground rods installed by the Contractor shall be tested as specified in IEEE Std 142. Cables and conductor wires shall be tagged at both ends, with the identifier shown on the shop drawings. Electrical work shall be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as shown. Wiring external to enclosures shall be run [in raceways][as follows:

a. Wiring other than low-voltage control and low-voltage network wiring

shall be installed in raceways.

b. Low-voltage control and low-voltage network wiring not in suspended ceilings over occupied spaces shall be installed in raceways, except that nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.

c. Low-voltage control and low-voltage network wiring in suspended ceilings over occupied spaces shall be installed in raceways, except:

(1) nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.

(2) plenum rated cable in suspended ceilings over occupied spaces may be run without raceways.]

3.2.20 Copper Tubing

Copper tubing shall be hard-drawn in exposed areas and either hard-drawn or annealed in concealed areas. Only tool-made bends shall be used. Fittings for copper tubing shall be brass or copper solder joint type except at connections to apparatus, where fittings shall be brass compression type.

3.2.21 Plastic Tubing

Plastic tubing shall be run within covered raceways or conduit except when otherwise specified. Plastic tubing shall not be used for applications where the tubing could be subjected to a temperature exceeding 55 degrees C 130 degrees F. Fittings for plastic tubing shall be for instrument service and shall be brass or acetal resin of the compression or barbed push-on type. Except in walls and exposed locations, plastic multitube instrument tubing bundle without conduit or raceway protection may be used where a number of air lines run to the same points, provided the multitube bundle is enclosed in a protective sheath, is run parallel to the building lines and is adequately supported as specified.

3.2.22 Pneumatic Lines

Pneumatic lines shall be installed such that they are not exposed to outside air temperatures. Pneumatic lines shall be concealed except in mechanical rooms and other areas where other tubing and piping is exposed.

All tubes and tube bundles exposed to view shall be installed neatly in lines parallel to the lines of the building. Tubing in mechanical/electrical spaces shall be routed so that the lines are easily traceable.

Air lines shall be purged of dirt, impurities and moisture before connecting to the control equipment. Air lines shall be number coded or color coded and keyed in the As-Built Drawings for future identification and servicing the control system.

3.2.22.1 Pneumatic Lines in Mechanical/Electrical Spaces

In mechanical/electrical spaces, pneumatic lines shall be plastic or copper tubing. Horizontal and vertical runs of plastic tubing or soft copper tubing shall be installed in raceways or rigid conduit dedicated to tubing. Dedicated raceways, conduit, and hard copper tubing not installed in raceways shall be supported every 2 m 6 feet for horizontal runs and

every 2.5 m 8 feet for vertical runs.

3.2.22.2 Pneumatic Lines External to Mechanical/Electrical Spaces

****
NOTE: Delete protective sheath for nonmetallic tubing in concealed, accessible areas not subject to abuse.
****

Tubing external to mechanical/electrical spaces shall be soft copper with sweat fittings or plastic tubing in raceways not containing power wiring. Raceways and tubing not in raceways shall be supported every 2.5 m 8 feet. Pneumatic lines concealed in walls shall be hard-drawn copper tubing or plastic tubing in rigid conduit. Plastic tubing in a protective sheath, run parallel to the building lines and supported as specified, may be used above accessible ceilings and in other concealed but accessible locations.

3.2.22.3 Terminal Single Lines

Terminal single lines shall be hard-drawn copper tubing, except when the run is less than 300 mm 12 inch in length, flexible polyethylene may be used.

3.2.22.4 Connection to Liquid and Steam Lines

****
NOTE: The designer will select tubing and fitting and fitting materials appropriate for the ductwork and piping services. Stainless steel tubing will only be used when required for the application such as in corrosive atmospheres.
****

Tubing for connection of sensing elements and transmitters to liquid and steam lines shall be [copper][Series 300 stainless steel] with [brass compression][stainless-steel compression] fittings.

3.2.22.5 Connection to Ductwork

Connections to sensing elements in ductwork shall be plastic tubing.

3.2.22.6 Tubing in Concrete

Tubing in concrete shall be installed in rigid conduit. Tubing in walls containing insulation, fill, or other packing materials shall be installed in raceways dedicated to tubing.

3.2.22.7 Tubing Connection to Actuators

Final connections to actuators shall be plastic tubing 300 mm 12 inches long and unsupported at the actuator.

3.2.23 Compressed Air Stations

****
NOTE: If possible, foundations and housekeeping pads should be specified in Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST

SYSTEMS.
****

The air compressor assembly shall be mounted on vibration eliminators, in accordance with ASME BPVC SEC VIII D1 for tank clearance. The air line shall be connected to the tank with a flexible pipe connector. Compressed air station specialties shall be installed with required tubing, including condensate tubing to a floor drain. Compressed air stations shall deliver control air meeting the requirements of ISA 7.0.01. Foundations and housekeeping pads shall be provided for the HVAC control system air compressors [in accordance with the air compressor manufacturer's instructions][as specified in Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS].

3.3 DRAWINGS AND CALCULATIONS

Contractor shall prepare and submit shop drawings.

3.3.1 Network Bandwidth Usage Calculations

****
NOTE:
1) use [the UMCS] when there is an existing UMCS.

2) use [the Building Point of Connection (BPOC) location] when a UMCS is anticipated and the BPOC location is on the drawing.

3) use [a single point on the backbone that is not on a local control bus] for a truly stand-alone building (no current or anticipated UMCS).

In cases 2) and 3) the Contractor may/will have to put a device on the network temporarily to provide a point for testing purposes.
****

The Contractor shall perform Building Control Network Bandwidth Usage Calculations for a normally loaded and a heavily loaded control network. Calculations shall be performed for network traffic on the backbone.

A heavily loaded control network is characterized as one performing the following activities simultaneously:

a. Transmitting every point in the building indicated on Points Schedules as being available to [the UMCS][the Building Point of Connection (BPOC) location][a single point on the backbone that is not on a local control bus] in response to polling requests at 15-minute intervals (for trending at UMCS).

b. Transmitting five points to [the UMCS][the Building Point of Connection (BPOC) location][a single point on the backbone that is not on a local control bus] in response to polling requests at 2-second intervals.

c. Transmitting 100 points to [the UMCS][the Building Point of Connection (BPOC) location][a single point on the backbone that is not on a local control bus] in response to polling requests at 5-second intervals.

d. Transmitting occupancy commands from [the UMCS][the Building Point of

Connection (BPOC) location][a single point on the backbone that is not on a local control bus] to every system schedule sequence in a one-minute interval.

e. Transmitting occupancy override commands from [the UMCS][the Building Point of Connection (BPOC) location][a single point on the backbone that is not on a local control bus] to every system schedule sequence in a one-minute interval.

A normally loaded control network is characterized as one performing the following activities simultaneously:

a. Transmitting every point in the building indicated on Points Schedules as requiring a trend to the UMCS in response to polling requests at 15-minute intervals (for trending at UMCS).

b. Transmitting 50 points to the UMCS in response to polling requests at 5-second intervals.

c. Transmitting occupancy commands from the UMCS to every system scheduler sequence in a one-minute interval.

3.3.2 DDC Contractor Design Drawings

****
NOTE: Designer must decide whether to require a specific drawing size (approx 11x17 or 22x34) or to leave it up to the Contractor.

Designer may choose to include a Riser Diagram in the design package to show project specific requirements such as DDC Hardware locations etc.
****

Drawings shall be on [ISO A1 841 by 594 mm 34 by 22 inches][or][A3 420 by 297 mm 17 by 11 inches] sheets in the form and arrangement shown. The drawings shall use the same abbreviations, symbols, nomenclature and identifiers shown. Each control system element on a drawing shall be assigned a unique identifier as shown. The DDC Contractor Design Drawings shall be delivered together as a complete submittal. Deviations shall be approved by the Contracting Officer. DDC Contractor Design Drawings shall include the following:

a. Drawing Index and HVAC Design Drawing Legend: The HVAC Control System Drawing Index shall show the name and number of the building, military site, State or other similar designation, and Country. The Drawing Index shall list all Contractor Design Drawings, including the drawing number, sheet number, drawing title, and computer filename when used. The Design Drawing Legend shall show and describe all symbols, abbreviations and acronyms used on the Design Drawings.

b. Valve Schedule: The valve schedule shall contain each valve's unique identifier, size, flow coefficient Kv (Cv), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure to torque data, dimensions, and access and clearance requirements data. The valve schedule shall contain actuator selection data supported by calculations of the force required to move and seal the valve, access and clearance requirements. A valve schedule shall be submitted for each HVAC system.

c. Damper Schedule: The damper schedule shall contain each damper's unique identifier, type (opposed or parallel blade), nominal and actual sizes, orientation of axis and frame, direction of blade rotation, actuator size and spring ranges, operation rate, positive positioner range, location of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. The Damper Schedule shall include the AMCA 500-D maximum leakage rate at the operating static-pressure differential. A damper schedule shall be submitted for each HVAC system.

d. Thermostat and Occupancy Sensor Schedule: The thermostat and occupancy sensor schedule shall contain each thermostat's unique identifier, room identifier and control features and functions as shown. A thermostat and occupancy sensor schedule shall be submitted for each HVAC system.

e. Critical Alarm Handling Schedule: The critical alarm handling schedule shall contain the same fields as the critical alarm handling schedule Contract Drawing with Contractor updated information and any other project-specific information required to implement the alarm handling function. A critical alarm handling schedule shall be submitted for each HVAC system.

f. Equipment Schedule: The equipment schedule shall contain the unique identifier, manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. An equipment schedule shall be submitted for each HVAC system.

g. Occupancy Schedule: The occupancy schedule drawing shall contain the same fields as the occupancy schedule Contract Drawing with Contractor updated information. An occupancy schedule shall be submitted for each HVAC system.

h. Points Schedule: The Points Schedule drawing shall contain the same fields as the Points Schedule Contract Drawing with Contractor updated information. A Points Schedule shall be submitted for each HVAC system.

i. Compressed Air Station Schematic: The compressed air station schematic diagram shall show all equipment, including: compressor with motor horsepower and voltage; starter; isolators; manual bypasses; tubing sizes; drain piping and drain traps; reducing valves; dryer; and data on manufacturer's names and model numbers, mounting, access, and clearance requirements. Air Compressor and air dryer data shall include calculations of the air consumption of all electric-to-pneumatic transducers and of any other control system devices to be connected to the compressed air station, and the compressed air supply dewpoint temperature at 140 kPa 20 psig. Compressed air station schematic drawings shall be submitted for each compressed air station.

j. Riser diagram of building control network: The Riser Diagram of the Building Control Network shall show all network cabling, DDC Hardware, and Network Hardware including:

(1) All DDC Hardware with room number and location within room.

(2) DDC Hardware unique identifiers and common descriptive names.

(3) All Network hardware with room number and location within room.

(4) Network hardware unique identifiers.

(5) All cabling.

(6) Room number and location within room of all cabling termination points.

(7) Room number and location within room of all network interface jacks.

k. A single riser diagram shall be submitted for each building.

l. Control System Schematics: The control system schematics shall be in the same form as the control system schematic Contract Drawing with Contractor updated information. A control system schematic shall be submitted for each HVAC system.

****
NOTE: Require Control Logic Diagrams if they have been included in the contract drawings.
****

m. Sequences of Operation[including Control Logic Diagrams]: The HVAC control system sequence of operation and [control logic diagrams] shall be in the same format as the Contract Drawings and shall refer to the devices by their unique identifiers. No operational deviations from specified sequences will be permitted without prior written approval of the Government. Sequences of operation[and control logic diagrams] shall be submitted for each HVAC control system.

n. Controller, Motor Starter and Relay Wiring Diagram: The controller wiring diagrams shall be functional wiring diagrams which show the interconnection of conductors and cables to each controller and to the identified terminals of input and output devices, starters and package equipment. The wiring diagrams shall show necessary jumpers and ground connections. The wiring diagrams shall show the labels of all conductors. Sources of power required for control systems and for packaged equipment control systems shall be identified back to the panel board circuit breaker number, controller enclosures, magnetic starter, or packaged equipment control circuit. Each power supply and transformer not integral to a controller, starter, or packaged equipment shall be shown. The connected volt-ampere load and the power supply volt-ampere rating shall be shown. Wiring diagrams shall be submitted for each HVAC control system.

3.3.3 Draft As-Built Drawings

The Contractor shall update the Contractor Design Drawings with all as-built data and submit as specified.

3.3.4 Final As-Built Drawings

The Contractor shall update the Draft As-Built Drawings with all final as-built data and submit as specified.

3.4 HVAC SYSTEMS SEQUENCES OF OPERATION

****
NOTE: These sequences are 'template' sequences. When editing this specification, the sequences should be put onto the drawings and these template sequences should be deleted. Note that the Alarm Handling and Scheduling sequences each need to be edited and placed onto their own drawing.

When removing the sequences, keep this subpart number and title intact, but replace the entire contents of the subpart with a note such as *"All Sequences of Operation are located on drawings"*.
****

3.4.1 Alarm Handling

****
NOTE: Alarm handling is generally performed by the Monitoring and Control (M&C) software (Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS)). The alarm handling described here is for redundant notification of critical alarms. These are alarms which must be received even if the UMCS/front-end is not functioning/present.

Choose the required functionality for the alarm handling notification and indicate alarms which are critical/require a redundant notification and the notification requirements on the Critical Alarm Schedule.

Selection of notification methods other than a. below may require a more complicated/expensive/sophisticated device. Note that option c. is most useful if the IP network connected to the Alarm Handler is different than the UMCS IP network (so that there is no single point of failure for both UMCS alarm handling and this device).
****

The Contractor shall install and configure DDC Hardware to provide alarm handling functionality for critical alarms as specified and shown, either in a piece of DDC Hardware dedicated to this function or in DDC Hardware performing other functions. The DDC Hardware providing alarm handling functionality shall provide the following capabilities as required:

a. Dial to a pager: The node shall be able to dial a paging service and leave a numeric message.

[b. Dial to an e-mail server: The node shall be able to dial and connect to a remote server and send an e-mail via Simple Mail Transfer Protocol (SMTP).]

[c. Send e-mail over IP Network: The alarm handling node shall be capable of connecting to an IP network and sending e-mail via Simple Mail Transfer Protocol (SMTP).]

[d. Provide network access: The node shall be capable of receiving a connection via the modem to allow a remote computer access to the control network.]

3.4.2 Scheduling

****
NOTE: FYI: Scheduling is normally performed by the Monitoring and Control (M&C) software (Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS)). The UMCS (Section 25 10 10) Contractor will set this up. In the absence of a UMCS or if communication with the UMCS is lost, a default schedule will be active.

The M&C software will have capabilities to perform scheduling according to day of week, holidays, etc and will have the capability to override system occupancy modes based on demand limiting programs or operator overrides.
****

3.4.2.1 System Mode

AHUs shall operate in Occupied, Warm-Up-Cool-Down, or Unoccupied modes as specified. VAV boxes, Fan Coils, and other terminal equipment shall operate in Occupied or Unoccupied modes as specified. Chillers, boilers, and other sources of heating/cooling for hydronic loads do not require scheduling; these systems receive requests for heating/cooling from their loads.

3.4.2.2 System Scheduler Requirements

****
NOTE: Indicate if a common schedule may be used for multiple Terminal Units (TUs). If allowing a common schedule for multiple TUs: keep the 'group of' bracketed text, and decide if TU groupings will be included on the drawings (keep the 'as shown' bracketed text) or if the Contractor should decide on groupings (remove the 'as shown' bracketed text).
****

The System Scheduler functionality shall reside in either a piece of DDC Hardware dedicated to this functionality or in the DDC Hardware controlling the system AHU. A single piece of DDC Hardware may contain multiple System Schedulers. A unique System Scheduler shall be provided for: each AHU including it's associated Terminal Units, and each stand-alone Terminal Unit (those not dependent upon AHU service)[or group of stand-alone Terminal Units acting according to a common schedule]. Each System Scheduler shall provide the following functionality:

a. Scheduled Occupancy Input: Accept network variable of type SNVT_occupancy (as defined in the LonMark SNVT List). Input shall support the following possible values: OC_STANDBY, OC_OCCUPIED and OC_UNOCCUPIED.

b. Occupancy Override Input: Accept network variable of type SNVT_occupancy (as defined in the LonMark SNVT List). Input shall

support the following possible values: OC_STANDBY, OC_OCCUPIED, OC_UNOCCUPIED, and OC_NUL.

c. Space Occupancy Inputs: For systems with multiple occupancy sensors, accept multiple inputs of network variable type SNVT_Occupancy (as defined in the LonMark SNVT List). Input shall support the following possible values: OC_OCCUPIED, OC_UNOCCUPIED, and OC_NUL. For systems with a single occupancy sensor, accept a network variable input of type SNVT_Occupancy or a hardware binary input (BI) indicating the space occupancy status as Occupied or Unoccupied.

d. Air Handler Occupancy Output: For a System Scheduler for a system containing an air handler, output one or more SNVTs indicating the desired occupancy status as one of the following possible values: Warm-Up-Cool-Down (when required by the AHU Sequence of Operation), Occupied and Unoccupied.

e. Terminal Unit Occupancy Output: For a System Scheduler for a stand-alone terminal unit, [a group of stand-alone terminal units acting according to a common schedule,] or a group of terminal units served by a single air handler, output one or more SNVTs indicating the desired occupancy status as one of the following possible values: Occupied and Unoccupied.

****
NOTE: Designer must provide the default (backup) 24-hour 7-day schedule on the Points Schedule (i.e. Occupied from 6AM - 10PM Monday through Friday, Unoccupied Saturday and Sunday).
****

f. Default Schedule: Incorporate a 24-hour 7-day default schedule as shown on the drawings which may be activated and deactivated by the System Scheduler Logic.

g. Communication Determination: Determine the time elapsed between receipts of the scheduled occupancy input SNVT, and use this elapsed time to activate and deactivate the Default Schedule as specified. (This provides the capability for the system scheduler to use its Default Schedule if it loses communication with the UMCS).

3.4.2.3 System Scheduler Output Determination

a. Air Handler Occupancy Output: If more than 95 minutes have passed since the last receipt of the Scheduled Occupancy input, the Air Handler Occupancy Output shall be determined by the default schedule and the Space Occupancy Inputs. Otherwise, the output shall be determined as follows:

(1) If the Override Occupancy Input is not OC_NUL, the Air Handler Occupancy Output shall determined as follows:

(a) The output shall be Occupied when the Override OccupancyInput is OC_OCCUPIED.

(b) The output shall be Unoccupied when the Override OccupancyInput is OC_UNOCCUPIED.

(c) If the system Sequence Of Operation specifies

Warm-Up-Cool-Down mode, the output shall be Warm-Up-Cool-Down when the Override Occupancy Input is OC_STANDBY.

(2) If the Override Occupancy Input is OC_NUL and the Schedule Occupancy input is OC_OCCUPIED, the Air Handler and Stand-Alone Terminal Unit Occupancy Output shall be OC_OCCUPIED.

(3) If the Override Occupancy Input is OC_NUL, the Schedule Occupancy input is not OC_OCCUPIED, and less than required number of Space Occupancy Inputs (as shown on the Occupancy Schedule Drawing) are OC_OCCUPIED (or the hardware BI is Unoccupied), the Air Handler Occupancy Output shall be determined by the Scheduled Occupancy Input

(a) The output shall be Occupied when the Scheduled Occupancy Input is OC_OCCUPIED.

(b) The output shall be Unoccupied when the Scheduled Occupancy Input is OC_UNOCCUPIED.

(c) If the system Sequence Of Operation specifies Warm-Up-Cool-Down mode the output shall be Warm-Up-Cool-Down when the Scheduled Occupancy Input is OC_STANDBY.

(4) If the Override Occupancy Input is OC_NUL and at least the required number (as shown on the Occupancy Schedule Drawing) of Space Occupancy Inputs are OC_OCCUPIED (or the hardware BI is Occupied), the Air Handler Occupancy Output shall be Occupied.

b. Terminal Unit Occupancy Output: If more than 95 minutes have passed since the last receipt of the Scheduled Occupancy input, the Terminal Unit Occupancy Output shall be determined by the default schedule. Otherwise, the output shall be determined as follows:

(1) If the Override Occupancy Input is not OC_NUL, the Terminal Unit Occupancy Output shall be determined as follows:

(a) The output shall be Occupied when the Override Occupancy Input is OC_OCCUPIED or OC_STANDBY (to allow AHU-dependent Terminal Units to operate in Occupied mode when their associated AHU is in Warm-Up-Cool-Down.

(b) The output shall be Unoccupied when the Override Occupancy Input is OC_UNOCCUPIED.

(2) If the Override Occupancy Input is OC_NUL, the AHU-Dependent Terminal Unit Occupancy Output shall determined as follows:

(a) The output shall be Occupied when the Scheduled Occupancy Input is OC_OCCUPIED or OC_STANDBY (to allow AHU-dependent Terminal Units to operate in Occupied mode when their associated AHU is in Warm-Up-Cool-Down.

(b) The output shall be Unoccupied when the Scheduled Occupancy Input is OC_UNOCCUPIED.

3.4.2.4 Air Handler System Scheduling

The AHU Occupancy Output SNVT shall be bound from the System Scheduler to

the DDC Hardware that executes the Occupancy Mode Determination part of the Air Handler Sequence of Operation.

For Air Handlers using occupancy sensors, the occupancy sensor output SNVT (of type SNVT_Occupancy) shall be bound to a Space Occupancy Input of the System Scheduler.

The Terminal Unit Occupancy Output SNVT shall be bound from the System Scheduler to each AHU-Dependent Terminal Unit.

AHU-Dependent Terminal Units with occupancy sensors shall have their Effective Occupancy SNVT (of type SNVT_Occupancy) bound to a Space Occupancy Input of the System Scheduler.

3.4.2.5 Stand-Alone Terminal Unit Scheduling

The Terminal Unit Occupancy Output shall be bound from the System Scheduler to the DDC Hardware that executes the Occupancy Mode Determination part of the Terminal Unit Sequence of Operation.

3.4.3 Sequences of Operation for Air Handling Units

****
NOTE:
1) The following sequences, with few exceptions, assume the use of a System Scheduler and space occupancy input(s) to switch between occupied and unoccupied mode setpoints.

2) Show occupied and unoccupied mode setpoints on the Points Schedule. A configured setpoint is operator adjustable over the control network, but resides in the local DDC Hardware. In these sequences it serves as the default occupied mode setpoint and (at a separate setting/value) as an unoccupied mode 'setback' setpoint.

3) Space occupancy input(s) may consist of an occupancy sensor and/or a local push-button. Indicate the use of a sensor and/or push-button by placing an 'X' in the 'Thermostat and Occupancy Sensor Schedule'. If a push-button is used, show the override time duration in the Schedule. The occupancy sensor specification requires a 15 minute off-mode delay prior to leaving the occupied mode. If a different time is desired, show it in the thermostat schedule and ensure that it is consistent with the Occupancy Sensor Product specification.

4) Occupancy sensor location is left up to the Contractor. If ceiling mount sensors are preferred, edit the sequences and/or indicate in the Thermostat and Occupancy Sensor Schedule.

5) For each unit, as applicable, indicate if the zone temperature setpoint will be occupant adjustable by placing an 'X' in the 'Thermostat and Occupancy Sensor Schedule'. For non-occupant-adjustable setpoints, show the setpoint

in the Points Schedule. The intent is that the Contractor provides one or the other as shown. Non-occupant-adjustable setpoints are adjustable by a system operator using a local display panel (LDP) or an operator workstation (and appropriate software).
****

3.4.3.1 All-Air Small Package Unitary System

****
NOTE: For heating-only or cooling-only systems, edit the sequence as required. Where applicable, select 'Emerg Heat' for heat pump systems.
****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. Fan ON-AUTO Switch

(1) ON: With the thermostat fan ON-AUTO switch in the ON position, the DDC Hardware shall start the fan and it shall run continuously.

(2) AUTO: With the thermostat fan ON-AUTO switch in the AUTO position, the DDC Hardware operates the fan according to HEAT-OFF-COOL[-EMERG HEAT] switch.

b. HEAT-OFF-COOL[-EMERG HEAT] Switch

(1) HEAT-COOL[-EMERG HEAT]: With the thermostat switch in the HEAT or COOL [or EMERG HEAT] positions, the DDC Hardware shall operate the package unit according to the Occupancy Mode.

(2) OFF: With the thermostat switch in the OFF position, the DDC Hardware shall de-energize the heating unit and cooling unit [and emergency supplemental heat].

c. Occupancy Modes

(1) Occupied: The unit DDC Hardware shall be in the Occupied Mode when the local space occupancy input(s) indicate that the space is occupied or when the input from the System Scheduler is occupied.

(2) Unoccupied: The unit DDC Hardware shall be in the Unoccupied Mode when the local space occupancy input(s) indicate that the space is unoccupied and when the input from the System Scheduler is unoccupied.

d. Safeties: The unit shall run subject to the unit manufacturer's safeties.

e. Zone Temperature Control

(1) In the Occupied Mode the zone temperature setpoint (ZN-T-SP) shall be at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.

(2) In the Unoccupied Mode the zone temperature setpoint (ZN-T-SP) shall be at the configured setpoint (ZN-T-SP) as shown.

(3) The DDC Hardware shall cycle the fan, cooling unit, heating unit[, and emergency supplemental heat], in accordance with the HEAT-COOL[-EMERG HEAT] switch setting, to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP).

3.4.3.2 Heating and Ventilating Unit (or Unit Ventilator)

****

NOTE:

1) A special interlock control sequence for each fan system will be developed by the designer if required.

2) This system has a single outside air duct. Select either 2-position outside air dampers or modulating dampers.

3)Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from two different spaces are required to help avoid needless turning on of the system (due to cleaning staff or security staff passing through after hours).

4) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule as required.

5) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be performed from a workstation (via SNVT) or local display panel (LDP). It is recommended that you coordinate the decision with the local O&M staff. Edit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

6) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

7) Smoke control is not addressed in this guide specification. Smoke control sequence of operation

for each fan system, if beyond the requirements described, will be developed by the designer, based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.
****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. HAND-OFF-AUTO switches: Supply fan motor starter shall accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches and shall start the fan. The fan motor starter shall accept an occupant accessible emergency shutoff switch as shown. The supply fan motor starter shall have an H-O-A switch:

(1) HAND: With the H-O-A switch in HAND position, the supply fan shall start and run continuously, subject to Safeties.

(2) OFF: With the H-O-A switch in OFF position, the supply fan shall stop.

(3) AUTO: With the H-O-A switch in AUTO position, the supply fan shall run subject to the Supply Fan Start/Stop (SF-SS) command and Safeties.

b. Occupancy Modes: The system shall obtain its Occupancy Mode input from the System Scheduler as specified and shown. The system shall operate in one of the following modes:

(1) Occupied: The Unit's DDC Hardware shall be in the Occupied Mode when the input from the System Scheduler (SYS-OCC) is occupied [or when the local space occupancy input(s) (ZN-OCC) indicate that the space is occupied].

(2) Unoccupied: The Unit's DDC Hardware shall be in the Unoccupied Mode when the input from the System Scheduler (SYS-OCC) is unoccupied [and when the local space occupancy input(s) (ZN-OCC) indicate that the space is unoccupied].

[(3) Warm Up/Cool Down: The Unit's DDC Hardware shall be in the Warm Up/Cool Down Mode based on input from the System Scheduler.]

c. System Enable and Loop Enable

****

NOTE: Select Mixed Air Damper Control for systems with 2-position dampers.
****

(1) Occupied mode: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS). The Zone Temperature Control loop [and Mixed Air Damper Control]shall be enabled.

(2) Unoccupied mode: All control loops shall be disabled. When BLDG-T drops below BLDG-T-LL-SP (with a 3 degrees C 5 degrees F deadband) the supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS) and the Zone Temperature Control loop shall be enabled.

[(3) Warm Up/Cool Down: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS). The Zone Temperature Control loop [and Mixed Air Damper Control]shall be enabled.]

d. Proofs and Safeties

(1) The supply fan and all DDC Hardware control loops shall be subject to Proofs and Safeties. Safeties shall be direct-hardwire interlocked to the fan starter circuit as shown. DDC Hardware shall monitor all proofs and safeties and failure of any proof or activation of any safety shall result in all control loops being disabled and the AHU fan being commanded off until reset.

(2) Proofs: Supply fan status (proof) (SF-S)

(3) Safeties:

(a) Heating Coil discharge air temperature low limit (freeze stat) (HTG-DA-T-LL)

(b) Supply air smoke (SA-SMK)

[(c) Return air smoke (RA-SMK)]

(4) DDC Hardware reset of all proofs and safeties shall be via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

****
NOTE: If the system has modulating dampers, select bracketed damper text in Zone Temperature Control paragraph. Otherwise, select Mixed Air Damper Control.
****

e. Zone Temperature Control

(1) When this loop is enabled, the DDC Hardware shall modulate the heating valve [and outside air, relief, and return air dampers in sequence] to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP). [Sequencing shall be as shown: Upon a rise in zone temperature above zone temperature setpoint (ZN-T-SP), subject to

the zone temperature setpoint deadband as shown, the outside air, relief, and return air dampers shall modulate to maintain zone temperature at setpoint. During occupied mode, outside air damper minimum position (OA-D-MIN) shall be as shown.] Upon a fall in zone temperature below zone temperature setpoint, subject to the deadband as shown, the heating valve shall modulate towards open to maintain zone temperature setpoint.

(2) When this loop is disabled, the heating valve shall be closed [and the outside air damper and relief damper shall be closed and the return damper shall be open].

[f. Mixed Air Damper Control: When this is enabled, the outside air and relief air dampers shall be open and the return air damper shall be closed. When this is disabled, the outside air and relief air dampers shall be closed and the return air damper shall be open.]

3.4.3.3 Single Zone with Heating and [DX][Cooling] Coils

****

NOTE:
1) Edit the sequence and drawings as necessary for systems with/without a preheat coil, economizer, and other project specific control loop requirements.

2) Minimum outside air flow control can be accomplished several different ways. Refer to the UFC, but don't use flow measurement in a constant volume system.

3) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule and Control Schematic as required.

4) Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from two different spaces are required to help avoid needless turning on of the system (due to cleaning staff or security staff passing through after hours).

5) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be performed from a workstation (via SNVT) or local display panel (LDP). It is recommended that you coordinate the decision with the local O&M staff. EEdit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

6) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

7) Smoke control is not addressed in this guide specification. Smoke control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer, based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.

****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. HAND-OFF-AUTO switch: Supply fan motor starter shall accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches and shall start the fan. The fan motor starter shall accept an occupant accessible emergency shutoff switch as shown. The supply fan motor starter shall have an H-O-A switch:

   (1) HAND: With the H-O-A switch in HAND position, the supply fan shall start and run continuously, subject to Safeties.

   (2) OFF: With the H-O-A switch in OFF position, the supply fan shall stop.

   (3) AUTO: With the H-O-A switch in AUTO position, the supply fan shall run subject to the Supply Fan Start/Stop (SF-SS) command and Safeties.

b. Occupancy Modes: The system shall obtain its Occupancy Mode input from the System Scheduler as specified and shown. The system shall operate in one of the following modes: Occupied, Unoccupied[, or WarmUp/CoolDown].

c. System Enable and Loop Enable:

   (1) Occupied Mode: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS) and all control loops shall be enabled.

(2) Unoccupied mode: While the building temperature (BLDG-T) is above setpoint (BLDG-T-LL-SP) all control loops shall be disabled and the supply fan shall not run. When BLDG-T drops below BLDG-T-LL-SP (with a 3 degrees C 5 degrees F deadband) the supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS) and the Heating Coil Temperature Control loop shall be enabled. The Outside Air Flow Control, Economizer Damper Control, and [DX] Cooling Coil Control loops shall be disabled.

[(3) Warm Up / Cool Down Mode: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS) and the Minimum Outside Air Flow Control loop shall be disabled. All other control loops shall be enabled.]

d. Proofs and Safeties:

(1) The supply fan and all DDC Hardware control loops shall be subject to Proofs and Safeties. Safeties shall be direct-hardwire interlocked to the fan starter circuit as shown. DDC Hardware shall monitor all proofs and safeties and failure of any proof or activation of any safety shall result in all control loops being disabled and the AHU fan being commanded off until reset.

(2) Proofs:
(a) Supply fan status (proof) (SF-S)

(3) Safeties:

(a) Heating coil discharge air temperature low limit (freeze stat) (HTG-DA-T-LL)

(b) Supply air smoke (SA-SMK)

(c) Return air smoke (RA-SMK)

(4) DDC Hardware reset of all proofs and safeties shall be via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

e. Minimum Outside Air Flow Control: When this loop is enabled the DDC Hardware shall open the 2-position minimum outside air damper to introduce the minimum outside air flow quantity as shown. When this loop is disabled, the minimum outside air damper shall be closed.

f. Economizer Damper Control:

(1) When this loop is enabled, and the Economizer is ON as determined by the Economizer Enable Logic, the DDC Hardware shall modulate the economizer outside air, relief, and return air dampers (Economizer dampers) in sequence with the [DX] cooling coil control and heating coil control valve as shown to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown.

(2) When this loop is disabled, or the Economizer is OFF as determined by the Economizer Enable Logic, the economizer outside air and relief air dampers shall be closed, and the return air

damper shall be open.

(3) Economizer Enable Logic. The economizer shall be ON when the outside air dry bulb temperature is between the high limit (ECO-HL-SP) and low limit (ECO-LL-SP) setpoints as shown. The Economizer shall otherwise be OFF. ECO-HL-SP and ECO-LL-SP shall each have a 1 degree C 2 degrees F deadband.

g. Heating Coil Control: When this loop is enabled the DDC Hardware shall modulate the heating coil control valve in sequence with the cooling coil valve and economizer dampers as shown to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown. When this loop is disabled, the heating coil control valve shall be closed.

h. [DX] Cooling Coil Control: When this loop is enabled the DDC Hardware shall [stage the DX Unit] [modulate the cooling coil control valve] in sequence with the heating coil valve and economizer dampers as shown to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown. When this loop is disabled, the [DX unit shall be off] [cooling coil control valve shall be closed].

3.4.3.4 Single Zone with Dual-Temperature Coil

****

NOTE:
1) Edit the sequence and drawings as necessary for systems with/without a preheat coil, economizer, and other project specific control loop requirements.

2) Minimum outside air flow control can be accomplished several different ways. Refer to the UFC, but don't use flow measurement in a constant volume system.

3) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule and Control Schematic as required.

4) Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from two different spaces are required to help avoid needless turning on of the system (due to cleaning staff or security staff passing through after hours).

5) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be performed from a workstation (via SNVT) or local display panel (LDP). It is recommended that you

coordinate the decision with the local O&M staff. Edit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

6) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

7) Smoke control is not addressed in this guide specification. Smoke control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer, based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.

****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. HAND-OFF-AUTO switch: Supply fan motor starter shall accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches and shall start the fan. The fan motor starter shall accept an occupant accessible emergency shutoff switch as shown. The supply fan motor starter shall have an H-O-A switch:

   (1) HAND: With the H-O-A switch in HAND position, the supply fan shall start and run continuously, subject to Safeties.

   (2) OFF: With the H-O-A switch in OFF position, the supply fan shall stop.

   (3) AUTO: With the H-O-A switch in AUTO position, the supply fan shall run subject to the Supply Fan Start/Stop (SF-SS) command and Safeties.

b. Occupancy Modes: The system shall obtain its Occupancy Mode input from the System Scheduler as specified and shown. The system shall operate in one of the following modes: Occupied, Unoccupied[, or WarmUp/CoolDown].

c. System Enable and Loop Enable:

(1) Occupied Mode: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS) and all control loops shall be enabled.

(2) Unoccupied mode: While the building temperature (BLDG-T) is above setpoint (BLDG-T-LL-SP) all control loops shall be disabled and the supply fan shall not run. When BLDG-T drops below BLDG-T-LL-SP (with a 3 degrees C 5 degrees F deadband) the supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS) and the Dual Temperature Coil Temperature Control loop shall be enabled. The Minimum Outside Air Flow Control, and Economizer Damper Control loops shall be disabled.

[(3) Warm Up / Cool Down Mode: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS). The Minimum Outside Air Flow Control loop shall be disabled and all other control loops enabled.]

d. Proofs and Safeties:

(1) The supply fan and all DDC Hardware control loops shall be subject to Proofs and Safeties. Safeties shall be direct-hardwire interlocked to the fan starter circuit as shown. DDC Hardware shall monitor all proofs and safeties and failure of any proof or activation of any safety shall result in all control loops being disabled and the AHU fan being commanded off until reset.

(2) Proofs: Supply fan status (proof) (SF-S)

(3) Safeties:

(a) Dual Temperature coil discharge air temperature low limit (freeze stat) (DT-DA-T-LL)

(b) Supply air smoke (SA-SMK)

(c) Return air smoke (RA-SMK)

(4) DDC Hardware reset of all proofs and safeties shall be via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

e. Minimum Outside Air Flow Control: When this loop is enabled the DDC Hardware shall open the 2-position minimum outside air damper to introduce the minimum outside air flow quantity as shown. When this loop is disabled, the minimum outside air damper shall be closed.

f. Economizer Damper Control:

(1) When this loop is enabled, and the Economizer is ON as determined by the Economizer Enable Logic, the DDC Hardware shall modulate the economizer outside air, relief, and return air dampers (Economizer dampers) to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown.

(2) When this loop is disabled, or the Economizer is OFF as

determined by the Economizer Enable Logic, the economizer outside air and relief air dampers shall be closed, and the return air damper shall be open.

(3) Economizer Enable Logic. The economizer shall be ON when the outside air dry bulb temperature is between the high limit (ECO-HL-SP) and low limit (ECO-LL-SP) setpoints as shown. The Economizer shall otherwise be OFF. ECO-HL-SP and ECO-LL-SP shall each have a 1 degree C 2 degrees F deadband.

g. Dual Temperature Coil Control:

(1) When this loop is enabled, the DDC Hardware shall select heating or cooling mode based on a pipe-mounted dual-temperature supply water sensor. A single sensor may be used for multiple instances of this sequence.

(2) The DDC Hardware shall modulate the coil control valve in sequence with the economizer dampers as shown to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown.

(3) When this loop is disabled, the control valve shall be closed.

3.4.3.5 Single Zone with Heating and Cooling Coils and Return Air Bypass

****

NOTE:
1) Edit the sequence and drawings as necessary for systems with/without a preheat coil, economizer, and other project specific control loop requirements.

2) Coordinate the enable/disable of the cooling coil 2-position valve with the chilled water source. If it is from a local chiller define and share the enabling signal that turns on the chiller and opens the 2-position valve. Do not use a DX unit in place of the chilled water cooling coil.

3) Minimum outside air flow control can be accomplished several different ways. Refer to the UFC, but don't use flow measurement in a constant volume system.

4) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule and Control Schematic as required.

5) Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from two different spaces are required to help avoid needless turning on of the system (due to cleaning staff or

security staff passing through after hours).

6) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be performed from a workstation (via SNVT) or local display panel (LDP). It is recommended that you coordinate the decision with the local O&M staff. Edit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

7) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

8) Smoke control is not addressed in this guide specification. Smoke control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer, based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.
****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. HAND-OFF-AUTO switch: Supply fan motor starter shall accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches and shall start the fan. The fan motor starter shall accept an occupant accessible emergency shutoff switch as shown. The supply fan motor starter shall have an H-O-A switch:

(1) HAND: With the H-O-A switch in HAND position, the supply fan shall start and run continuously, subject to Safeties.

(2) OFF: With the H-O-A switch in OFF position, the supply fan shall stop.

(3) AUTO: With the H-O-A switch in AUTO position, the supply fan

shall run subject to the Supply Fan Start/Stop (SF-SS) command and Safeties.

b. Occupancy Modes: The system shall obtain its Occupancy Mode input from the System Scheduler as specified and shown. The system shall operate in one of the following modes: Occupied, Unoccupied[, or WarmUp/CoolDown].

c. System Enable and Loop Enable:

(1) Occupied Mode: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS) and all control loops shall be enabled.

(2) Unoccupied mode: While the building temperature (BLDG-T) is above setpoint (BLDG-T-LL-SP) all control loops shall be disabled and the supply fan shall not run. When BLDG-T drops below BLDG-T-LL-SP (with a 3 degrees C 5 degrees F deadband) the supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS) and the Heating Coil Temperature Control loop shall be enabled. All other control loops shall be disabled.

[(3) Warm Up / Cool Down Mode: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS). The Minimum Outside Air Flow Control loop shall be disabled and all other control loops shall be enabled.]

d. Proofs and Safeties:

(1) The supply fan and all DDC Hardware control loops shall be subject to Proofs and Safeties. Safeties shall be direct-hardwire interlocked to the fan starter circuit as shown. DDC Hardware shall monitor all proofs and safeties and failure of any proof or activation of any safety shall result in all control loops being disabled and the AHU fan being commanded off until reset.

(2) Proofs: Supply fan status (proof) (SF-S)

(3) Safeties:

(a) Heating coil discharge air temperature low limit (freezestat) (HTG-DA-T-LL)

(b) Supply air smoke (SA-SMK)

(c) Return air smoke (RA-SMK)

(4) DDC Hardware reset of all proofs and safeties shall be via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

e. Minimum Outside Air Flow Control: When this loop is enabled the DDC Hardware shall open the 2-position minimum outside air damper to introduce the minimum outside air flow quantity as shown. When this loop is disabled, the minimum outside air damper shall be closed.

f. Economizer Damper Control:

(1) When this loop is enabled, and the Economizer is ON as determined by the Economizer Enable Logic, the DDC Hardware shall modulate the economizer outside air, return air, [and relief air dampers] (Economizer dampers) in sequence with the bypass and supply dampers and the heating coil control valve as shown to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown.

(2) When this loop is disabled, or the Economizer is OFF as determined by the Economizer Enable Logic, the economizer outside air and relief air dampers shall be closed, and the return air damper shall be open.

(3) Economizer Enable Logic. The economizer shall be ON when the outside air dry bulb temperature is between the high limit (ECO-HL-SP) and low limit (ECO-LL-SP) setpoints as shown. The Economizer shall otherwise be OFF. ECO-HL-SP and ECO-LL-SP shall each have a 1 degree C 2 degrees F deadband.

g. Heating Coil Control: When this loop is enabled the DDC Hardware shall modulate the heating coil control valve in sequence with the bypass and supply dampers and the economizer dampers as shown to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown. When this loop is disabled, the heating coil control valve shall be closed.

h. Cooling Coil Control: When this loop is enabled the DDC Hardware shall open the 2-position cooling coil control valve. When this loop is disabled, the 2-position cooling coil control valve shall be closed.

i. Bypass and Supply Air Damper Control: When this loop is enabled the DDC Hardware shall modulate the bypass and supply air dampers in sequence with the heating coil control valve and the Economizer dampers as shown to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown. When this loop is disabled the bypass damper shall be closed and supply air damper open.

3.4.3.6 Single Zone with Humidity Control

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NOTE:
1) Edit the sequence and drawings as necessary for systems with/without a preheat coil and other project specific control loop requirements.

2) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule and Control Schematic as required.

3) Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from 2 different spaces are required to help avoid needless

turning on of the system (due to cleaning staff or security staff passing through after hours).

3) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be performed from a workstation (via SNVT) or local display panel (LDP). It is recommended that you coordinate the decision with the local O&M staff. Edit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

4) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

5) Smoke control is not addressed in this guide specification. Smoke control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer, based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.
****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a . HAND-OFF-AUTO switch: Supply fan motor starter shall accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches and shall start the fan. The fan motor starter shall accept an occupant accessible emergency shutoff switch as shown. The supply fan motor starter shall have an H-O-A switch:

(1) HAND: With the H-O-A switch in HAND position, the supply fan shall start and run continuously, subject to Safeties.

(2) OFF: With the H-O-A switch in OFF position, the supply fan shall stop.

(3) AUTO: With the H-O-A switch in AUTO position, the supply fan shall run subject to the Supply Fan Start/Stop (SF-SS)command and Safeties.

b. Occupancy Modes: The system shall obtain its Occupancy Mode input from the System Scheduler as specified and shown. The system shall operate in one of the following modes: Occupied, Unoccupied[, or WarmUp/CoolDown].

c. System Enable and Loop Enable:

(1) O ccupied Mode: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS) and all control loops shall be enabled.

(2) Unoccupied mode: While the building temperature (BLDG-T) is above setpoint (BLDG-T-LL-SP) all control loops shall be disabled and the supply fan shall not run. When BLDG-T drops below BLDG-T-LL-SP (with a 3 degrees C 5 degrees F deadband) the supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS), the Preheat Coil Control loop and Reheat Coil Control loop shall be enabled and all other loops shall be disabled.

[(3) Warm Up / Cool Down Mode: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS). The Minimum Outside Air Flow Control loop shall be disabled and all other control loops shall be enabled.]

d. Proofs and Safeties

(1) The supply fan and all DDC Hardware control loops shall be subject to Proofs and Safeties. Safeties shall be direct-hardwire interlocked to the fan starter circuit as shown. DDC Hardware shall monitor all proofs and safeties and failure of any proof or activation of any safety shall result in all control loops being disabled and the AHU fan being commanded off until reset.

(2) Proofs: Supply fan status (proof) (SF-S)

(3) Safeties:

(a) Preheat coil discharge air temperature low limit (freezestat) (PH-DA-T-LL)

(b) Supply air smoke (SA-SMK)

(c) Return air smoke (RA-SMK)

(4) DDC Hardware reset of all proofs and safeties shall be via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

e. Minimum Outside Air Flow Control: When this loop is enabled the DDC Hardware shall open the 2-position minimum outside air damper to introduce the minimum outside air flow quantity as shown. When this loop is disabled, the minimum outside air damper shall be closed.

f. Preheat Coil Control Loop: When this loop is enabled the DDC Hardware shall modulate the preheat coil valve to maintain the preheat coil discharge air temperature (PH-T) at setpoint (PH-T-SP) as shown. When this loop is disabled, the preheat coil valve shall be closed.

g. Cooling-and-Dehumidification Coil Control: When this loop is enabled the DDC Hardware shall modulate the cooling and dehumidification valve to maintain either the zone temperature (ZN-T) at setpoint (ZN-T-SP) or zone relative humidity (ZN-RH) at setpoint (ZN-RH-SP), whichever calls for more chilled water flow. The valve shall be modulated in sequence with the reheat valve and humidification valve as shown to avoid simultaneous cooling and reheating, and simultaneous dehumidification and humidification. When this loop is disabled, the coil valve shall be closed.

h. Reheat Coil Control: When this loop is enabled the DDC Hardware shall modulate the reheat coil valve to maintain the zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown. The valve shall be modulated in sequence with the cooling-and-dehumidification valve as shown to avoid simultaneous cooling and reheating. When this loop is disabled, the coil valve shall be closed.

i. Humidification Control: When this loop is enabled the DDC Hardware shall modulate the humidifier valve to maintain zone relative humidity (ZN-RH) at setpoint (ZN-RH-SP). The valve shall be modulated in sequence with the cooling-and-dehumidification valve as shown to avoid simultaneous dehumidification and humidification. When the supply air duct humidity (SA-RH) rises above 80% relative humidity, the humidifier valve shall begin to modulate towards closed and shall, under proportional control, continue to gradually move towards closed until the supply air duct humidity reaches 90% relative humidity, at which point the humidifier valve shall be fully closed. When this loop is disabled, the humidifier valve shall be closed.

3.4.3.7 Multizone [Dual-Duct] [with][without] Return Fan

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NOTE:

1) The sequence is identical for a Dual-Duct system. You need only change hot/cold deck to hot/cold duct.

2) Edit the sequence and drawings as necessary for systems with/without a return fan, preheat coil, economizer, and other project specific control loop requirements.

3) Choose whether or not to require setpoint reset of the hot deck temperature setpoint, and whether the reset should be based on Outside Air Temperature or Coldest Zone Temperature. Edit the control schematic drawing to show the reset parameters.

4) Minimum outside air flow control can be accomplished several different ways. Refer to the UFC, but don't use flow measurement in a constant volume system.

5) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule and Control Schematic as required.

6) Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from 2 different spaces are required to help avoid needless turning on of the system (due to cleaning staff or security staff passing through after hours).

7) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be performed from a workstation (via SNVT) or local display panel (LDP). It is recommended that you coordinate the decision with the local O&M staff. Edit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

8) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

9) Smoke control is not addressed in this guide specification. Smoke control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer, based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.

****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on

the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. HAND-OFF-AUTO switches:
Supply fan motor starter shall accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches and shall start the fan. The fan motor starter shall accept an occupant accessible emergency shutoff switch as shown. The supply fan motor starter shall have an H-O-A switch:

(1) HAND: With the H-O-A switch in HAND position, the supply fan shall start and run continuously, subject to Safeties.

(2) OFF: With the H-O-A switch in OFF position, the supply fan shall stop.

(3) AUTO: With the H-O-A switch in AUTO position, the supply fan shall ru n subject to the Supply Fan Start/Stop (SF-SS)command and Safeties.

[Return fan motor starter shall accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches shall start the fan. The return fan motor starter shall have an H-O-A switch:

(1) HAND: With the H-O-A switch in HAND position, the return fan shall run subject to Safeties.

(2) OFF: With the H-O-A switch in OFF position, the return fan shall be off.

(3) AUTO: With the H-O-A switch in AUTO position, the return fan shall run subject to the supply fan running.]

b. Occupancy Modes: The system shall obtain its Occupancy Mode input from the System Scheduler as specified and shown. The system shall operate in one of the following modes: Occupied, Unoccupied[, or WarmUp/CoolDown].

c. System Enable and Loop Enable:

(1) Occupied Mode: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS). All control loops shall be enabled. The Zone Temperature Control loops serviced by the AHU shall also be enabled.

(2) Unoccupied mode: While the building temperature (BLDG-T) is above setpoint (BLDG-T-LL-SP) all control loops shall be disabled and the supply fan shall not run. When BLDG-T drops below BLDG-T-LL-SP (with a 3 degrees C 5 degrees F deadband) the supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS), the Hot Deck Coil Control loop and all Zone Temperature Control loops shall be enabled, and all other control loops shall be disabled.

[(3) Warm Up / Cool Down Mode: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS). The Minimum Outside Air Flow Control loop shall be disabled and all control loops shall be enabled. The Zone Temperature Control loops serviced by the AHU shall also be enabled.]

d. Proofs and Safeties:

(1) The supply fan[, return fan,] and all DDC Hardware control loops shall be subject to Proofs and Safeties. Safeties shall be direct-hardwire interlocked to the fan starter circuit as shown. DDC Hardware shall monitor all proofs and safeties and failure of any proof or activation of any safety shall result in all control loops being disabled and the AHU fan being commanded off until reset.

(2) Proofs:

(a) Supply fan status (proof) (SF-S)

[(b) Return fan status (proof) (RF-S)]

(3) Safeties:

(a) Mixed air temperature low limit (freeze stat) (MA-T-LL)

(b) Supply air smoke (SA-SMK)

[(c) Return air smoke (RA-SMK)]

(4) DDC Hardware reset of all proofs and safeties shall be via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

e. Minimum Outside Air Flow Control: When this loop is enabled the DDC Hardware shall open the 2-position minimum outside air damper to introduce the minimum outside air follow quantity as shown. When this loop is disabled, the minimum outside air damper shall be closed.

f. Mixed Air Temperature Control With Economizer:

(1) When this loop is enabled, and the Economizer is ON as determined by the Economizer Enable Logic, the DDC Hardware shall modulate the economizer outside air, relief, and return air dampers to maintain the mixed air temperature (MA-T) at setpoint (MA-T-SP) as shown.

(2) When this loop is disabled, or the Economizer is OFF as determined by the Economizer Enable Logic, the economizer outside air and relief air dampers shall be closed, and the return air damper shall be open.

(3) Economizer Enable Logic. The economizer shall be ON when the outside air dry bulb temperature is between the high limit (ECO-HL-SP) and low limit (ECO-LL-SP) setpoints as shown. The Economizer shall otherwise be OFF. ECO-HL-SP and ECO-LL-SP shall each have a 1 degree C 2 degrees F deadband.

g. Hot Deck Coil Control:

(1) When this loop is enabled the DDC Hardware shall modulate the hot deck heating coil valve to maintain the hot deck temperature

(HD-T) at setpoint (HD-T-SP) as shown. When this loop is disabled, the hot deck coil valve shall be closed.

[(2) The DDC Hardware shall reset the hot deck temperature setpoint (HD-T-SP) using a linear reset schedule as shown. Reset of the setpoint (HD-T-SP) shall be based on [Outside Air Temperature] [Coldest Zone Temperature].]

h. Cold Deck Coil Control: When this loop is enabled the DDC Hardware shall modulate the cold deck cooling coil valve to maintain the cold deck temperature (CD-T) at setpoint (CD-T-SP) as shown. When this loop is disabled, the cold deck cooling coil valve shall be closed.

i. Zone Temperature Control:

(1) The zone temperature setpoint (ZN-T-SP) shall be at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.

(2) The DDC Hardware shall modulate the hot deck and cold deck dampers to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP). Sequencing shall be as shown: Upon a rise in zone temperature above zone temperature setpoint the zone cold deck damper shall modulate towards open as the hot deck damper modulates towards closed. Upon a fall in zone temperature below zone temperature setpoint the hot deck damper shall modulate towards open as the cold deck damper modulates towards closed.

3.4.3.8 Multizone with Hot Deck Bypass [with][without] Return Fan

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NOTE:
1) NOTE: Edit the sequence and drawings as necessary for systems with/without a return fan, preheat coil, economizer, and other project specific control loop requirements.

2) Minimum outside air flow control can be accomplished several different ways. Refer to the UFC, but don't use flow measurement in a constant volume system.

3) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule and Control Schematic as required.

4) Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from 2 different spaces are required to help avoid needless turning on of the system (due to cleaning staff or security staff passing through after hours).

5) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be performed from a workstation (via SNVT) or local display panel (LDP). It is recommended that you coordinate the decision with the local O&M staff. Edit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

6) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

7) Smoke control is not addressed in this guide specification. Smoke control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer, based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.

****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. HAND-OFF-AUTO switches:
Supply fan motor starter shall accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches and shall start the fan. The fan motor starter shall accept an occupant accessible emergency shutoff switch as shown. The supply fan motor starter shall have an H-O-A switch:

(1) HAND: With the H-O-A switch in HAND position, the supply fan shall start and run continuously, subject to Safeties.

(2) OFF: With the H-O-A switch in OFF position, the supply fan shall stop.

(3) AUTO: With the H-O-A switch in AUTO position, the supply fan

shall run subject to the Supply Fan Start/Stop (SF-SS)command and Safeties.

[Return fan motor starter shall accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches shall start the fan. The return fan motor starter shall have an H-O-A switch:

(1) HAND: With the H-O-A switch in HAND position, the return fan shall run subject to Safeties.

(2) OFF: With the H-O-A switch in OFF position, the return fan shall be off.

(3) AUTO: With the H-O-A switch in AUTO position, the return fan shall run subject to the supply fan running.]

b. Occupancy Modes: The system shall obtain its Occupancy Mode input from the System Scheduler as specified and shown. The system shall operate in one of the following modes: Occupied, Unoccupied[, or WarmUp/CoolDown].

c. System Enable and Loop Enable:

(1) Occupied Mode: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS). All control loops shall be enabled. The Zone Temperature Control loops serviced by the AHU shall also be enabled.

(2) Unoccupied mode: While the building temperature (BLDG-T) is above setpoint (BLDG-T-LL-SP) all control loops shall be disabled and the supply fan shall not run. When BLDG-T drops below BLDG-T-LL-SP (with a 3 degrees C 5 degrees F deadband) the supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS), and all Zone Temperature Control loops shall be enabled. The Minimum Outside Air Flow Control, Mixed Air Temperature Control With Economizer, and Cold Deck Coil Control loops shall be disabled.

[(3) Warm Up / Cool Down Mode: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS). The Minimum Outside Air Flow Control loop shall be disabled and all other control loops shall be enabled. The Zone Temperature Control loops serviced by the AHU shall also be enabled.]

d. Proofs and Safeties:

(1) The supply fan[, return fan,] and all DDC Hardware control loops shall be subject to Proofs and Safeties. Safeties shall be direct-hardwire interlocked to the fan starter circuit as shown. DDC Hardware shall monitor all proofs and safeties and failure of any proof or activation of any safety shall result in all control loops being disabled and the AHU fan being commanded off until reset.

(2) Proofs:

(a) Supply fan status (proof) (SF-S)

[(b) Return fan status (proof) (RF-S)]

(3) Safeties:

(a) Mixed air temperature low limit (freeze stat) (MA-T-LL)

(b) Supply air smoke (SA-SMK)

[(c) Return air smoke (RA-SMK)]

(4) DDC Hardware reset of all proofs and safeties shall be via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

e. Minimum Outside Air Flow Control: When this loop is enabled the DDC Hardware shall open the 2-position minimum outside air damper to introduce the minimum outside air follow quantity as shown. When this loop is disabled, the minimum outside air damper shall be closed.

f. Mixed Air Temperature Control With Economizer:

(1) When this loop is enabled, and the Economizer is ON as determined by the Economizer Enable Logic, the DDC Hardware shall modulate the economizer outside air, relief, and return air dampers to maintain the mixed air temperature (MA-T) at setpoint (MA-T-SP) as shown.

(2) When this loop is disabled, or the Economizer is OFF as determined by the Economizer Enable Logic, the economizer outside air and relief air dampers shall be closed, and the return air damper shall be open.

(3) Economizer Enable Logic. The economizer shall be ON when the outside air dry bulb temperature is between the high limit (ECO-HL-SP) and low limit (ECO-LL-SP) setpoints as shown. The Economizer shall otherwise be OFF. ECO-HL-SP and ECO-LL-SP shall each have a 1 degree C 2 degrees F deadband.

g. Cold Deck Coil Control: When this loop is enabled the DDC Hardware shall modulate the cooling coil valve to maintain the cold deck supply air temperature (SA-T) at setpoint (SA-T-SP) as shown. When this loop is disabled, the cooling coil valve shall be closed.

h. Zone Temperature Control: The Zone Temperature Control loops shall always be enabled.

(1) The zone temperature setpoint (ZN-T-SP) shall be at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.

(2) The DDC Hardware shall modulate the zone bypass and cold deck dampers, and the zone reheat coil valve to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP). Sequencing shall be as shown: Upon a rise in zone temperature above zone temperature setpoint, subject to the zone temperature setpoint deadband as shown, the zone cold deck damper shall modulate towards open as the bypass deck damper modulates towards closed. Upon a fall in zone temperature below zone temperature setpoint, subject to the

deadband as shown, the bypass damper shall be full open and the zone heating valve shall modulate towards open.

3.4.3.9 Variable Air Volume System [with][without] Return Fan

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NOTE:
1) Edit the sequence and drawings as necessary for systems with/without a return fan, preheat coil, economizer, and other project specific control loop requirements.

2) Minimum outside air flow control can be accomplished several different ways. Refer to the UFC.

3) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule and Control Schematic as required.

4) This spec does not include a variable frequency drive (VFD) specification. Specify a VFD that meets the requirements of the control sequence including the integral H-O-A and a safety shutdown input circuit that is separate from the start/stop input circuit and Fire Alarm Panel (FAP) override switch.

5) Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from 2 different spaces are required to help avoid needless turning on of the system (due to cleaning staff or security staff passing through after hours).

6) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be performed from a workstation (via SNVT) or local display panel (LDP). It is recommended that you coordinate the decision with the local O&M staff. Edit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

7) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

8) Smoke control is not addressed in this guide specification. Smoke control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.

****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. HAND-OFF-AUTO switches:
Supply fan variable frequency drive (VFD) unit shall accept a Fire Alarm Panel (FAP) signal that takes precedence over all other VFD inputs and switches and shall cause the VFD to run at 100% speed. The VFD shall accept an occupant accessible emergency shutoff switch as shown. The supply fan variable frequency drive (VFD) unit shall have an integral H-O-A switch:

(1) HAND: With the H-O-A switch in HAND position, the supply fan shall start and run continuously, subject to Safeties. Fan speed shall be under manual-operator control.

(2) OFF: With the H-O-A switch in OFF position, the supply fan shall stop.

(3) AUTO: With the H-O-A switch in AUTO position, the supply fan shall run subject to the Supply Fan Start/Stop Signal (SF-SS) and Safeties. Fan speed shall be under control of the DDC Hardware.

[Return fan variable frequency drive (VFD) unit shall accept a Fire Alarm Panel (FAP) signal that takes precedence over all other VFD inputs and switches and shall cause the VFD to run at 100% speed. The return fan variable frequency drive (VFD) unit shall have an integral H-O-A switch:

(1) HAND: With the H-O-A switch in HAND position, the return fan shall run subject to Safeties. Fan speed shall be under manual-operator control.

(2) OFF: With the H-O-A switch in OFF position, the return fan shall be off.

(3) AUTO: With the H-O-A switch in AUTO position, the return fan

shall run subject to the supply fan running. Fan speed shall be under control of the DDC Hardware.]

b. Occupancy Modes: The system shall obtain its Occupancy Mode input from the System Scheduler as specified and shown. The system shall operate in one of the following modes: Occupied, Unoccupied[, or Warm Up/Cool Down].

c. Proofs and Safeties:

(1) The supply fan[, return fan,] and all DDC Hardware control loops shall be subject to Proofs and Safeties. Safeties shall be direct-hardwire interlocked to the VFD as shown. DDC Hardware shall monitor all proofs and safeties and failure of any proof or activation of any safety shall result in all control loops being disabled and the AHU fan being commanded off until reset.

(2) Proofs:

(a) Supply fan status (SF-S)

[(b) Return fan status (RF-S)]

(3) Safeties:

(a) Cooling coil discharge air temperature low limit (freezestat) (CLG-DA-T-LL)

(b) Supply air duct pressure high limit (SA-P-HL)

(c) Supply air smoke (SA-SMK)

(d) Return air smoke (RA-SMK)

(4) DDC Hardware reset of all proofs and safeties shall be via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

d. System Enable and Loop Enable

(1) Occupied mode: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS). All control loops shall be enabled. The Zone Temperature Control loops for VAV boxes serviced by the AHU shall also be enabled.

(2) Unoccupied mode: While the building temperature (BLDG-T) is above setpoint (BLDG-T-LL-SP) all control loops shall be disabled (except fan-powered VAV box Zone Temperature Control loops) and the supply fan shall not run. When BLDG-T drops below BLDG-T-LL-SP (with a 3 degrees C 5 degrees F deadband) the supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS), the Supply Duct Static Pressure Control[, Return Fan Volume Control][, Preheat Control] loops shall be enabled. The Minimum Outside Air Flow Control, Mixed Air Temperature Control, and Cooling Coil Control loops shall be disabled.

[(3) Warm Up/Cool Down: The supply fan shall be enabled (SYS-ENA) and commanded to run (SF-SS). The Minimum Outside Air Flow Control loop shall be disabled and all other control loops shall be enabled. The Zone Temperature Control loops for VAV boxes serviced by the AHU shall also be enabled.]

e. Fan Capacity Control:

(1) Supply Duct Static Pressure Control. When this loop is enabled the DDC Hardware shall modulate the supply fan variable frequency drive unit to maintain the duct static pressure (SA-P) at setpoint (SA-P-SP) as shown, as measured by the duct static pressure tap and sensor as shown. When this loop is disabled, the DDC Hardware capacity modulation output to the VFD shall be zero percent.

[(2) Return Fan Volume Control. When this loop is enabled the DDC Hardware shall modulate the return fan variable frequency drive unit to maintain a constant volumetric airflow difference at setpoint (F-DIFF-SP) as shown, as measured by the airflow measurement arrays located in the supply and return ducts as shown. When this loop is disabled, the output to the VFD shall be zero percent.]

f. Minimum Outside Air Flow Control: When this loop is enabled the DDC Hardware shall modulate the minimum outside air damper to maintain the minimum OA volumetric flow (MINOA-F) at setpoint (MINOA-F-SP) as shown. When this loop is disabled, the minimum outside air damper shall be closed.

g. Mixed Air Temperature Control With Economizer

(1) When this loop is enabled, and the Economizer is ON as determined by the Economizer Enable Logic, the DDC Hardware shall modulate the economizer outside air, relief, and return air dampers to maintain the mixed air temperature (MA-T) at setpoint (MA-T-SP) as shown.

(2) When this loop is disabled, or the Economizer is OFF as determined by the Economizer Enable Logic, the economizer outside air and relief air dampers shall be closed, and the return air damper shall be open.

(3) Economizer Enable Logic. The economizer shall be ON when the outside air dry bulb temperature is between the high limit (ECO-HL-SP) and low limit (ECO-LL-SP) setpoints as shown. The Economizer shall otherwise be OFF. ECO-HL-SP and ECO-LL-SP shall each have a 1 degree C 2 degrees F deadband.

h. Cooling Coil Control: When this loop is enabled the DDC Hardware shall modulate the cooling coil valve to maintain the supply air temperature (SA-T) setpoint (SA-T-SP) as shown. When this loop is disabled, the cooling coil valve shall be closed.

[i. Preheat Coil Control: When this loop is enabled the DDC Hardware shall modulate the preheat coil valve to maintain the preheat coil discharge air temperature (PH-DA-T) at setpoint (PH-DA-T-SP) as shown. When this loop is disabled, the preheat coil valve shall be closed.]

3.4.4 Sequences of Operation for Terminal Units

****
NOTE: For the VAV Box Sequences:
1) Show the occupancy schedule (days/times) on the Occupancy Schedule drawing. For simplicity, it is recommended that all boxes, served by a common air handler, operate on the same schedule.

2) Space occupancy input(s) may consist of an occupancy sensor and/or a local push-button. Indicate the use of a sensor and/or push-button by placing an 'X' in the 'Thermostat and Occupancy Sensor Schedule'. If a push-button is used, show the override time duration in the Schedule. The occupancy sensor specification requires a 15 minute off-mode delay prior to leaving the occupied mode. If a different time is desired, show it in the thermostat schedule and ensure that it is consistent with the Occupancy Sensor Product specification.

3) For each VAV box thermostat, indicate if the zone temperature setpoint will be occupant adjustable placing an 'X' in the 'Thermostat and Occupancy Sensor Schedule'. For non-occupant-adjustable setpoints, show the setpoint in the Points Schedule. The intent is that the Contractor provides one or the other as shown. Non-occupant-adjustable setpoints are adjustable by a system operator using a local display panel (LDP) or operator workstation (and appropriate software).
****

3.4.4.1 Zone Temperature Control - Cooling-Only VAV Box

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. Occupancy Modes:

(1) Occupied: The VAV box DDC Hardware shall be in the Occupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is occupied or when the input from the System Scheduler (SYS-OCC) is occupied.

(2) Unoccupied: The VAV box DDC Hardware shall be in the Unoccupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is unoccupied and the input from the System Scheduler (SYS-OCC) is unoccupied.

b. Safeties: This system has no safeties.

c. Zone Temperature Control

(1) In the Occupied Mode the zone temperature setpoint (ZN-T-SP) shall be at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown. The DDC

Hardware shall modulate the VAV box damper to maintain VAV box supply air flow (VAV-SA-F) at setpoint as measured by a multi-point flow sensing element at the inlet to the VAV box. Sequencing shall be as shown: Upon a rise in zone temperature (ZN-T) above zone setpoint (ZN-T-SP), subject to the zone temperature setpoint deadband as shown, the airflow setpoint shall be adjusted between minimum and maximum flow based on the difference between zone temperature and zone temperature setpoint as shown.

(2) In the Unoccupied Mode the VAV box damper shall be at its minimum position.

3.4.4.2 Zone Temperature Control - VAV Box with Reheat

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. Occupancy Modes:

(1) Occupied: The VAV box DDC Hardware shall be in the Occupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is occupied or when the input from the System Scheduler (SYS-OCC) is occupied.

(2) Unoccupied: The VAV box DDC Hardware shall be in the Unoccupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is unoccupied and the input from the System Scheduler (SYS-OCC) is unoccupied.

b. Safeties: VAV boxes with electric resistance heating elements shall require proof of air flow before activating the heating elements.

c. Zone Temperature Control:

(1) In the Occupied Mode the zone temperature setpoint (ZN-T-SP) shall be at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.

(2) In the Unoccupied Mode the zone temperature setpoint (ZN-T-SP) shall be at the configured setpoint as shown.

(3) The DDC Hardware shall modulate the VAV box damper to maintain VAV box supply air flow (VAV-SA-F) at setpoint as measured by a multi-point flow sensing element at the inlet to the VAV box. Sequencing shall be as shown: Upon a rise in zone temperature above zone temperature setpoint (ZN-T-SP), subject to the zone temperature setpoint deadband as shown, the airflow setpoint shall be adjusted between minimum and maximum flow based on the difference between zone temperature and zone temperature setpoint as shown. Upon a fall in zone temperature below zone temperature setpoint, subject to the deadband as shown, the airflow shall be maintained at a fixed air flow setpoint (with a setting independent of the cooling minimum air flow), and the heating valve shall modulate towards open or the staged electric resistance heating coil(s) shall cycle on in sequence.

3.4.4.3 Zone Temperature Control - Fan Powered VAV Box

****
NOTE: This sequence is applicable to both Series and Parallel fan powered VAV boxes.

As specified in Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM, fans located in series fan-powered VAV boxes must start whenever the AHU fan that serves these boxes is started. Therefore, this sequence allows the AHU to start regardless of the VAV box fan status.
****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. Occupancy Modes:

(1) Occupied: The VAV box DDC Hardware shall be in the Occupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is occupied or when the input from the System Scheduler (SYS-OCC) is occupied.

(2) Unoccupied: The VAV box DDC Hardware shall be in the Unoccupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is unoccupied and the input from the System Scheduler (SYS-OCC) is unoccupied.

b. Safeties: VAV boxes with electric resistance heating elements shall require proof of air flow before activating the heating elements.

c. Zone Temperature Control

(1) In the Occupied Mode the zone temperature setpoint (ZN-T-SP) shall be at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.

(2) In the Unoccupied Mode the zone temperature setpoint (ZN-T-SP) shall be at the configured setpoint as shown.

(3) Sequencing shall be as shown:

(a) In occupied and unoccupied modes, upon a rise in zone temperature above zone temperature setpoint (ZN-T-SP), subject to the zone temperature setpoint deadband as shown, the airflow setpoint shall be adjusted between minimum and maximum based on the difference between zone temperature and zone temperature setpoint as shown. The DDC Hardware shall modulate the VAV box damper to mix supply and plenum return air as it maintains VAV box supply airflow (VAV-SA-F) at setpoint as measured by a multi-point flow sensing element at the inlet to the VAV box.

(b) In occupied mode, upon a fall in zone temperature below zone temperature setpoint, subject to the deadband as shown, the VAV box fan shall cycle on (note that the fan is always on in the occupied mode for a series box), the DDC Hardware shall modulate

the VAV box damper to mix supply and plenum return air to maintain a fixed air flow setpoint (with a setting independent of the cooling minimum air flow), and the heating valve shall modulate towards open or the staged electric resistance heating coil(s) shall cycle on in sequence.

(c) In unoccupied mode, upon a fall in zone temperature below zone temperature setpoint, subject to the deadband as shown, the VAV box fan shall cycle on (note that the fan is always on in the occupied mode for a series box), the VAV box damper shall be at its minimum position, and the heating valve shall modulate towards open or the staged electric resistance heating coil(s) shall cycle on in sequence.

3.4.4.4 Perimeter Radiation Control Sequence

****
NOTE:
1) Show the occupancy schedule (days/times) on the Occupancy Schedule drawing. For simplicity, it is recommended that all units operate on the same schedule.

2) Space occupancy input(s) may consist of an occupancy sensor and/or a local push-button. Indicate the use of a sensor and/or push-button by placing an 'X' in the Thermostat Schedule. If a push-button is used, show the override time duration in the Schedule. The occupancy sensor specification requires a 15 minute off-mode delay prior to leaving the occupied mode. If a different time is desired, show it in the thermostat schedule and ensure that it is consistent with the Occupancy Sensor Product specification.
****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. Occupancy Modes

(1) Occupied: The radiator DDC Hardware shall be in the Occupied Mode when the local space occupancy input(s) indicate that the space is occupied or when the input from the System Scheduler is occupied.

(2) Unoccupied: The radiator DDC Hardware shall be in the Unoccupied Mode when the local space occupancy input(s) indicate that the space is unoccupied and when the input from the System Scheduler is unoccupied.

b. Safeties: This system has no safeties.

c. Space Temperature Control

(1) In the Occupied Mode the DDC Hardware shall modulate the heating control valve to maintain space temperature at the configured setpoint or at the occupant-adjustable setpoint via the

wall-mounted thermostat, as shown.

(2) In the Unoccupied Mode the DDC Hardware shall modulate the heating control valve to maintain space temperature at the configured setpoint as shown.

3.4.4.5 Unit Heater and Cabinet Unit Heater

****
NOTE:
1) Show the occupancy schedule (days/times) on the Occupancy Schedule drawing. For simplicity, it is recommended that all units operate on the same schedule.

2) Space occupancy input(s) may consist of an occupancy sensor and/or a local push-button. Indicate the use of a sensor and/or push-button by placing an 'X' in the Thermostat Schedule. If a push-button is used, show the override time duration in the Schedule. The occupancy sensor specification requires a 15 minute off-mode delay prior to leaving the occupied mode. If a different time is desired, show it in the thermostat schedule and ensure that it is consistent with the Occupancy Sensor Product specification.
****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. Off-Auto Switch

(1) OFF: With the thermostat OFF-AUTO switch in the OFF position, the DDC Hardware shall stop the fan and close the heating control valve.

(2) AUTO: With the thermostat OFF-AUTO switch in the AUTO position, the DDC Hardware shall control the unit in accordance with its Occupancy Mode.

b. Occupancy Modes

(1) Occupied: The unit heater DDC Hardware shall be in the Occupied Mode when the local space occupancy input(s) indicate that the space is occupied or when the input from the System Scheduler is occupied.

(2) Unoccupied: The unit heater DDC Hardware shall be in the Unoccupied Mode when the local space occupancy input(s) indicate that the space is unoccupied and when the input from the System Scheduler is unoccupied.

c. Safeties: The unit shall run subject to the unit manufacturer's safeties.

d. Space Temperature Control

(1) In the Occupied Mode the DDC Hardware shall modulate the heating control valve and cycle the multi-speed fan to maintain space temperature at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.

(2) In the Unoccupied Mode the DDC Hardware shall modulate the heating control valve and cycle the multi-speed fan to maintain space temperature at the configured setpoint as shown.

3.4.4.6 Gas-Fired Infrared Heater

****
NOTE:
1) Use of a System Scheduler is likely not needed in this application. If it is, edit the sequence and the drawings.

2) Space occupancy input(s) may consist of an occupancy sensor and/or a local push-button. Indicate the use of a sensor and/or push-button by placing an 'X' in the Thermostat Schedule. If a push-button is used, show the override time duration in the Schedule. The occupancy sensor specification requires a 15 minute off-mode delay prior to leaving the occupied mode. If a different time is desired, show it in the thermostat schedule and ensure that it is consistent with the Occupancy Sensor Product specification.
****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. On-Off-Auto Switch

(1) ON: With the thermostat ON-OFF-AUTO switch in the ON position, the DDC Hardware shall energize the heater and the heater shall run continuously.

(2) OFF: With the thermostat ON-OFF-AUTO switch in the OFF position, the DDC Hardware shall de-energize the heater.

(3) AUTO: With the thermostat ON-OFF-AUTO switch in the AUTO position, the DDC Hardware shall control the heater in accordance with its Occupancy Mode.

b. Occupancy Modes

(1) Occupied: The unit DDC Hardware shall be in the Occupied Mode when the local space occupancy input(s) indicate that the space is occupied.

(2) Unoccupied: The unit DDC Hardware shall be in the Unoccupied Mode when the local space occupancy input(s) indicate that the space is unoccupied.

c. Safeties: The heater shall run subject to the unit manufacturer's safeties.

d. Space Temperature Control

(1) In the Occupied Mode the DDC Hardware shall operate the heater to maintain space temperature at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.

(2) In the Unoccupied Mode the DDC Hardware shall operate the heater to maintain space setpoint at the configured unoccupied setpoint as shown.

3.4.4.7 Dual Temperature Fan-Coil Unit

****
NOTE:
1) Show the occupancy schedule (days/times) on the Occupancy Schedule drawing. For simplicity, it is recommended that all units operate on the same schedule.

2) Space occupancy input(s) may consist of an occupancy sensor and/or a local push-button. Indicate the use of a sensor and/or push-button by placing an 'X' in the Thermostat Schedule. If a push-button is used, show the override time duration in the Schedule. The occupancy sensor specification requires a 15 minute off-mode delay prior to leaving the occupied mode. If a different time is desired, show it in the thermostat schedule and ensure that it is consistent with the Occupancy Sensor Product specification.

3) Show 2-way and 3-way valve selections on the Valve Schedule.

4) Fan coil units typically have unit-mounted thermostats. Indicate if wall mounting is desired and/or show in the Thermostat Schedule for the individual fan coil units.
****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. Off-Auto Switch

(1) OFF: With the thermostat OFF-AUTO switch in the OFF position, the DDC Hardware shall stop the fan and close the dual-temperature control valve.

(2) AUTO: With the thermostat OFF-AUTO switch in the AUTO position, the DDC Hardware shall control the unit in accordance with its Occupancy Mode.

b. Occupancy Modes

(1) Occupied: The unit DDC Hardware shall be in the Occupied Mode when the local space occupancy input(s) indicate that the space is occupied or when the input from the System Scheduler is occupied.

(2) Unoccupied: The unit DDC Hardware shall be in the Unoccupied Mode when the local space occupancy input(s) indicate that the space is unoccupied and when the input from the System Scheduler is unoccupied.

c. Heat/Cool Modes: The DDC Hardware shall automatically switch the fan coil unit DDC Hardware between the heating and cooling modes and the resultant control action, based on a pipe-mounted dual-temperature supply water temperature sensor.

d. Safeties: The unit shall run subject to the unit manufacturer's safeties.

e. Space Temperature Control

(1) In the Occupied Mode the DDC Hardware shall modulate the dual-temperature control valve and cycle the multi-speed fan to maintain space temperature at the configured setpoint or at the occupant-adjustable setpoint via the [wall-mounted] thermostat, as shown.

(2) In the Unoccupied Mode the DDC Hardware shall modulate the dual-temperature control valve and cycle the multi-speed fan to maintain space temperature at the configured setpoint as shown.

3.4.5 Sequences of Operation for Hydronic Systems

3.4.5.1 Hydronic Heating Hot Water from Distributed [Steam][HTHW] Converter

****
NOTE:
1) Select Steam or High Temperature Hot Water as required.

2) The designer may want to consider other conditions under which this system is enabled, such as outside air temperature.
****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. System Enable and loop enable

(1) This system shall monitor the enabled status of all systems served by this system. If one or more systems served by this system are enabled, this system shall be enabled (SYS-ENA). If all systems served by this system are not enabled, this system shall not be enabled.

(2) When this system is enabled (SYS-ENA) and the hot water pump is proofed on, the Heat Exchanger Control loop shall be enabled.

b. HAND-OFF-AUTO Switch: The hot water pump motor starter shall have an H-O-A switch:

(1) HAND: With the H-O-A switch in HAND position, the pump shall start and run continuously.

(2) OFF: With the H-O-A switch in OFF position, the pump shall stop.

(3) AUTO: With the H-O-A switch in AUTO position, the pump shall run subject to the Hot Water Pump Start/Stop (HW-PMP-SS) command.

c. Proofs and Safeties:

(1) DDC Hardware shall monitor all proofs and safeties.

(2) Proofs: Hot water pump status (HW-PMP-S)

(3) Safeties: None

(4) DDC Hardware reset of all proofs and safeties shall be via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

****
NOTE: If a reset schedule is not required delete this option ([determined from a linear reset schedule]) from the sequence along with the reset schedule in the drawing. Where reset is used, edit the temperatures shown in the reset schedule on the drawing.
****

d. Heat Exchanger Valve Control: When this loop is enabled DDC Hardware shall modulate the [steam][high temperature hot water] valve to maintain the Hot Water Supply Temperature (HWS-T) at setpoint (HWS-T-SP). The Hot Water Supply Temperature Setpoint (HW-T-SP) shall be [determined from a linear reset schedule] as shown. When this loop is disabled, the valve shall be closed.

3.4.5.2 Hydronic Heating Hot Water From Single-Building Boiler

****
NOTE: The designer may want to consider other conditions under which this system is enabled, such as outside air temperature.
****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. System Enable and loop enable

(1) This system shall monitor the enabled status of all systems served by this system. If one or more systems served by this system are enabled, this system shall be enabled (SYS-ENA). If all systems served by this system are not enabled, this system shall not be enabled.

(2) When this system is enabled (SYS-ENA) and the hot water pump is proofed on, the boiler control and hot water temperature control loops shall be enabled.

b. HAND-OFF-AUTO Switch: The hot water pump motor starter shall have an H-O-A switch:

(1) HAND: With the H-O-A switch in HAND position, the pump shall start and run continuously.

(2) OFF: With the H-O-A switch in OFF position, the pump shall stop.

(3) AUTO: With the H-O-A switch in AUTO position, the pump shall run subject to the Hot Water Pump Start/Stop (HW-PMP-SS) command.

c. Proofs and Safeties:

(1) DDC Hardware shall monitor all proofs and safeties.

(2) Proofs: Hot water pump

(3) Safeties: None

(4) DDC Hardware reset of all proofs and safeties shall be via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

d. Boiler Control: When this loop is enabled, the DDC Hardware shall turn the boiler on. When this loop is disabled, the boiler shall be off.

e. Hot Water Temperature Control: When this loop is enabled the DDC Hardware shall modulate the 3-way mixing valve to maintain hot water supply temperature (HWS-T) at setpoint (HWS-T-SP). The Hot Water Supply Temperature Setpoint (HWS-T-SP) shall be [determined from a linear reset schedule] as shown. When this loop is disabled, the valve shall be in its normal (failsafe) position.

3.4.5.3 Hydronic Dual-Temperature System with [Steam][High Temperature Hot Water] and Chilled Water

****
NOTE:
1) Select Steam or High Temperature Hot Water as required.

2) The Heating Mode low-limit switch is needed only if there is a boiler (to avoid boiler shock). You may choose to delete the switch from the control schematic drawing, ladder diagram and sequence when

using a heat exchanger.

3) The designer may want to consider other conditions under which this system is enabled, such as outside air temperature.

****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. System Enable and loop enable

(1) This system shall monitor the enabled status of all systems served by this system. If one or more systems served by this system are enabled, this system shall be enabled (SYS-ENA). If all systems served by this system are not enabled, this system shall not be enabled.

(2) When this system is enabled (SYS-ENA), and the HEATING/COOLING switch is in HEATING and the dual-temperature return water temperature (DTWR-T) is above the dual-temperature return water low-limit temperature (DTWRR-T-LL) setpoint of 18 degrees C 65 degrees F, the [single-building boiler] [Heat Exchanger Control loop] shall be enabled.

****

NOTE: Chiller Enable (the following paragraph) is only required when there is a local chiller. In cases where chilled water is from a central plant delete the chiller enable requirement.

****

([3) When this system is enabled (SYS-ENA), and the HEATING/COOLING switch is in COOLING and the dual-temperature return water (DTWR-T) is below the dual-temperature return water high-limit temperature (DTWR-T-HL) setpoint of 29 degrees C 85 degrees F, the chiller shall be enabled.]

b. Switchover valve operation

(1) With the HEATING/COOLING switch in the HEATING position, the switchover valve shall open the heat-cool system piping to the [heat exchanger] [boiler] and close the heat-cool system piping to the [central plant chilled water] [single-building chiller] whenever the dual-temperature return water temperature (DTWR-T) is above the dual-temperature return water low-limit temperature (DTWR-T-LL) setpoint of 18 degrees C 65 degrees F.

(2) With the HEATING/COOLING switch in the COOLING position, the switchover valve shall open the heat-cool system piping to the [central plant chilled water] [single-building chiller] and close the heat-cool system piping to the [heat exchanger] [boiler] whenever the dual-temperature return water temperature (DTWR-T) is below the dual-temperature return water high-limit temperature (DTWR-T-HL) setpoint of 29 degrees C 85 degreesF.

(3) For any other combination of HEATING/COOLING mode switch position, DTWR-T-LL switch position, and DTWR-T-HL switch position, the heat-cool switchover valve shall maintain its last state.

(4) The DDC Hardware shall monitor the status of the DTWR-T-LL and DTWR-T-HL switches.

c. HAND-OFF-AUTO Switch: The Dual-Temperature water pump motor starter shall have an H-O-A switch:

(1) HAND: With the H-O-A switch in HAND position, the pump shall start and run continuously.

(2) OFF: With the H-O-A switch in OFF position, the pump shall stop.

(3) AUTO: With the H-O-A switch in AUTO position, the pump shall run subject to the Dual-Temperature Water Pump Start/Stop (DTW-PMP-SS) System Enable (SYS-ENA) command.

d. Proofs and Safeties

(1) DDC Hardware shall monitor all proofs and safeties.

(2) Proofs: None

(3) Safeties: Heat exchanger differential pressure switch (HX-P-LL) shall be direct-hardwire interlocked to the [steam][high temperature hot water] valve.

(4) DDC Hardware reset of all proofs and safeties shall be via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

[e. Heat Exchanger Valve Control: When this loop is enabled and there is hot water flow through the heat exchanger as sensed by the differential pressure switch (HX-P-LL) safety, the DDC Hardware shall modulate the [steam][high temperature hot water] valve to maintain the Hot Water Supply Temperature (HWS-T) at setpoint (HWS-T-SP). The Hot Water Supply Temperature Setpoint (HW-T-SP) shall be [determined from a linear reset schedule] as shown. The DDC Hardware shall monitor the status of the HX-P-LL safety. When this loop is disabled, the valve shall be closed.]

3.4.5.4 Hydronic Secondary with Variable Speed Pump

****

NOTE:
1) This spec does not include a variable frequency drive (VFD) specification. Specify a VFD that meets the requirements of the control sequence including the integral H-O-A.

2) The designer may want to consider other conditions under which this system is enabled, such as outside air temperature.

****

Contractor shall install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs, outputs and alarms as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control shall be proportional-integral (PI) control.

a. System Enable and loop enable:

(1) This system shall monitor the enabled status of all systems served by this system. If one or more systems served by this system are enabled, this system shall be enabled (SYS-ENA). If all systems served by this system are not enabled, this system shall not be enabled.

(2) When this system is enabled (SYS-ENA) the Pressure Control loop shall be enabled.

b. HAND-OFF-AUTO Switch: The hot water pump variable frequency drive (VFD) unit shall have an integral H-O-A switch:

(1) HAND: With the H-O-A switch in HAND position, the pump shall start and run continuously. Pump speed shall be under manual-operator control.

(2) OFF: With the H-O-A switch in OFF position, the pump shall stop.

(3) AUTO: With the H-O-A switch in AUTO position, the pump shall run subject to the Hot Water Pump Start/Stop (HW-PMP-SS) command and pump speed shall be under control of the DDC system.

c. roofs and Safeties

(1) DDC Hardware shall monitor all proofs and safeties.

(2) Proofs: None

(3) Safeties: None

(4) DDC Hardware reset of all proofs and safeties shall be via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

d. Pressure Control: When this loop is enabled the DDC Hardware shall modulate the pump variable frequency drive unit to maintain the pipe system pressure at setpoint as shown, as measured by the differential pressure tap and sensor as shown. When this loop is disabled, the DDC Hardware capacity modulation output to the VFD shall be zero percent.

3.5 CONTROLLER TUNING

The Contractor shall tune each controller in a manner consistent with that described in the ASHRAE FUN SI ASHRAE FUN IP. Tuning shall consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. Each loop shall be tuned while the system or plant is operating at a high gain (worst

case) condition, where high gain can generally be defined as a low-flow or low-load condition. Upon final adjustment of the PID settings, in response to a change in controller setpoint, the controlled variable shall settle out at the new setpoint with no more than two (2) oscillations above and below setpoint. Upon settling out at the new setpoint the controller output shall be steady. With the exception of naturally slow processes such as zone temperature control, the controller shall settle out at the new setpoint within five (5) minutes. The Contractor shall return the controller to its original setpoint and shall record and submit the final PID configuration settings with the O&M Instructions and on the associated Points Schedule.

3.6 START-UP AND START-UP TEST

The Contractor shall perform the following startup tests for each control system to ensure that the described control system components are installed and functioning per this specification.

a. General: The Contractor shall adjust, calibrate, measure, program, configure, set the time schedules, set alarms, and otherwise perform all necessary actions to ensure that the systems function as specified and shown in the sequence of operation and other contract documents.

b. Systems Check: An item-by-item check shall be performed for each HVAC system;

****
NOTE: If the specification has been edited to include M&C Software (from Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEMS (UMCS)), include the requirement to inspect M&C Clients to make sure they display shutdown conditions.
****

(1) Step 1 - System Inspection: With the system shut down, it shall be verified that power and main air are available where required and that all output devices are in their failsafe and normal positions. Each local display panel [and each M&C Client] shall be inspected to verify that all displays indicate shutdown conditions.

(2) Step 2 - Calibration Accuracy Check: A two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter shall be performed by comparing the SNVT output from the DDC Hardware the sensor is connected to the actual value of the variable measured at the sensing element. Digital indicating test instruments shall be used, such as digital thermometers, motor-driven psychrometers, and tachometers. The test instruments shall be at least twice as accurate as the specified sensor accuracy. The calibration of the test instruments shall be traceable to National Institute Of Standards And Technology standards. The first check point shall be with the HVAC system in the shutdown condition, and the second check point shall be with the HVAC system in an operational condition. Calibration checks shall verify that the sensing element-to-DDC system readout accuracies at two points are within the specified product accuracy tolerances. If not, the device shall be recalibrated or replaced and the calibration check repeated.

(3) Step 3 - Actuator Range Check: With the system running, a signal shall be applied to each actuator through the DDC Hardware controller. Proper operation of the actuators and positioners for all actuated devices shall be verified and the signal levels shall be recorded for the extreme positions of each device. The signal shall be varied from live zero to full range, and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. Where applicable, it shall be verified that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

c. Weather Dependent Test: Weather dependent test procedures that cannot be performed by simulation shall be performed in the appropriate climatic season. When simulation is used, the actual results shall be verified in the appropriate season.

Test Report: Upon completion of the Start-Up Test, the Contractor shall prepare and submit a Start-Up and Start-Up Testing Report documenting the results of the tests performed and certifying that the system is installed and functioning per this specification, and is ready for the Performance Verification Test (PVT).

3.7 PERFORMANCE VERIFICATION TEST (PVT)

****
NOTE: A set of Field Test Procedures are being developed by an A/E under contract with Huntsville Center. Once complete, these Test Procedures will be included or referenced here.

Brief interim guidance is provided here.
****

3.7.1 PVT Procedures

****
NOTE: The designer must decide whether to require a one-point accuracy check and/or inlet and outlet air temperature measurements.

Project specific requirements should be added, particularly for problematic controls based on designer and user experience.
****

The performance verification test procedures shall explain, step-by-step, the actions and expected results that will demonstrate that the control system performs in accordance with the sequences of operation, and other contract documents. [The PVT shall include a one-point accuracy check of each sensor.][The PVT shall include inlet and outlet air temperature measurements for all AHU-dependent terminal units.]The PVT Procedure shall describe a methodology to measure and trend the network bandwidth usage on the network backbone and compare it to the Bandwidth Usage Calculation submittal. A control system performance verification test equipment list shall be included that lists the equipment to be used during performance verification testing. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

3.7.2 PVT Execution

The Contractor shall demonstrate compliance of the control system with the contract documents. Using test plans and procedures approved by the Government, the Contractor shall demonstrate all physical and functional requirements of the project. The performance verification test shall show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. The performance verification test shall measure and trend the Network Bandwidth Usage and compare it to the Bandwidth Usage Calculation submittal. The performance verification test shall not be started until after receipt by the Contractor of written permission by the Government, based on Government approval of the Start-Up and Start-Up Testing Report and completion of balancing. The tests shall not be conducted during scheduled seasonal off periods of base heating and cooling systems.

3.7.3 PVT Report

Contractor shall prepare a PVT report documenting all tests performed during the PVT and their results. The PVT report shall include all tests in the PVT Procedures and any other testing performed during the PVT. Failures and repairs shall be documented with test results.

3.8 TRAINING

****
NOTE: Training requirements should be coordinated with the user (including the Controls/HVAC/Electrical shop supervisor). Extent of training should be based on the needs of the installation personnel.
****

A training course shall be conducted for [_____] operating staff members designated by the Government in the maintenance and operation of the system, including specified hardware and software. The training period, for a total of [32][_____] hours of normal working time, shall be conducted within 30 days after successful completion of the performance verification test. The training course shall be conducted at the project site and the Government reserves the right to videotape the training sessions for later use. Audiovisual equipment and [_____] sets of all other training materials and supplies shall be provided. A training day is defined as 8 hours of classroom instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

3.8.1 Training Documentation

****
NOTE: Designer must choose appropriate shop supervisor(s) to coordinate training attendance.
****

The Contractor shall prepare training documentation consisting of:

a. Course Attendee List: A List of course attendees which shall be developed in coordination with and signed by the [Controls][HVAC][Electrical] shop supervisor.

b. Training Manuals: Training manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. Where the Contractor presents portions of the course material by audiovisuals, copies of those audiovisuals shall be delivered to the Government as a part of the printed training manuals. Training manuals shall be delivered for each trainee with two additional copies delivered for archival at the project site.

3.8.2 Training Course Content

For guidance in planning the required instruction, the Contractor shall assume that attendees will have a high school education or equivalent, and are familiar with HVAC systems. The training course shall cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each controller enclosure, the layout of one of each type of unitary equipment and the locations of each, the location of each control device external to the panels, the location of the compressed air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, repair procedures, use of LNS Plug-ins, and use of the GPPC Programming software. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. The results of the performance verification test and the Start-Up and Start-Up Testing Report shall be presented as benchmarks of HVAC control system performance by which to measure operation and maintenance effectiveness.

APPENDIX A

QC CHECKLIST

This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.

This checklist is for (check one:)

Pre-Construction QC Checklist Submittal (Items 1-5) |____|

Post-Construction QC Checklist Submittal (Items 1-12) |____|

Close-out QC Checklist Submittal (Items 1-19) |____|

Initial each item in the space provided (|____|) verifying that requirement has been met.

Items verified for Pre-Construction, Post-Construction and Closeout QC Checklists Submittal:

1 Network bandwidth calculations have been performed, and the backbone type (Ethernet or TP/FT-10) has been determined based on these calculations. |____|

2 All DDC Hardware (nodes) are numbered on Control System Schematic Drawings. |____|

3 Signal lines on Control System Schematic are labeled with the signal type. |____|

4 Local Display Panel (LDP) Locations are shown on Control System Schematic drawings. |____|

5 Points Schedule drawings have been sub-divided by device (DDC Hardware), including DDC Hardware node numbers. |____|

Items verified for Post-Construction and Closeout QC Checklist Submittal:

6 All DDC Hardware is installed on a TP/FT-10 local control bus. |____|

7 All Application Specific Controllers (ASCs) are LonMark certified. |____|

8 Communication between DDC Hardware is only via CEA-709.1B using SNVTs. Other protocols and network variables other than SNVTs have not been used. |____|

9 Explicit messaging has not been used. |____|

10 System Scheduler functionality has been installed for all HVAC systems and default schedules have been configured at each System Scheduler. |____|

11 All sequences are performed as specified using DDC Hardware. |____|

12 Training schedule and course attendee list has been developed and coordinated with shops and submitted. |____|

QC CHECKLIST

Items verified for Closeout QC Checklists Submittal:

13	Final As-built Drawings, including the Points Schedule drawings accurately represent the final installed system.	|____|
14	LonWorks Network Services (LNS) Database is up-to-date and accurately represents the final installed system.	|____|
15	LNS Plug-ins have been submitted for all ASCs.	|____|
16	Programming software has been submitted for all General Purpose Programmable Controllers (GPPCs).	|____|
17	All software has been licensed to the Government	|____|
18	O&M Instructions have been completed and submitted.	|____|
19	Training course has been completed.	|____|

_____

(QC Representative Signature) (Date)

-- End of Section --

Appendix FF

Bulletin Board, Project Sign, And Project Safety Sign

EP 310-1-6a
01 Jun 06

Construction Project Identification Sign

Below are two samples of the Construction Project Identification sign showing how this panel is adaptable for use to identify either military (top) or civil works projects (bottom). The graphic format for this 4'x 6' sign panel follows the legend guidelines and layout as specified below. The large 4'x 4' section of the panel on the right is to be white with black legend. The 2'x 4' section of the sign on the left with the full Corps Signature (reverse version) is to be screen-printed Communication Red on the white background The designation of a sponsor in the area indicated is optional with Military or Civil Works construction signs. Signs may list one sponsoring entity. If agreement on a sponsor designation cannot be achieved, the area should be left blank.

This sign is to be placed with the Safety Performance sign shown on the following page. Mounting and fabrication details are provided on page 16-4.

Special applications or situations not covered in these guidelines should be referred to the district Sign Program Manager.

Legend Group 1: One- to two-line description of Corps relationship to project.
Color: White
Typeface: 1.25" Helvetica Regular
Maximum line length: 19"

Legend Group 2: Division or District Name (optional). Placed below 10.5" reverse Signature (6" Castle).
Color: White
Typeface: 1.25" Helvetica Regular

Legend Group 2a: One- to three-line identification of Military or Civil Works sponsor (optional). Place below Corps Signature to cross-align with Group 5a-b.
Color: White
Typeface: 1.25" Helvetica Regular
Maximum line length: 19"

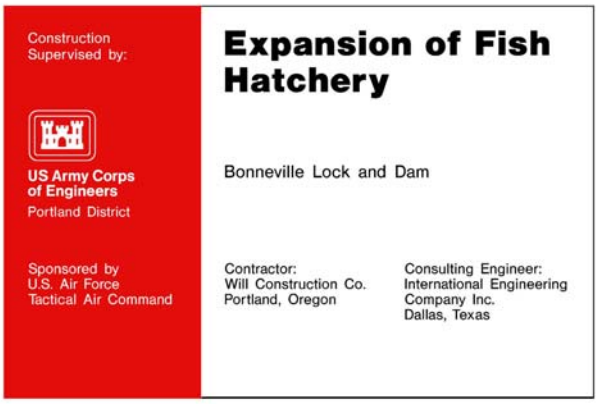
Legend Group 3: One- to three-line project title legend describes the work being done under this contract.
Color: Black
Typeface: 3" Helvetica Bold
Maximum line length: 42"

Legend Group 4: One- to two-line identification of project or facility (civil works) or name of sponsoring department (military).
Color: Black
Typeface: 1.5" Helvetica Regular
Maximum line length: 42"

Cross-align the first line of Legend Group 4 with the first line of the Corps Signature (US Army Corps) as shown.

Legend Groups 5a-b: One- to five-line identification of prime contractors including: type (architect, general contractor, etc.), corporate or firm name, city, state. Use of Legend Group 5 is optional.
Color: Black
Typeface: 1.25" Helvetica Regular
Maximum line length: 21"

All typography is flush left and rag right, upper and lower case with initial capitals only as shown. Letter- and word-spacing to follow Corps standards as specified in Appendix D.



Sign Type	Legend Size (A)	Panel Size	Post Size	Specification Code	Mounting Height	Color Bkg/Lgd
CID-01	various	4'x6'	4"x4"	HDO-3	48"	WH-RD/BK

Figure 1- Project Sign

SAFETY SIGN

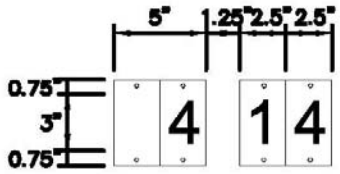
All typography is flush left and rag right, upper and lower case with initial capitals only as shown. Letter and word spacing to follow Corps Standards (EP 310-1-6a and 6b).

Legend Group 1: Standard two-line title "Safety is a Job Requirement" with (8" od.) Safety Green First Aid logo. Typeface: 3" Helvetiva Bold; Color: Black.

Legend Group 2: One to two-line project title legend describes the work being done under this contract and name of host project. Typeface: 1.5" Helvetica Regular; Color: Black; Maximum line length: 42".

Legend Group 3: One to two-line identification: name of prime contractor and city, state address. Typeface: 1.5" Helvetica Regular; Color: Black; Maximum line length: 42".

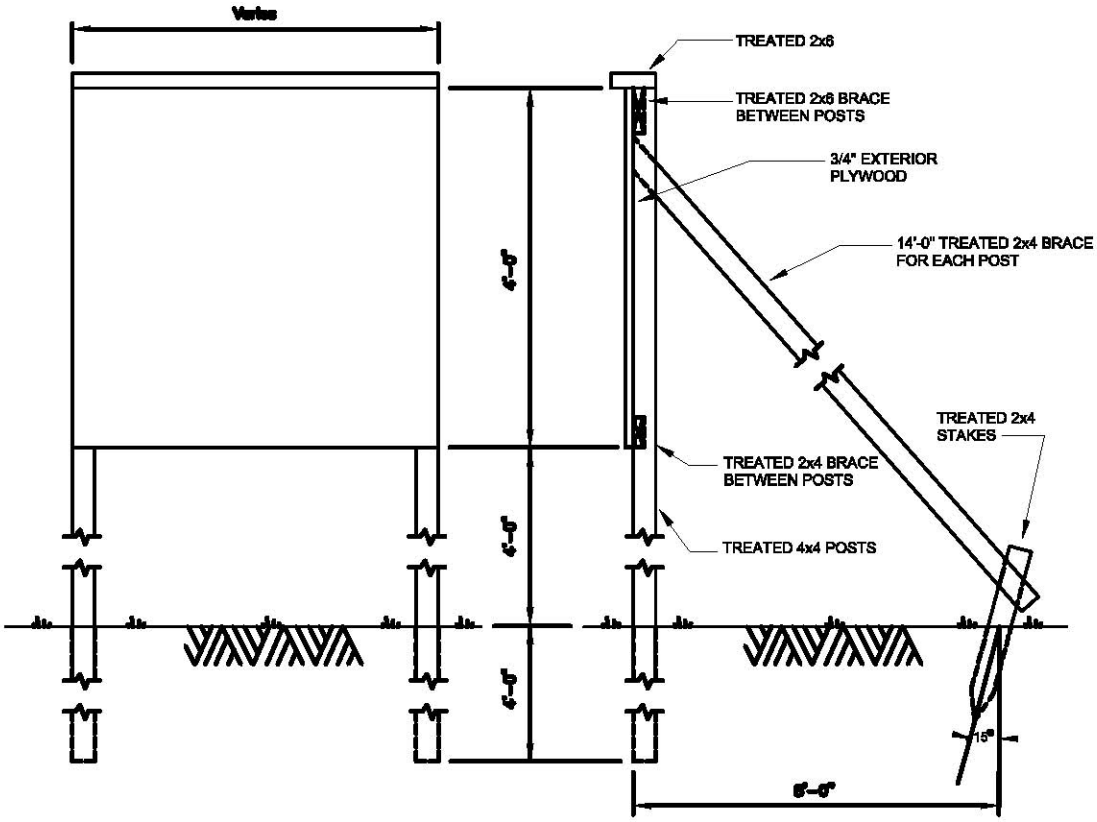
Legend Group 4: Standard safety record captions as shown. Typeface 1.25" Helvetica Regular; Color: Black.

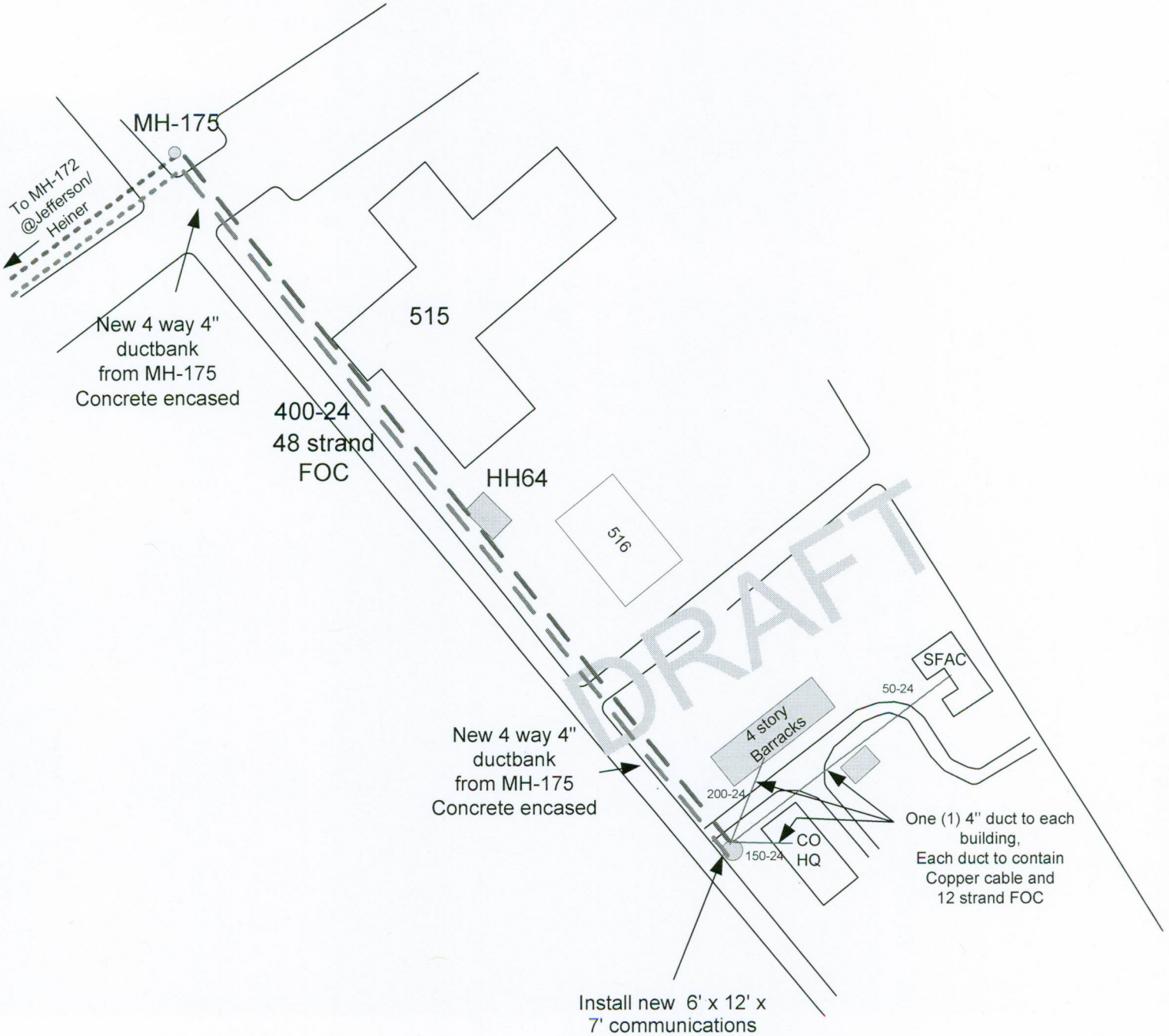


Replaceable numbers are to be mounted on white 0.060 aluminum plates and screw-mounted to backdrop. Typeface: 3" Helvetica Regular; Color: Black; Plate size: 2.5"x 4.5".

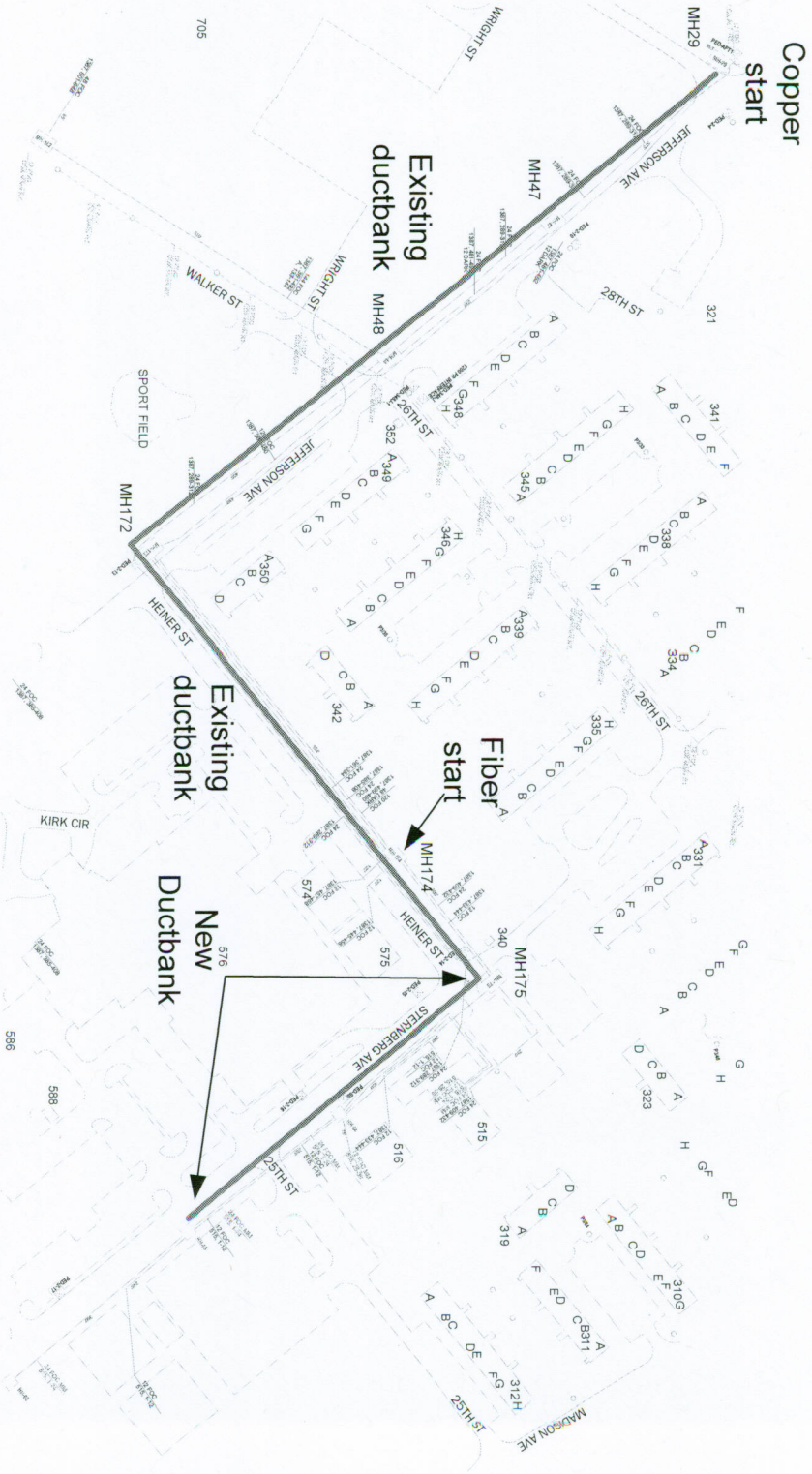
Figure 2 – Safety Sign

SIGN ERECTION DETAILS





Anticipated building load:
Barracks 80 room x 1.5 = 120; 200 pair
Company Ops – 76 x 1.5=114; 150 pair
SFAC Bldg – 20 x 1.5=30; 50 pair
TOTAL PAIRS - 400


Copper start
MH29
JEFFERSON AVE
MH47
Existing ductbank
MH48
WRIGHT ST
WALKER ST
28TH ST
26TH ST
SPORT FIELD
MH172
HEINER ST
Existing ductbank
Fiber start
MH174
KIRK CIR
New Ductbank
MH175
STERNBERG AVE
25TH ST
MADISON AVE
705
321
341
352
348
349
345A
338
346G
350
339
334A
342
335
331
340
574
575
576
515
516
323
319
310G
311
312H
586
588

OSP Cable construction standards

- All new handholes will have at minimum 4" of pea gravel or other applicable material placed in them.
- All new handholes will be 30" W x 48"L and have a minimum 20K rated lid.
- Any innerducts passing through manholes/handholes will be cut no more than 4 inches from the sidewall. NO solid innerduct pass throughs are permitted.
- A minimum of 12 strands single mode fiber will be deployed to end user buildings (EUB).
- Any asphalt/concrete cuts will extend at least 6 inches beyond either side of the trench.
- Backfill materials will be deposited and tamped in 6 inch layers until the conduit has a cover of not less than one foot. After one foot, the remainder of the backfill material will be tamped in 1 foot layers.
- Any open trenching will have warning tape placed no closer than 1 foot above ducts.
- All fiber installation will include a locate wire, either 12 AWG or RG 56. All unused ducts will also have locate wire placed in them.
- Entrance conduits will not be mounted on the exteriors of buildings unless **previously approved** by the U.S. Government. Where approved, the amount of conduits mounted on the external walls of buildings shall be minimized. Pull boxes shall be placed where conduits penetrate external walls.
- Electrical-metallic tubing(EMT) will not be used on the exterior of buildings.
- The transition from plastic to rigid metal conduit (RMC) shall take place at the bottom of the trench PRIOR to sweeps or bends to the building.
- Direct burial of copper cable is the preferred method of placement in less congested areas. FOC will **NOT** be direct buried.
- All manholes will be set on a leveled, crushed, washed gravel base with a minimum thickness of 6" under the entire manhole.
- Manhole and handholes in duct systems in cantonment areas[1] that have or may potentially have multiple cables shall not be spaced more than 600 feet apart.
- Manhole and handholes in duct systems in sparsely populated areas or at end of runs that will only have FOC or small copper cables (not to exceed 100 pair) can be spaced up to 1000 feet apart.
- All new manholes will have the applicable racking, pulling-in irons, and grounding system incorporated. They will also have a sump cast into the floor, approximately 13"x13" and 4" deep with a removable perforated or punched plate cover.
- Ducts placed under paved road surfaces and certain heavy traffic non-surfaced roads shall be protected by one of the following methods: Concrete-encased duct, galvanized RSC, steel pipe casings, or directional boring of HDPE ducts.

- The duct system shall be concrete encased in all main cantonment areas unless otherwise specified in the Engineering Design Plan (EDP) or Performance Work Statement /PWS.
- The section length of conduits shall not exceed 600 feet between pulling points in main conduit runs without U.S. Government approval.
- New main duct runs shall consist of a minimum 6-way, 4 inch duct banks.
- A lateral duct run is defined as a minor branch from the main duct run between MH's. New lateral duct runs shall be a minimum of 4-way, 4 inch duct banks.
- Entrance ducts are defined as ducts from a MH or hand hole to a EUB. New EUB entrance ducts shall be a minimum of 2-way, 4 inch duct banks. Ducts will be cut to a height no more than 6" AFF.
- At least 24" of cover is required above the top of the duct bank. At least 18" of cover is required under roads or sidewalks IF duct is concrete encased.
- Entrance conduits in minor buildings, as listed in the design package, shall be a minimum of 1-way, 4 inch duct if the entrance cables are less than 1" diameter and if less than 40% of the duct shall be used.
- Cables entering a building from the outside and not rated for inside plant use may not extend beyond 50 feet from the cable's point of entry into the building. The point of entry may be extended beyond the 50 feet limitation by using either rigid metal conduit (RMC) or IMC, both of which shall be grounded.
- Ducts placed by horizontal directional drilling (HDD) shall not directly enter a MH, but shall be attached to conduit stubouts that extend a minimum of 10 feet from the MH.

This list and its references are not intended to be all inclusive of applicable construction standards on Fort Eustis/Story. Items of concern, which you feel needs to be addressed should be brought to the attention of this office. Any omissions or errors are unintentional and will be corrected when they are made known. These standards come from numerous sources including EIA standards, NEC code, BCS, I3A Standards, and US Government technical orders and manuals. Contractors will be responsible for adhering to all applicable construction and installation standards.

Please contact the appropriate U.S . Government employee if there are any questions.

All cost estimates will include a detailed BOM as well as a statement of work. Attachment is the typical backboard layout for new construction.

[1] *Term "Cantonment" is defined to mean the part of the military installation where the following buildings/functions are permanently located/concentrated: administrative offices, headquarters, operations buildings, motor pools, logistic facilities, troop barracks, dining facilities, garrison support functions, theaters, post exchanges, etc. The key here is "CONCENTRATION OF BUILDINGS".*

Guidelines from "Technical Guide for Installation Information Infrastructure Architecture" by Fort Detrick Engineering Directorate July 2008