US Army Corps
of Engineers®

FAR EAST DISTRICT DESIGN GUIDE

September 2023

Record of Changes (changes are indicated by \1\.../1/)

No	Date	Description	Chief Technical Services Branch
0	13 Sep 23	**Original**	

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CHAPTER 1 - GENERAL INSTRUCTIONS

1.1 PURPOSE

The purpose of the Design Guide is to provide guidance that assists designers in preparing engineering deliverables for the U.S. Army Corps of Engineers (USACE), Far East District (henceforth referred to as the Far East District). Designers include the Architect-Engineer firms under contract with the Far East District, the Far East District project delivery teams producing in-house designs, and other USACE districts providing reach back support to the Far East District.

1.1.1 SCOPE

The Design Guide covers technical requirements for plans and design analysis submittals, specifications preparation, and Quality Control requirements for U.S. and Republic of Korea (ROK) funded design and construction projects to include Military Construction (MILCON); Republic of Korea In-Kind (ROKFC In-Kind); Sustainment, Restoration and Modernization (SRM); Non-Appropriated Funds (NAF); and Operations & Maintenance (O&M).

The Design Guide contents focus on quality and technical design requirements. The Design Guide does not cover subjects such as scopes of work, project management, progress milestones and scheduling, value engineering, handling of sensitive information, and other procedural/managerial types of instructions and requirements.

1.1.2 APPLICATION

This Design Guide applies to all engineering deliverables produced for the U.S. Army Corps of Engineers, Far East District.

1.1.3 AUTHORITATIVE DOCUMENT

This Design Guide forms the standard for the Far East District to the extent specified herein. Every attempt shall be made to comply with the Design Guide, but exceptions may exist. These exceptions will be addressed on a case-by-case basis. All exceptions shall be raised through the project Design Manager/COR. The Design Guide will function as a supplement and expectations guide to the requirements of the Base Contract and SOW. Should this design guide and the contract documents conflict, the contract will take precedence. Any deviations from references or those of the subsequent chapters including the use of criteria obtained directly from the Using Agency or other sources must be considered, approved, or resolved by FED.

1.2 DESIGN POLICY

The Unified Facilities Criteria (UFC) and the Far East District (FED) Guide Specifications shall be used to the greatest extent practical by all the Department of Defense (DoD) Components for planning, design, and construction (restoration and modernization) of facilities, regardless of funding source per DoD Directive Number

4270.5 paragraph 4.7, dated 12 February 2005, Incorporating Change 1, August 31, 2018.

The UFCs require compliance, as applicable, with Host Nation agreements and the Status of Forces Agreement.

1.3 DESIGN CRITERIA, REGULATIONS, MANUALS AND STANDARDS

The designer shall use criteria established in the UFCs. The designer is responsible for determining the applicability of these design criteria to each project and incorporating any applicable Service Component criteria in order to comply with all necessary design requirements. The latest version of each reference shall be used, and designer must ensure compliance with the most stringent of the references.

This Design Guide provides guidance on implementation of these agreements.

The UFCs and Engineer Manuals, Engineering Pamphlets, Engineer Regulations, and, Engineer Technical Letters are available electronically at the Whole Building Design Guide website (https://www.wbdg.org/ffc/dod) or HQ USACE website (https://www.publications.usace.army.mil).
Engineering criteria related to Host Nation agreements in Korea are referenced in the discipline specific chapters. The Korea Environmental Governing Standards (KEGS) issued by U.S. Forces Korea (USFK) applies to all U.S. Installations located within Korea.

UFC 1-200-01 is the overarching document for DoD buildings and facilities. UFC 1-200-01 directs the use of the International Building Code (IBC), the International Existing Building Code (IEBC), Core UFC, other UFC as applicable to the building, facility, structure, or system, and Facility Criteria (FC) as they pertain to the applicable DoD Component.

Established local or regional Installation Standards shall be referenced to meet the user's functional needs and maintain the architectural character and quality inherent and unique to specific project locations.

1.3.1 IMPLEMENTATION OF NEW CRITERIA

New criteria will be implemented as soon as possible consistent with the guidance provided below:

1.3.1.1 ROUTINE

Routine application requires the use of new criteria in future protects and in current projects, if received prior to initiation of site adaptation of standard drawings or at the 35 percent concept design stage.

1.3.1.2 SPECIAL

Special application requires the use of new criteria in future projects and integration into projects already designed, by issuing amendments to bidding documents where necessary during the bidding period, but only if it is clear that bidders will have adequate time to receive and consider the changes without postponing bid opening.

1.3.1.3 IMMEDIATE

Immediate application requires integration into all project, including those already under construction, except-where immediate application would cause on or more of the following conditions:

(a) Delay critical beneficial occupancy dates,

(b) Result in negative cost/benefit ratio due to removal of construction already in place,

(c) Result in the loss of materials already delivered, or

(d) Require further funding which would require further apportionment or jeopardize funding of other items in the construction program.

For such exceptions, the major subordinate commands (MSC) are authorized to waive implementation of the change for an Army project, and for an Air Force project, the matter will be referred to the Air Force Civil Engineer Center (AFCEC) for implementation approval. If new criteria are received shortly before bid opening, the changes will be incorporated in the bidding documents by the use of amendments, with postponed bid opening if necessary, rather than by issuing change orders after award of the contract. Unless special or immediate application is specified, new or revised design criteria issued by HQUSACE will receive routine application.

1.4 METRIC POLICY

Far East District policy is to use the metric system of measurement (International System of Units, SI) in planning and design criteria, FED Guide Specifications, and construction contract documents.

1.4.1 SI DEFINITIONS

1.4.1.1 HARD METRIC

A hard metric measurement indicates a non-interchangeable International System of Units (SI) value and is based on SI values that change in size and properties from Inch- Pound (IP) values. Hard metric measurements are often used for field data such as distance from one point to another or distance above the floor. Products are considered to be hard metric when they are manufactured to metric dimensions or have an industry recognized metric designation.

1.4.1.2 SOFT METRIC

A soft metric measurement is a non-mathematical, industry related conversion. Soft metric measurements are used for measurements pertaining to products, test values, and other situations where the I-P units are the standard for manufacture, verification, or other controlling factor. A soft metric measurement is also indicated for products that are manufactured in industry designated metric dimensions but are required by law to allow substitute I-P products.

1.4.1.3 NEUTRAL

A neutral measurement is indicated by an identifier which has no expressed relation to either an SI or an I-P value (e.g., American Wire Gage (AWG) which indicates thickness but in itself is neither SI nor I-P).

1.4.2 GENERAL POLICY

1.4.2.1 PRODUCTS

All products shall be specified in hard metric unless such products are unavailable or uneconomical. The DOR is responsible for making the determination on whether or not to use the metric system of measurement on a project-by-project basis. However, decisions to not use the metric system shall be approved by the Far East District and shall be justifiable and documented in permanent project files.

1.4.2.2 WEIGHTS AND MEASUREMENTS

All dimensions shall be specified in hard metric units of weights and measurements and shall comply with Federal Standard 376B Preferred Metric Units for General Use by the Federal Government.

1.4.2.3 CONVERSION OF VALUES

The practice of converting US Units (to include Customary, Empirical, and English units) into SI units is highly problematic. Practitioners preparing and/or providing construction contract documents shall eliminate the practice of converting units of weights and measurements. In circumstances that may require the use of US Units, the AE shall coordinate the use of such units with the project Design Manager and Project Manager, and be approved by the Far East District.

1.4.2.4 METRIC PROJECT DEFINITION

The Far East District considers a project to be metric when such applications intended for use in engineering studies, analyses, plans, and/or construction contract documents are performed using the SI unit system as described above. All designs shall be initiated with SI units of weights and measurements as referenced above as Hard Metric.

1.5 KOREAN MATERIALS AND PRODUCTS

The design shall incorporate Korean materials, products and construction methods to the maximum extent possible. The use of Korean materials, products and construction

methods ensures that the project is biddable and constructible, and the facility can be maintained with local materials/supplies by the local workforce.

All the local materials/supplies shall comply with FED Guide Specifications and UFGS.

A list of acceptable local industrial standards is available for reference from FED Specifications Section.

There are several important exceptions when Korean materials and products should not be used. The exceptions include, but are not limited to, fire and life safety devices and elevator items that do not meet U.S. code and criteria.

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CHAPTER 2 - SUBMITTAL REQUIREMENTS

2.1 GENERAL

Design submittals prepared in accordance with the AR 420-1, ER 1110-345-700, and the chapter 2 of this design guide.

The Basis of Design shall include all items listed in the chapter 2, even when items are not applicable to a project.

Provide sufficient dimensions that avoid construction difficulties for either the construction contractor or Government construction contract administration staff in accordance with the para. 5-3.5.3 of UFC 3-101-01.

Use reference symbols on the drawings to indicate which section or detail applies. Use material indications to clearly identify all construction materials.

Prepare project specifications based on FED Guide Specifications unless written permission is given from FED except for the sections not covered by the FED Guide specifications. The sections that are not in the FED Guide specifications shall be prepared from UFGS.

2.1.1 PROJECT DESIGN PHASES

Design is typically accomplished in the following phases:

Table 1: Design Submittal Phases

Design Phase Name	**Design Percent Complete**
Programming Charrette	0%
Parametric Design	15%
Concept Design	30%
Preliminary Final Design	60%
Final Design	90%
Backcheck	95%
Contract Documents	100%
Amendments, as Required	Revision

The technical content of drawings, design analysis, and specifications for each Design Phase shall be prepared in accordance with ER 1110-345-700 and the relevant chapters of this guide.

2.1.2 BUILDING GROSS AREA CALCULATION METHODS

For vertical construction, facilities are limited in gross area to that identified on the project DD Form 1391 or other project authorization documents. Facilities shall also

meet gross area and travel distance requirements contained in the building and fire codes. These two requirements are performed separately and require the designer to calculate gross area differently. It is critical to understand and apply the correct method and criteria for the purpose intended.

2.1.2.1 BUILDING GROSS AREA CALCULATION FOR SCOPE AND DD FORM 1391 COMPLIANCE

Calculations are based on DOD mandated methods and are used to validate congressional statutory compliance. The facility Gross Area calculations shall be as stated in UFC 3-101-01 ARCHITECTURE. This calculation method recognizes the relationship of building area and construction cost. Facility type “Unit Costs” are based on this calculation method. This evaluation recognizes different cost factors apply to roofs, overhangs, stairs, etc. Thus, these areas are given a different value than enclosed/conditioned space. Exclusively use this calculation method when performing facility scope and square meter analysis of the project scope and area limitations.

2.1.2.2 GROSS AREA CALCULATION FOR BUILDING AND LIFE SAFETY CODE COMPLIANCE:

Calculations are based on latest version of UFC 1-200-01 DOD BUILDING CODE. Gross area begins at the interior face of exterior walls and firewalls. It excludes vents, shafts, and courts. The same definition is used in the NFPA 101, The Life Safety Code. This method is used to calculate the area limitations for construction types, occupancy types, and exit distances when completing the Fire Protection/Life Safety Code compliance worksheet.

2.2 DESIGN DEVELOPMENT

The development of engineering design analysis, drawings, specifications, and CID are based on the following documents:

- AR 420-1 Army Facilities Management
- ER 1110-1-8155 Specifications
- ER 1110-345-700 Design Analysis, Drawings and Specifications
- ERDC/ITL TR-12-1 A/E/C Graphic Standard
- ERDC/ITL TR-12-6 A/E/C CAD Standard
- FC 1-300-09N Navy and Marine Corps Design Procedure
- UFC 3-101-01 Architecture
- UFC 3-120-10 Interior Design
- UFC 3-410-01 Heating, Ventilating, and Air Conditioning Systems
- UFC 3-501-01 Electrical Engineering
- UFC 3-600-01 Fire Protection Engineering for Facilities

2.3 DESIGNER RESPONSIBILITY

The designer is responsible for providing a professional high quality, integrated design.

The Integrated Design approach is defined by UFC 1-200-02 Section 2-2. The UFC cites International Green Construction Code (IgCC) *Informative Appendix F* for the integrated design, as described in IgCC F101.1.1 for the *Charrette Process*. Ensure that each project has implemented an integrated design approach that meets the requirements of UFC 1-200- 02 and IgCC.

The Designer of Record (DOR) shall stamp, sign, and date each design drawing and other design deliverables under their responsible discipline at 100% Contract Documents submittal stage.

Designers are responsible to obtain a copy of the cited references. ER 1110-3-12, Chapter 5, and ER 1110-1-8152 discuss design responsibility. All responsibilities defined in ERs shall be referenced as well as responsibilities in this Design Guide.

Use of this document and adherence to its requirements in no way relieves the contractor of any of his or her professional, legal, or other responsibility to deliver a safe, functional, useable design that complies with all relevant codes and standards.

2.4 GENERAL DRAWING REQUIREMENTS

Drawings shall comply with the most recent A/E/C CAD Standards.

Electronic files created by the designer and files modified from existing source material shall be supplied to the Far East District upon request. All electronic files shall be compatible with the Far East District's existing CAD system. Verify CAD system requirements with the Far East District CAD Manager.

Requirements for PDF files are as follows:

- File Structure for drawings: Within the main PDF folder, subfolders shall be organized by discipline. These disciplines are defined by A/E/E CADD Standards. Both individual files and combined files per discipline shall be submitted.
- Rotation: All PDF files shall be rotated to match the sheet orientation.
- Bookmarks: All PDF files shall include drawing sheet number and sheet title information per drawing, and table of contents for DA, in the bookmarks.
- Searchable Text: All PDF files shall be able to search text.

2.5 PARAMETRIC DESIGN REQUIREMENTS

Follow the requirements of the Scope of Work for parametric design requirements.

Refer to AR 420-1, issue date 24 August 2012 and the USACE Instructions for Parametric Design (Code 3), dated 1 October 2008.

MILCON projects that receive a code 3 Parametric Design directive require the conduct of a design charrette and preparation of a Parametric Design Report (PDR), equivalent to approximately 15% design as defined in AR 420-1.

2.6 CONCEPT DESIGN REQUIREMENTS

The designer shall prepare the concept design based on the discussions and decisions made at the design charrette.

The concept design goal is to demonstrate that the designer has a thorough understanding of the scope of the project and the owner's requirements, as discussed at the design charrette. The design shall meet the base installation design requirements and relevant criteria.

At the concept design stage, the designer shall confirm all CAD requirements (i.e., sheet numbering, sheet size, A/E/C CAD & USACE standards) with the Far East District Engineering Division.

A CONCEPT DESIGN SUBMITTAL TYPICALLY CONSISTS OF THE FOLLOWING:

2.6.1 CONCEPT (30%) DESIGN ANALYSIS

The design analysis shall be in compliance with ER 1110-345-700, Appendix B. The design analysis will address the following major design discipline subjects in the narrative:

Table 2: Design Analysis Outline

ITEM #	DISCIPLINE	REQUIREMENT
1.	GENERAL	General description: Purpose authorization Project description Criteria
		Include a discussion of: Existing conditions Project goals Design assumptions

ITEM #	DISCIPLINE	REQUIREMENT
2.	ALL	Design calculations Referenced criteria Include placeholder sections for topics not required in the concept submittal, but needed for intermediate submittal Economic summary; Life cycle cost analysis Description of materials and methods of construction to be used Identify sole source items that require a Justification & Approval (J&A) through the Contracting Officer
3.	CIVIL	Site analysis that discusses the opportunities and constraints of the site and includes the recommendations from the Installation Master Plan and Installation Planning Standards Preliminary erosion control analysis Preliminary grading narrative Site specific traffic analysis Site specific drainage analysis of existing and proposed conditions Narrative descriptions of water, wastewater and gas systems, including existing condition
4.	LANDSCAPING	Preliminary plant material analysis that reflects the selection of plant material native to the project area, if required
5.	ENVIRONMENTAL	Hazard analysis (lead-based paint, asbestos, radon, contaminated soil, etc., if required) Natural and/or archeological site survey, as applicable
6.	FIRE PROTECTION/ LIFE SAFETY	Life safety and fire protection analysis in accordance with UFC 3-600-01 1-7.2 Life safety egress floor plans Preliminary Hydraulic Analysis

ITEM #	DISCIPLINE	REQUIREMENT
7.	STRUCTURAL	List all design loads and assumptions Provide design calculations for all load derivations General description of the foundation system General description of the lateral load resisting system Name of computer programs used for analysis Preliminary calculations to size structural members including, but not limited to columns, beams, joists, girders, lateral force resisting system
8.	ANTITERRORISM (AT)	Narrative that describes the approach used and basis for AT measures, and narrative that describes compliance with IAW UFC 4-010-01 Provide purpose of facility Provide maximum number of personnel that routinely occupy the facility and level of protection Provide AT calculations which establish the standoff distances if minimum standards to not apply Identify areas where alternative design for exterior doors are required Progressive collapse analysis (PCA) Determine PCA method per UFC 4-023-03 when facility is three stories or taller Name of 3D computer program to be used General description of how PCA is being applied to the structure Provide preliminary PCA calculations
9.	ARCHITECTURE	Design Directives and Scope of Work Type of Construction Life Safety Code Analysis Gross Floor Area Calculations Accessibility Architectural Compatibility Roof System Selection Thermal Insulation

ITEM #	DISCIPLINE	REQUIREMENT
		Security Requirements Anti-Terrorism Architectural Acoustics Sustainable Design & Building Envelope Doors and Windows Interior Design Demolition or Deconstruction Special Construction Features Calculation for number of plumbing fixture
10.	MECHANICAL/ PLUMBING	Exterior envelope U-factors (walls, glazing, roof, etc.) Ventilation/exhaust rate calculations Equipment requirements and calculations Cooling/heating plant sizing summary Radon mitigation requirements analysis, as applicable
11.	ELECTRICAL	Design analysis narrative explaining the electrical scope, existing electrical conditions and proposed design approaches Design analysis appendix showcasing datasheets of proposed electrical equipment/items to be used in the project, and any pertinent analysis/ calculations for early evaluation such as a lightning protection risk analysis, grounding, life cycle cost analysis (LCCA) and preliminary load analysis for transformer sizing
12.	TELECOM	Design analysis narrative explaining the telecommunications scope, existing conditions and proposed design approaches Design analysis appendix showcasing datasheets of proposed telecommunications equipment/items to be used in the project

ITEM #	DISCIPLINE	REQUIREMENT
13.	SUSTAINABLE DESIGN	Preliminary UFC 1-200-02 compliance checklist including a narrative describing how each requirement will be met (not required for projects seeking GPC certification) Preliminary energy compliance analysis (UFC 1-200-02) Third party certification checklist (i.e., LEED, CASBEE, or Guiding Principles Compliance) including a narrative for each proposed credit identifying how that credit will be fulfilled
14.	COMISSIONING	Establish the owner's project requirements (OPR) and the Basis of Design (BOD) utilizing the Far East District template. Develop Design Phase Commissioning Plan that meets ER 1110-345-723 requirements.
15.	APPENDIX	Include DD Form 1391
16.	RENOVATIONS	Verification of implementation triggers for seismic (UFC 3-301-01) and antiterrorism (UFC 4-010-01) requirements based on Property Replacement Values (PRV) versus renovation costs of the existing building(s)

2.6.2 CONCEPT DESIGN DRAWINGS

Below is a list of the design drawings that are required at the Concept Design Phase.

Table 3: Concept Design Drawings

ITEM #	DISCIPLINE	DRAWING TYPE	ADDITIONAL REQUIREMENTS
1.	GENERAL	Title sheet and general sheets with. Vicinity map and location plan with haul route. Construction notes and legend pages, phases (as required)	General sheets to include project index

ITEM #	DISCIP LINE	DRAWING TYPE	ADDITIONAL REQUIREMENTS
2.	LIFE SAFETY / CODE ANALYSIS	Life Safety Plans IAW UFC 3-600-01 1-7.2.3 IBC Code Summary Life Safety Code Summary	Preliminary Code Compliance Site Plan (UFC 3-600-01 1-7.2.4.2)
3.	CIVIL	Project site plans	Including AT standoff setbacks
		Concept grading plans	
		Concept utility plans	
		Subsurface investigation and analysis	
4.	ARCHITECTURE	Plans	Functional relationships and analysis Work area usage Security requirements Traffic flow patterns Roof plan illustrating storm water flow and control
		Building code analysis	
		Exterior building elevations	Showing principal shapes, fenestrations, and finishes
		Building sections	
		Typical Wall Section	
		Interior finish selection	General concepts presented

ITEM #	DISCIPLINE	DRAWING TYPE	ADDITIONAL REQUIREMENTS
		Window and door schedules	
5.	STRUCTURAL	Structural notes • Design loads • Special inspections • Geotechnical information • Materials	Including but not limited to: Risk category AT classification Identify lateral force resisting system
		Foundation plan	Dimensions including but not limited to: Footings, piles, pile caps, tie beams, grade beams, etc.
		Floor plan(s)	Including but not limited to: Column size and locations, beam size and locations, floor slab thickness, openings coordinated with architecture, and location of floor drains as applicable, and lateral force resisting system location
		Roof plan	Including but not limited to: Column size and locations, joist, girder, and truss dimensions and locations, openings coordinated with architecture, lateral force resisting system location, and roof deck
		Building sections	
6.	MECHANICAL	Preliminary DDC controls schematics and sequences of operation	Clearly indicate HVAC zones
		Preliminary HVAC layout	Including equipment capacities and sizes

ITEM #	DISCIP LINE	DRAWING TYPE	ADDITIONAL REQUIREMENTS
		Preliminary plumbing layout	Including equipment capacities and sizes
7.	PLUMBING	Plumbing Legend, General Notes, Abbreviations	
8.	ELECTRICAL	Preliminary electrical layout	See chapter 13 for descriptions of electrical
		Existing/demo site plan(s) New power/lighting site plan(s) General interior power plan(s) General interior lighting plan(s)	Design submittal requirements
		Typical details	
		Riser and/or one-line diagram	
9.	TELECOM	Telecom legend, general notes, abbreviations	
		Preliminary telecom layout: Existing/demo site plan(s) New telecom site plan(s) General interior telecom plan(s)	See chapter 14 for descriptions of telecom design submittal requirements

ITEM #	DISCIP LINE	DRAWING TYPE	ADDITIONAL REQUIREMENTS
		Typical details	
		Riser diagram	
10.	FIRE PROTECTION	General Fire Suppression & FA/MN Notes Preliminary Fire Protection Floor Plans Preliminary Fire Alarm/Mass Notification Plans	FA/MN Riser Diagram Fire Suppression Riser Diagram
11.	ENVIRONMENTAL		

2.6.3 OUTLINE SPECIFICATIONS

Prepare the outline specifications consisting of a list of specifications to cover all aspects of the project. Sections will come from the current FED Guide Specifications or UFGS Master. Add sections from other sources when FED Guide Specifications or UFGS is not available. New specification sections shall be numbered in accordance with the current Construction Specifications Institute (CSI) MasterFormat. The outline shall cover applicable Divisions 01 through 49. Use SpecsIntact program to form the outline specifications. Print the project table of contents without scope in PDF file and submit as the outline specifications.

2.6.4 CONCEPT COST ESTIMATE

Provide a current working estimate.

2.6.5 CONCEPT QUALITY CONTROL

The designer shall coordinate work of all disciplines and conduct thorough Quality

Control of all documents to be submitted to the Government for review. Quality control requirements are covered in chapter 5.

2.7 PRELIMINARY FINAL DESIGN REQUIREMENTS

Prepare the preliminary final design and specifications based on concept design, project criteria and general instructions. At this stage the building and site design shall be finalized with the User, Installation and Far East District.

The preliminary final design effort shall be a continuation of the concept design. The preliminary final design goals are to show the project is on schedule and at an acceptable level of quality and completeness. It shall also demonstrate that the designer's Quality Control (QC) process is functioning properly. The designer shall conduct a full QC review prior to the submittal of the preliminary final design. The designer QC review shall consist of a full Quality Control and Independent Technical Review (ITR). Complete coordination amongst design disciplines shall be conducted to review and resolve design conflicts.

Per UFC 3-120-10, Table B4-1, an SID Binder shall be submitted at Preliminary Design to supplement the description of finish materials. Brand names and model numbers are prohibited.

Preliminary final design typically consists of the concept design with the addition of the following items listed below:

2.7.1 PRELIMINARY (60%) FINAL DESIGN ANALYSIS

The design analysis shall be in compliance with ER 1110-345-700. The design analysis will build upon the concept submittal and address the following major design discipline subjects in the narrative.

Table 4: Preliminary Design Analysis

ITEM #	DISCIPLINE	REQUIREMENT
1.	GENERAL	General description: Purpose authorization Project description Criteria
		Include a discussion of: Existing conditions Project goals Design assumptions

ITEM #	DISCIPLINE	REQUIREMENT
2	ALL	Design calculations and presuppositions Referenced criteria Include placeholder sections for topics not required in the intermediate submittal, but needed for the final submittal
		Economic summary; life cycle cost analysis and value engineering summary Description of materials and methods of construction to be used
3.	CIVIL	Site analysis that discusses the opportunities and constraints of the site and include the recommendations from the Installation Master Plan and Installation Planning Standards Erosion control analysis Grading narrative Site specific traffic analysis Threat scenario analysis for Access Control Points (ACP) and Entry Control Facilities (ECF) Site specific drainage analysis of existing and proposed conditions and calculations justifying proposed finished floor elevations Narrative descriptions of water, wastewater and gas systems, including existing conditions and capacity Complete subsurface investigation and analysis
4.	LANDSCAPING	Preliminary plant material analysis that reflects the selection of plant material native to the project area, if required

ITEM #	DISCIPLINE	REQUIREMENT
5.	ENVIRONMENTAL	Hazard analysis (lead-based paint, asbestos, radon, contaminated soil, etc., if required) Natural and/or archeological site survey, as applicable
6.	FIRE PROTECTION / LIFE SAFETY	Updated Life Safety and Fire Protection Analysis IAW UFC 3-600-01 1-7.2
7.	STRUCTURAL	List all design loads and assumptions Provide design calculations for all load derivations Provide design calculations for the foundation system Provide design calculations for the lateral load resisting system, diaphragm, chord and collector elements Calculations to size structural members including, but not limited to columns, beams, joists, girders, lateral force resisting system Provide design calculations for non-structural components, supports and attachments
8.	ANTITERRORISM (AT)	Narrative that describes the approach used and basis for AT measures, and narrative that describes compliance with IAW UFC 4-010-01 Specifically address all 21 Standards Provide blast resistant window calculations if applicable Provide performance requirements for exterior blast doors, if required

ITEM #	DISCIPLINE	REQUIREMENT
9.	PROGRESSIVE COLLAPSE ANALYSIS (PCA)	Determine PCA method per UFC 4-023-03 Name of 3D computer program to be used General description of how PCA is being applied to the structure Provide preliminary PCA calculations
10.	ARCHITECTURE	Design Directives and Scope of Work Type of Construction Life Safety Code Analysis Gross Floor Area Calculations Accessibility Architectural Compatibility Roof System Selection Thermal Insulation Security Requirements Anti-Terrorism Architectural Acoustics Sustainable Design & Building Envelope Doors and Windows Interior Design Demolition or Deconstruction Special Construction Features Calculation for number of plumbing fixture Calculation for roof drainage

ITEM #	DISCIP LINE	REQUIREMENT
11.	MECHANICAL / PLUMBING	Designed HVAC systems types, capacities, and controls, including a description of the selected system Pressure loss calculations for all air fans and hydronic pumps Designed plumbing system types, including description of the selected system Compressed air system type, capacity, and controls Designed Petroleum, Oil, and Lubricants (POL) system types, including a description of the selected system (as required) Energy modeling assumptions, climate zone classifications, building envelope requirements and results of the energy modeling and design energy use calculations Commissioning requirements Radon survey data with mitigation system, as applicable
12.	ELECTRICAL	Design analysis narrative explaining the electrical scope, existing electrical conditions and proposed design approaches Design analysis appendix showcasing datasheets of proposed electrical equipment/items to be used in the project Design analysis calculations detailing all pertinent electrical design calculations such as lighting calculations, short circuit analysis, and voltage drop calculations; as well as parametric and concept design calculations/analysis and any updates to them

ITEM #	DISCIPLINE	REQUIREMENT
13.	TELECOM	Design analysis narrative explaining the telecommunications scope, existing electrical conditions and proposed design approaches Design analysis appendix showcasing datasheets of proposed telecommunications equipment/items to be used in the project Design analysis calculations detailing all pertinent telecommunications design calculations as described in this document
14.	SUSTAINABLE DESIGN	Updated UFC 1-200-02 compliance checklist including a narrative describing how each requirement will be met (not required for projects seeking GPC certification) Updated Energy Compliance Analysis IAW UFC 1-200-02 Updated Third Party Certification checklist (i.e., LEED, CASBEE, or Guiding Principles Compliance) including a narrative for each proposed credit identifying how that credit will be fulfilled
15.	COMMISSIONING	Update the OPR, BOD and design phase commissioning plan. Provide all related TPC required documentation in preparation for construction.
16.	APPENDIX	Include DD Form 1391 Life cycle cost analysis Whole Building Energy Simulations Owner Project Requirements

ITEM #	DISCIP LINE	REQUIREMENT
17.	RENOVATIONS	Verification of implementation triggers for seismic (UFC 3- 310-04) and antiterrorism (UFC 4-010-01) requirements based on Property Replacement Values (PRV) versus renovation costs of the existing building(s)

2.7.2 PRELIMINARY (60%) FINAL DESIGN DRAWINGS

Table 5: Preliminary Final Design Drawings Outline

ITEM #	DISCIP LINE	DRAWING TYPE	ADDITIONAL REQUIREMENTS
1.	GENERAL	Title sheet and general sheets	General sheets to include project index
		Vicinity map and location plan with haul route	
		Construction notes and legend pages, phases (as required)	
2.	LIFE SAFETY / CODE ANALYSIS	Building Life Safety Code Analysis Code Compliance Site Plan Life Safety Plan	Occupant Load Schedule (Table) General & Sheet Notes and Legend as necessary
3.	CIVIL	Geotechnical boring logs	
		Existing conditions (topography)	

ITEM #	DISCIP LINE	DRAWING TYPE	ADDITIONAL REQUIREMENTS
		Demolition plan	
		Project site plan	Including standoff setbacks and traffic flow patterns
		Grading plans and sections	
		Utility plans and profiles	
		Road sections, plans and profiles	
		Civil and site details	
4.	ARCHITECTURE	Plans: Floor plans Reflected ceiling plans Roof plans Furniture & equipment plans Signage plans Interior finish floor plans Life safety egress floor plans	Functional relationships and analysis Work area use Security requirements Roof plan to illustrate storm water flow and control
		Air Barrier	Indicate how the air Barrier is applied, in accordance with UFC 3-101-01 on separate sheets.
		Building code	
		Exterior building elevations	Showing fenestration, finishes and coordination between disciplines
		Interior elevations	Show coordination between finishes, interdisciplinary and features of the buildings
		Building section	Sections indicating the major conditions through the building
		Wall sections	Identify air barriers, moisture barrier, and insulation barrier system.

ITEM #	DISCIP LINE	DRAWING TYPE	ADDITIONAL REQUIREMENTS
		Schedules: Wall types Door, window, louver Exterior finishes Room finish Interior finish	Include AT requirements for exterior doors and windows. Provide interior or exterior wall or partition types for all walls. Indicate all wall type locations on the floor plan.
5.	STRUCTURAL	Structural notes Update structural notes from concept submittal	
		Foundation plan	Update the foundation plan from the concept submittal to include but not limited to: Coordination w/ architecture, mechanical, electrical, and plumbing for openings, slab recesses, control joints, seismic joints, etc. Coordinate footing and pier locations with new and existing utilities
		Floor plan	Update the floor plan from the concept submittal to include but not limited to: Horizontal diaphragms, shear transfer, collector elements, lateral bracing and openings Coordination w/ architecture, mechanical, electrical, and plumbing for floor openings
		Roof plan	Update the roof plan from the concept submittal to include but not limited to: Horizontal diaphragms, shear transfer, collector elements, lateral bracing and openings Coordination w/ architecture, mechanical, electrical, and plumbing for roof openings

ITEM #	DISCIP LINE	DRAWING TYPE	ADDITIONAL REQUIREMENTS
		Foundation schedule and details	Details include foundation sections showing connections to walls, slab, grade beams, etc.
		Wall sections and details	Details to include shear transfer, opening details, boundary elements, etc.
		Column schedules and details	
		Beam / girder schedules and details	
		Slab schedules and details	
		Building sections	
		Shear wall and building frame elevations as applicable	
		Non-structural components, supports and attachments	See ASCE 7 Chapter 13 for design requirements
6.	MECHANICAL	Mechanical legend, general notes, abbreviations	
		Plans: Site HVAC Piping Compressed air	
		Sections	Mechanical room plans shall be supplemented by at least one section; at least two sections for more complex, congested applications Provide ample building sections in congested areas for coordination with arch/structural
		DDC points list	Control points of the DDC for the utility monitoring system Identify the installation monitoring system and the compatibility of the proposed installed system

ITEM #	DISCIP LINE	DRAWING TYPE	ADDITIONAL REQUIREMENTS
		Equipment schedules Air handling units Exhaust fans Heat recovery units Chillers Compressor, dryer, accumulator Tank	*Any other HVAC design
		Isometrics	Refrigerant, chilled, and hot water piping diagrams
		Riser diagrams	
		DDC schematics and equipment control	
		Details	Preliminary details indicating the method and approach of the design intent Preliminary one-line diagrams
7.	PLUMBING	Plumbing Legend, general notes, abbreviations	
		Plans: Site plumbing	Sub-pipe system layout for radon mitigation Show condensate drain lines from all cooling coils Indicate required depth of water trap Show slope from drain pan
		Sections	
		Equipment control sequences	
		Schedules plumbing fixtures Plumbing equipment	
		Isometric / riser diagrams	
		Details	

ITEM #	DISCIPLINE	DRAWING TYPE	ADDITIONAL REQUIREMENTS
8.	ELECTRICAL	Electrical legend, notes, abbreviations Plans: Site plan(s) Demolition plan(s) Lighting plan(s) Power plan(s) Mech. connections plan(s) Lightning protection plan(s) Grounding plan(s) Cathodic protection plan(s)	See chapter 13 for descriptions of electrical design submittal requirements
		Schedules Lighting fixture schedule Mech. connections schedule Panel schedules	
		Electrical riser and/or one-line diagram	
		Electrical details	
		Telecom legend, notes, abbreviations	
9.	TELECOM	Plans: Demo plan(s) Telecom site plan(s) Building telecom plan	See chapter 14 for description of telecom design submittal requirements
		Telecom riser diagram	
		Telecom details	
		Fire suppression legend, general notes, abbreviations	
10.	FIRE PROTECTION	Fire alarm & mass notification legend, notes, abbreviations Fire Suppression legend, notes, and abbreviations	Fire alarm riser layout Sprinkler riser layout

ITEM #	DISCIPLINE	DRAWING TYPE	ADDITIONAL REQUIREMENTS
		Plans Fire alarm & mass notification system plan Fire suppression system plan	All devices are shown on the plans All piping and sprinkler heads are shown on the plans
		Code analysis	
		Details	Seismic Bracing Relevant piping connections
		FA/MN Matrix	
		Hydraulic Calculation Node Plan	
11.	FOOD SERVICE (as required)	Plans Equipment plans	
		Schedules Equipment schedule	
		Details	
		AV plans	
12.	AUDIO / VIDEO (as required)	Schedules	
		Details	
		Project site plan	
13.	ENVIRONMENTAL	Area site plan	
		Existing conditions	
		Demolition plan	
		Grading plan	
		Road sections, plans and profiles	
		Utility plans and profiles	

ITEM #	DISCIP LINE	DRAWING TYPE	ADDITIONAL REQUIREMENTS
		Civil and site details	
		Geotechnical boring logs	

2.7.3 PRELIMINARY FINAL DESIGN SPECIFICATIONS

Submit draft specifications for review in redlined form using SpecsIntact revision features. Discarded design choices will be visible in spite of markings. Additions to the guide specifications will also be easily identified. Edit specifications to the level of the design completion. When a set of specification sections is edited for the project, use sections from the most current FED Guide Specifications or UFGS available. For example, if the concept submittal is submitted in FY19, but the editing of sections does not occur until FY20, then the designer will use FED Guide Specifications or UFGS sections from the FY20 release. Provide Specifications volume in PDF file format consisting of redlined Division 01 through 49 sections, submittal register, and other attachments called out in the specifications. Provide the PDF file in color and with revisions shown.

2.7.4 PRELIMINARY FINAL DESIGN COST ESTIMATE

Provide a current working estimate.

2.7.5 PRELIMINARY FINAL DESIGN QUALITY CONTROL

The designer shall conduct a thorough Quality Control of all documents to be submitted to the Government for review. Quality control requirements are covered in chapter 4.

2.8 FINAL DESIGN REQUIREMENTS

The designer shall prepare the final design and specifications based on the concept/preliminary final design and review comments received from the concept/preliminary final design review.

The final submittal shall be complete with all information necessary for bidding and complete construction and shall be ready for advertising from the Government perspective. The drawings shall show the name of the designer and the reviewer. The submittal shall incorporate all previous review comments. The designer shall provide a response indicating the reason for not incorporating any non-concurred comments. The designer shall submit a complete response to all previous review comments in DrChecks with the submission. SID Binder shall be submitted in the Final design to supplement the description of finishing materials for which brand name and model number are prohibited.

2.8.1 FINAL DESIGN ANALYSIS

The completed design analysis shall incorporate all comments and revisions from the previous submission.

Sustainability needs to be fully documented. This includes a completed UFC 1-200-02 compliance checklist and narrative, final TPC checklist and narrative, and the completed agency specific HPSB compliance checklist. For renovation projects, include a narrative on the renovation costs compared to the replacement values of the existing building(s) and associated implementation triggers for seismic (UFC 3-301-01) and Antiterrorism (UFC 4-010-01) requirements.

2.8.2 FINAL DESIGN DRAWINGS

Design drawings shall be complete with all information necessary for bidding and complete construction.

The drawings shall include sufficient in detail to provide for fair and competitive bids from contractors, and to provide for the construction of the project without additional drawings, except for shop drawings or as may be required to deal with unforeseen conditions encountered during construction.

When standard design drawings are used, additional sheets will be incorporated as appropriate.

2.8.3 FINAL SPECIFICATIONS

Continuation of section processing from the preliminary stage. If a preliminary submittal is not required by the contract, redlined specifications described in paragraph PRELIMINARY DESIGN SPECIFICATION shall be submitted at this final design submission stage. Complete the final specifications to the level that they would be ready to advertise. The specifications shall incorporate all concurred comments and revisions from the previous submission by enabling SpecsIntact tracked changes. All errors and conflicts from verification reports generated by SpecsIntact shall be resolved. The contents of the final specification package shall be as follows:

- Table of contents for entire project, listing in order the section number and title
- Specification Sections, Division 01 thru 49 including attachments called out in the specifications
- List of Drawings, Section 00 01 15
- List of Government Furnished Property, Section 00 01 16
- Completed ENG Form 4288 and the data file (NAVY4288.txt)

In addition to the final specifications' submittal requirements, provide the following files for Electronic Bid Set (EBS) preparation:

- CLIN Schedule, Section 00 10 00
- Payment, Section 01 22 00
- PDF Drawing File Index

Provide the final specifications along with editable files such as SpecsIntact SEC files, PDF, and Excel spreadsheet.

2.8.4 FINAL COST ESTIMATE

Complete final working cost estimate that includes estimate narratives, quantity take-off documentations and calculations, vendor quotes and all supporting cost data and final construction schedule.

2.8.5 FINAL QUALITY CONTROL

The designer shall conduct a thorough Quality Control of all documents to be submitted to the Government for review. Submit Quality Control (QC) and Independent Technical Review (ITR) documents to include: Completed QC checklists; completed ITR annotated comment sheets; a signed Statement of Completion of ITR; the project Scope of Work; and the approved project DQCP.

2.9 BACKCHECK DESIGN REQUIREMENTS

The designer shall prepare the backcheck design and specifications based on the final design, project criteria, and general instructions.

The backcheck submittal shall be complete in every respect. The drawings shall show the name of the designer and the reviewer. The submittal typically incorporates all previous review comments; and Biddability, Constructability, Operability, Environmental and Sustainability (BCOES) review comments made from the concept to final design phases. All comments shall have been addressed, validated, and closed. The designer shall provide a response indicating the reason for not incorporating any non-concurred comments. The designer shall submit a complete response to all previous review comments in DrChecks with the submission.

Backcheck design typically consists of, but is not limited to, the following:

- Complete backcheck design construction drawings
- Complete set of backcheck specifications. The redline corrections shall be removed from the specifications after all the review comments have been resolved and incorporated
- Complete backcheck design analysis
- Complete backcheck working cost estimate to include estimate narratives, quantity take-off documentations and calculations, vendor quotes, and all supporting cost data and final construction schedule

The designer shall conduct a thorough Quality Control of all documents to be submitted to the Government for review.

2.10 DESIGN REVISION REQUIREMENTS

Drawings should be prepared according to the ERDC/ITL TR-12-1. and related matters should be discussed with the FED CADD Manager.

Revisions shall be "clouded," and noted in the revision block on the drawing. The revised drawing shall be denoted by a circle or delta symbol located by the change(s)

and in the revision block with the revision number within the circle or the delta.

The revised or new words in the specifications shall appear bold or between asterisks (*). To delete words, overstrike appearance should be used, so a reviewer is able to read what was deleted. Paragraphs should not be renumbered when making deletions by revision. For example, if a paragraph is deleted, the paragraph number shall remain and shall be noted as "NOT USED". New paragraphs or subparagraphs should always be inserted at the most logical chronological place between existing paragraphs or subparagraphs. Revised pages shall be identified with “Revised, DD/MMM/YY” for modification in a footer.

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CHAPTER 3 – SPECIFICATIONS

3.1 GENERAL

Architect-Engineer (A-E) firms and personnel performing design for Far East District shall be responsible for Division 01-49 specification sections, with Far East District Engineering Division coordination effort required for design aspects of Division 01 specification sections (e.g. Draft DD1354, Scope of Work, Section 01 45 35 SPECIAL INSPECTIONS, Commissioning, etc.).

3.2 DESIGN CRITERIA ENGINEERING REGULATIONS

- ER 415-1-10 Construction Contractor Submittal Procedures
- ER 1110-1-8155 Specifications
- ER 1110-345-700 Design Analysis, Drawings and Specifications

3.3 GUIDE SPECIFICATIONS

FED Guide Specifications shall be used in writing specifications. The FED Guide Specifications can be modified using the free SpecsIntact software (available at https://specsintact.ksc.nasa.gov/). Designers are required to use FED Guide Specifications and SpecsIntact. FED Guide Specifications shall be edited for each particular project by making suitable modifications and alterations thereto.

In the course of editing specifications, all inapplicable portions of the FED Guide Specifications shall be deleted, and additional information shall be included in the proper part of each section. Those sections shall be prepared and submitted by the designer in accordance with the CSI MasterFormat and UFGS guidelines. Where various choices (indicated as “brackets”) are provided in the FED Guide Specifications, the proper choice for the specific design shall be selected and other choices deleted. Where FED Guide Specifications allow use of optional materials or methods, options shall be included in the completed specifications to the extent that such material and methods are suitable and available for construction in Korea.

3.4 PREPARATION OF PROJECT SPECIFICATIONS

Specifications shall be furnished to Far East District in the native SpecsIntact (.sec) file format.

3.4.1 CONTENT

The Specifications shall be in sufficient detail so that when used with the project drawings, estimates or bids can be furnished by contractors, material suppliers, or manufacturers on a fair and competitive basis; and construction can be completed without additional specifications except as necessary to deal with unforeseen

conditions or to accomplish changes made during construction. Sections shall be prepared in a manner to supplement the project drawings only to the extent necessary. The use of trade names, proprietary items, and the drafting of a specification by adopting a manufacturer's description is not allowed. To the extent possible, the specifications shall refer to recognized standards and organizations such as ASTM, ANSI, AWWA, etc. Specifications shall include at a minimum the following items if appropriate:

- Size or capacity
- Materials of construction
- Detailed description of equipment construction and function

3.4.2 SPECSINTACT

3.4.2.1 DESIGN-BID-BUILD PROJECTS (D-B-B)

For D-B-B projects, the A-E's Division 01-49 SpecsIntact (.sec) files shall be submitted with the design review PDF submittals. Far East District Engineering Division requires the .sec files for review as well as for the submittal records. For the CONCEPT (30%) submittal, the A-E will only need to provide the table of contents of Division 01-49 sections.

For the RTA package, the A-E will provide their final version of Division 01-49 .sec files, along with PDFs of any Division 01-49 attachments, to Far East District. The A-E is also responsible for making changes to the .sec files during amendment phase.

3.4.2.2 DESIGN-BUILD PROJECTS (D-B)

For D-B projects, the A-E's Division 01 (.sec) files shall be submitted with the design review PDF submittals. For the RTA package, the A-E will provide the Division 01, SOW/Design Criteria attachments (Word and PDF versions) to Far East District. The A-E is also responsible for making changes to the Division 01, SOW/Design Criteria attachments during the amendment phase.

3.4.2.3 PRIORITIES OF PUBLICATIONS REFERENCES

References known to nationally recognized industry and technical society specifications shall be used. References shall be by specific issue; the revision letter, date, or other specific identification shall be included. Availability of publications is available on the Whole Building Design Guide website at: http://www.wbdg.org.

3.4.3 MATERIAL DESCRIPTIONS

Except for unique spare parts that are inherently sole source, trade or brand names will only be used as a last resort and only with acceptance of a Justification and Approval (J&A) routed by the Project Manager (PM) through the appropriate offices of Far East District. The naming of a particular commercial product with the words "or approved equal", or adopting verbatim a manufacturer's description of a particular commercial article is not allowed, unless approved by the Contracting Officer. If approved for use, no less than three (3) manufacturers with complete address, telephone number, fax number, e-mail address, and Point of Contact (POC) if known,

shall be included within the specifications. The specifier shall describe the needs of the design, or the Government, with sufficient clarity to appraise prospective bidders of the specific requirements. Every effort shall be made to describe properly in the specifications (and supplement by drawing details, where applicable), the physical, chemical, or performance characteristics of materials, products, or construction methods in a manner to ensure full and free competition. This concept also applies to non-unique spare parts where competitive, equivalent items are available (belts, filters, hoses, valves, bearings, lamps, etc.).

3.4.4 AMBIGUITIES

Ambiguities shall be avoided in the preparation of specifications. Specific instructions shall be included in the specifications in lieu of the expression "as directed (approved) by the Contracting Officer". Designer shall contact Far East District Design Manager to obtain specific information to avoid the necessity for indefinite specification requirements. For example, when material is to be salvaged and stored, the specifications shall state the disposition of such material, e.g. "to be stored in Building 210" or "in the Base Salvage Yard", rather than "where directed by the Contracting Officer". When ultimate disposition of excess excavated materials, broken concrete, etc., is impossible to determine at the time of the writing of the specifications, the specification shall state that the haul will not exceed a stated distance when such material can be disposed of on Government controlled property. When waste material is to be disposed of by the Contractor off the Government property, the specifications shall state, "Waste material shall be disposed of off the Government premises by and at the expense of the Contractor." Where necessary to demolish or move structures, Far East District shall be contacted for disposition of material, equipment or the structure in order that detailed instructions may be given in the Specifications or Contract Clauses.

3.4.5 PROJECT TABLE OF CONTENTS

A Table of Contents for the project specifications shall be prepared, with attachments and appendices indicated. A template of the Table of Contents can be obtained upon request from Far East District Design Manager.

3.4.6 GUIDE SPECIFICATIONS

When editing FED Guide Specifications, intent shall be clearly defined and the guide specifications shall be revised accordingly. Specifications shall not be written which leave the burden of intent (interpretation) on the bidders, contractor, or construction personnel administering the contract in the field.

3.5 AMENDMENTS

During the time period a project is being advertised for bids/proposals, revisions to drawings and/or specifications due to a prospective offeror’s Request for Information (RFI) may become necessary. When directed by the Contracting Officer and/or the Contracting Officer’s Representative, the designer shall prepare the necessary

revisions to the drawings and/or specifications in response to the RFIs as part of an amendment.

3.5.1 SCHEDULING OF AMENDMENTS

Amendment revisions shall be prepared and submitted under a strict time schedule in order that revisions can be issued to bidders at the appropriate time during the advertising period. Close coordination with the Far East District Project Manager and Design Manager is required at this time.

3.5.2 REPARATION OF REVISIONS

The following rules typically apply when editing specifications for revisions:

- To delete words: Overstrike appearance shall be used, so a reviewer is able to read what was deleted.
- New text should appear bold or between asterisks(*)".

Paragraphs shall not be renumbered when making deletions by revision. For example, if a paragraph is deleted, the paragraph number shall remain and shall be noted as "NOT USED". New paragraphs or subparagraphs shall always be inserted at the most logical chronological place between existing paragraphs or subparagraphs. Revised pages shall be identified with "Am-000x " for amendment or "Revised, DD/MMM/YY" for modification in a footer.

Submit the revised specification sections to Far East District in native SpecsIntact (.sec) and .pdf files format.

3.6 SPECIAL REQUIREMENTS

3.6.1 GOVERNMENT FURNISHED PROPERTY

When Government Furnished Contractor Installed (GFCI) materials or equipment are involved, such Government Furnished items shall be listed separately and submitted along with specifications at the Final and RTA submittals. The list shall contain the quantity, item description including manufacturer's make and model number if available, dimensions, cube weight, and power source if applicable, e.g. gas, electric, steam, 120V, 220V, 240V, etc.

3.6.2 REMOVAL OF EQUIPMENT OR MATERIALS (EXISTING FACILITIES)

Equipment or materials to be removed shall be identified in the scope of work and shall include any special disposal instructions such as store for re-use or return to Stakeholder.

3.6.3 SHOP DRAWINGS AND SUBMITTALS

The designer shall identify all required submittals and shop drawings and categorize them for the Government Approval or For Information Only per ER 415-1-10. The designer shall use SpecsIntact's "submittal tags" feature to identify all submittals so that SpecsIntact will automatically compile a list of all required submittals and shop drawings for the projects and create the ENG Form 4288 for the project.

3.6.4 SERVICES OF MANUFACTURER'S TECHNICAL REPS

The designer shall include information regarding services of manufacturer's technical reps in contract requirements for projects and equipment when required to ensure proper installation, start-up and/or training of operation and maintenance personnel. The requirements for these services shall be added in the Technical Specifications (Division 02-49) only upon approval and coordination with Far East District.

3.6.5 SPECIAL INSPECTION

Designer shall utilize the Far East District templates for the Statement of Special Inspections and the Schedule of Special Inspections that are attachments to UFGS Section 01 45 35 Special Inspections.

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CHAPTER 4 – COST ESTIMATES

4.1 GENERAL

All U.S. format cost estimates shall be prepared in accordance with ER 1110-1-1300 and UFC 3-740-05, Change 2. Cost estimates shall be prepared using the Corps of Engineers Micro Computer-Aided Cost Estimating System (MCACES) - Second Generation (MII, pronounced M2), for which software will be provided by the Government. MII cost estimates must utilize local labor, equipment and materials pricing supported by local quotes and local materials, labor and equipment cost publications. Materials and associated costs should be designated as local (domestically procured) or offshore (U.S. procured).

All ROK-Funded Construction In-Kind (ROKFC I-K) project cost estimates shall be prepared in the ROK Ministry of National Defense (MND) cost format which is a Bill of Quantities (BOQ) format based using the EMS software latest edition. All estimates shall include Cost Distribution Sheets, Trade Summary Sheets and Construction Cost Sheets according to the proposal schedule. Complete back-up data shall be furnished - overhead breakdown, quantity takeoffs, labor and equipment rates, material quotations, with 3 quotes, and productivity, etc.

References throughout this document to Current Working Estimates (CWE) and Codes, “A”, Code “B” and Code “C”, refer to the definitions in ER 1110-3-1300 “Military Programs Cost Engineering.”, Paragraph “11. CWE and Codes” dated 26 August 1999.

During design charrettes, budgetary cost estimates (Code “A”) shall be included in the Charrette Report submittal.

4.2 PRE-CONCEPT PARAMETRIC DESIGN

Cost Estimate. The A-E shall prepare a Code “A” CWE for the Pre-concept design. The CWE shall be summarized in the same format as the programming document, and estimate should reflect escalation to the projected mid-point of construction. The CWE shall be prepared and submitted using ENG Form 3086 when MILCON approvals apply.

4.3 CONCEPT DESIGN

Cost Estimate. The A-E shall prepare a Code “B” CWE for the Concept Design.

4.4 PRELIMINARY FINAL DESIGN

Cost Estimate. The A-E shall prepare a Revised Code “B” CWE that best reflects the total project Current Working Estimate (CWE) based on the 60% design. As a minimum, the Estimated Construction Cost (ECC) shall be broken down and summarized to reflect the current proposal schedule and type of funding

appropriations when applicable. A detailed breakdown of the work and associated costs shall be provided that reflects the final drawings and specifications, and latest proposal schedule. The detailed estimate shall be prepared in accordance with applicable guidance and should include Cost Distribution Sheets, Trade Summary Sheets and Construction Cost Sheets. Complete cost estimate back-up data shall be furnished with the submittal (i.e. overhead breakdown, quantity takeoffs, labor and equipment rates, material quotations and productivity, catalog cut sheets, etc.) in accordance with applicable guidance documents.

4.5 FINAL DESIGN, BACKCHECK AND CONTRACT DOCUMENTS

4.5.1 US FORMAT AND MND/DIA FORMAT COST ESTIMATES

U.S. FORMAT COST ESTIMATE. The A-E shall prepare a Code “C” CWE. The CWE shall be broken down according to the current project proposal schedule. The Estimated Construction Cost (ECC) shall be summarized to reflect options and type of funding appropriations when applicable. A detailed breakdown of the work and associated costs shall be provided that reflects the drawings, specifications, and latest proposal schedule. The detailed estimate shall be prepared in accordance with applicable guidance and should include Cost Distribution Sheets, Trade Summary Sheets and Construction Cost Sheets. Complete cost estimate back-up data shall be furnished with the submittal (i.e. overhead breakdown, quantity takeoffs, labor and equipment rates, material quotations and productivity, catalog cut sheets, etc.) in accordance with applicable guidance documents.

A Code “C” Cost Estimate shall be submitted at each of the 60% (if applicable), 90%, 95%, and 100% Design Phase Submittals.

MND/DIA FORMAT COST ESTIMATE – ROK-Funded Construction In-Kind

For ROK-Funded Construction In-Kind (ROKFC I-K) projects, an MND/DIA Format Cost Estimates shall be prepared at the 90%, 95%, and 100%, Design Phase Submittals.

For all ROKFC I-K projects, the A-E shall prepare an MND/DIA Format Cost Estimate in addition to the US format cost estimate using the latest version of the Korean estimating system (i.e. EMS). The EMS version current as of the contract award date shall be used. EMS estimating system information: Company: Koreasoft; Software: "EMS-7" (current as of July 2020) (www.koreasoft.co.kr, +82-02-529-6071).

Provide editable EMS data files on a CD/DVD of the Code “C” estimate and backup supporting information developed to Cost Engineering Branch (CEPOF-EDC).

For ROK I-K cost estimates –

- A separate cost estimate shall be provided for disposing of industrial waste.
- All temporary construction components such as scaffolding, shoring and
- Equipment shall be identified and shown separately.

MND/DIA Format Cost Estimates shall meet the following requirements:

- The process(es) and equipment indicated in the MND Format Cost Estimate shall meet the requirements for a complete construction project.
- The MND/DIA Format Cost Estimate shall match the Specifications and Drawings. Quantities in the MND Format Cost Estimate shall reflect the material/quantity takeoffs from the Drawings.
- The MND/DIA Format Cost Estimate shall include an Offshore Materials List which identifies and numbers all items, systems or components in the design where no locally-available products meet the design requirement(s), and include quantities, unit prices, and total cost for each in both United States Dollars and Korean Won.
- All materials, components and testing fees, if needed, required to install a complete and useable system or assembly shall be included. Notes may be included on the Drawings or in the Specifications that state the intent that all miscellaneous materials and components normally used in the standard installation of an item are included whether shown in detail or not.
- The MND/DIA Format Cost Estimate shall include complete backup documentation to facilitate ROK MND/DIA's review.
- The detailed breakdown of the MND/DIA Format Cost Estimate shall be in Korean only.
- Summary sheets of the MND/DIA Format Cost Estimate shall be prepared in both English and in Korean

  Each summary sheet shall delineate the cost of materials, labor, equipment, miscellaneous expenses, overhead, profit, V.A.T., and inspector's cost. The pricing method shall be as follows:

  - Both basic and optional bid items shall be identified.
  - Price List of Commodity for Government (Korean) Purchases.
  - (PLCGP): All project requirements shall be based on pricing information contained thereto.
  - For pricing items not contained in the PLCGP, the following references shall be used, as a minimum:

    The Comprehensive Market Price Information published by Daehan Construction.

    The Information on Commodity Prices, published by Korea Price Research Center.

    Consolidated Price Information, published by Korea Pricing Information.

The latest MND-Defense Procurement Agency (DPA) established pricing information on specific items, if available.

- Instances where pricing information conflicts, the PLCGP shall take precedence. For each pricing item, a cost comparison of at least three (3) sources shall be provided in which no priced items shall exceed those items in the PLCGP. All offshore items shall be selected from at least three (3) alternate sources. Provide a complete and current offshore material lists with backup documents.

- All items/materials indicated in the Drawings and Specifications which do not have an exact match in the MND cost estimating program's database of materials, shall be identified and listed. These will be discussed and the one of the following actions will be taken.

  The material(s) as identified in the Drawings and Specifications may be changed to align with the MND database material(s),

  OR

  The Cost Estimate shall include backup information indicating how the cost was determined; e.g., 3-local vendor quotes, historical data from past projects, commonly used and industry accepted price and Korea Labor Production Rate Book, etc.

The A-E shall assure that the MND/DIA Format Cost Estimate is produced accurately and completely by performing Quality Control to Drawings/Specifications, including:

Specifications shall correctly identify the materials that are used in the project in enough detail to be purchased.

Drawings shall be completed in enough detail and contain enough detailed notes to identify the materials used and to match the material described in the Specifications.

4.5.2 QUALITY CONTROL CHECK

The A-E shall provide a Cost Estimating Quality Control Check Sheet as shown below

Project Name:	
Type of Estimate:	
Estimator:	
Date:	
Company Name:	
QA Reviewer Name:	
QA Review Signature:	

INSTRUCTIONS: Check items pertaining to this estimate as "Yes" or "No"
Check "N/A" for lines that do not pertain to the level of estimate being reviewed.
For items that are indicated "No", indicate why in "Comment."

Yes	NO	N/A	Ref #	BASIC INFORMATION FOR REVIEWER	COMMENT
			1	Has Estimator Checklists been included and reviewed?	
			2	What is the type of estimate provided?	
			3	Do the project narrative give a Clear Definition of the Scope of Work?	
			4	Does the work listed in the estimate match the work defined in the Scope of work?	
			5	Are General Assumptions or presumptions Noted and Reasonable?	
			6	Have Costs and Quantities been spot checked and verified?	
			7	Have all amendments been check and acknowledged?	
			8	Have all cost impacts from amendments been included in the IGE?	
			9	Are Effective Dates for Labor, Equipment, and Material Pricing given?	
			10	Is there a reasonable subcontractor/prime contractor relationship?	
			11	Does the estimate included appropriate owner Costs (Contingency, S&A)?	

Project Name:	
Type of Estimate:	
Estimator:	
Date:	
Company Name:	
QA Reviewer Name:	
QA Review Signature:	

INSTRUCTIONS: Check items pertaining to this estimate as "Yes" or "No"
Check "N/A" for lines that do not pertain to the level of estimate being reviewed.
For items that are indicated "No", indicate why in "Comment."

Yes	NO	N/A	Ref #	BASIC INFORMATION FOR REVIEWER	COMMENT
			12	Does contingency amount reflect level of design and impact of cost?	
			13	Are proper Contingencies and S&A used shown?	
			14	Does the Estimate Include appropriate Escalation?	
			15	Is a Construction Schedule Included?	
			16	Has a Duration been specified? Does it match the Construction Schedule?	
			17	Is a Bid Schedule Included and is it complete?	
			18	Does the Bid Schedule match the estimate?	
			19	Are there Unique Techniques of Construction Considered and Documented?	
			20	Is Construction Methodology Sound?	
			21	Has the estimate and notes captured all current amendments?	
			22	Has Site Access been considered?	
			23	Are Unusual Conditions (Soil, Water, Weather) Considered and Documented?	
			24	Has Equipment/Labor Availability & Distance Traveled Considered?	
			25	Are Environmental Concerns considered and documented?	
			26	Are Mobilization and Demobilization considered for project?	
			27	Do quantities look reasonable?	
			28	Did you do a Spot check of critical cost area quantities and pricing?	

Project Name:	
Type of Estimate:	
Estimator:	
Date:	
Company Name:	
QA Reviewer Name:	
QA Review Signature:	

INSTRUCTIONS: Check items pertaining to this estimate as "Yes" or "No"
Check "N/A" for lines that do not pertain to the level of estimate being reviewed.
For items that are indicated "No", indicate why in "Comment."

Yes	NO	N/A	Ref #	BASIC INFORMATION FOR REVIEWER	COMMENT
			29	Are note fields used to briefly explain the task and item details?	
			30	Are there quotes for major material cost & are they current and complete – include freight, taxes, etc.?	
			31	Does the Estimate contain Sub Quotes (dependent on type of estimate.)?	
			32	Are Dates for completion given, milestone dates set?	
			33	Does estimate include all items scoped in the design document?	
			34	Were the quantity take -off sheets provided?	
			35	Does Air Tightness Test cost include in the CWE or IGE?	
			36	At this point do you, the reviewer, have a good understanding of the project?	

Additional Comments / Notes / Concerns –

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CHAPTER 5 - QUALITY CONTROL REQUIREMENTS

5.1 CRITERIA

ENGINEERING REGULATIONS

- ER 1110-3-12 Quality Management
- ER 5-1-11 U.S. Army Corps of Engineers (USACE) Business Process
- ER 415-1-11 Biddability, Constructability, Operability, Environmental, and Sustainability (BCOES) Reviews

5.2 DEFINITIONS

5.2.1 QUALITY

Quality is the totality of features and characteristics of a product or service that bear on its ability to meet the stated or implied needs and expectations of the project. There shall be consensus on expectations for quality among the PDT members (includes Far East District). The expectations for quality shall be reflected in the Design Quality Control Plan (DQCP).

5.2.2 QUALITY ASSURANCE

Quality Assurance (QA) is the Government oversight of the Designer of Record (DOR) Quality Control (QC) process to ensure their effectiveness in the production of quality products. ER 5-1-11 defines QA as an integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed to meet project requirements defined in the Design Quality Control Plan (DQCP). Typical QA activities may include:

- Reviewing and accepting the DQCP prepared by the designer
- Ensuring that activities described in DQCP have been/are being performed
- Verifying that Designer of Record (DOR), Quality Control (QC) personnel and Independent Technical Review (ITR) personnel are the same members as identified in the DQCP
- Ensuring that an ITR is conducted per ER 1110-3-12 with emphasis on determining that the ITR was appropriate to the level of risk and complexity inherent in the project; that the ITR verified compliance with established policy principles and procedures; utilized justified and valid assumptions; and reviewed methods, procedures, alternatives, and reasonableness of results, including whether the product meets Stakeholder's needs
- Verifying that appropriate staff signed Quality Control checklists
- Ensuring that all review comments have been adequately resolved
- Verifying that the product received satisfies contract requirements
- Engaging in frequent dialogue with the Designer of Record (DOR) to ensure that the project will satisfy Far East District requirements and avoid lost effort

5.2.3 QUALITY CONTROL

Quality Control (QC) is the process that ensures the performance of tasks meets the agreed upon requirements of the Stakeholder, appropriate laws, regulations, policies, and technical criteria, schedule, and budget. ER 5-1-11 defines QC as the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established in the DQCP; operational techniques and activities that are used to fulfill requirements for quality. QC is the responsibility of the Designer of Record (DOR). The Government shall not be reviewing the design package for Quality Control issues.

5.3 DESIGN QUALITY CONTROL PLAN

After the project start, the designer shall provide a project specific DQCP that shall address all Quality Control features listed below. The Far East District COR shall ensure the proper PDT members review and provide acceptance of the DQCP before the designer proceeds with any further work. The DQCP shall be a living document and shall be updated as required throughout all stages of the design.

5.3.1 ROLES AND RESPONSIBILITIES

- Identify the entire design team to include the Designer of Record (DOR) for each discipline, QC review team and the Independent Technical Review (ITR) team.
- Provide qualifications of major designers that will be part of the design team. The DOR for each discipline shall consist of licensed engineers and architects.
- The QC review team member shall be the designer's principal or senior designer that is not involved with the project on a day-to-day basis.
- The Independent Technical Review (ITR) team members shall be designers that are not involved in the project and shall conduct a thorough independent technical review.
- The designer shall notify Far East District COR in writing of any revision to the DOR, QC personnel, and ITR personnel as indicated in the DQCP during the design process.

5.3.2 COORDINATION PROCEDURES

Describe Designer of Record interdisciplinary coordination procedures:

- Clearly identify step-by-step QC coordination process between design disciplines, including the QC review and ITR processes, comment sheets, and certifications.
- Provide a flowchart illustrating key QC activities and their order of execution for each deliverable stage.
- Identify Centers of Standardization (COS) and describe how the COS standard designs will be verified for standard design compliance.
- QC review and Independent Technical Review (ITR) of all submittal documents

shall be conducted prior to submitting the documents to the Government. This is to check for any last-minute spelling, printing, and coordination errors. Errors shall be corrected prior to submitting to the Government.

- QC is the responsibility of the design team.
- Submittals shall be considered incomplete and rejected by the Government if completed QC review and ITR documentation are not provided. Re-submittal shall be at the cost of the designer.

5.3.3 DRAFTING COMPLIANCE

Identify how the CADD/BIM requirements have been met in accordance with the Submittal Requirements chapter of the Design Guide.

Provide the documentation required in the Submittal Requirements chapter and identify any software programs used, describe the process by which the input and output will be checked and validated.

5.3.4 SUSTAINABILITY COMPLIANCE

Identify how the project will meet the sustainability requirements and the QC procedures that will be conducted through each design phase.

5.3.5 LESSONS LEARNED

Provide a description and list of applicable Lessons Learned from similar projects. List Lessons Learned in the following format:

- Project
- Lessons Learned Statement
- Discussion
- Recommended Solution

5.3.6 RISK ANALYSIS

Provide a design risk analysis to include probable risks and risk mitigating strategies for undesirable project outcomes. Mitigating strategies include ways the designer can overcome less than ideal schedules, missing design information, etc.

5.3.7 QUALITY CONTROL REVIEW

- Quality Control (QC) review, which is referred to as Quality Checks and Reviews in ER 1110-3-12, is the DOR's own Quality Control effort and refers to quality checks, technical checks, and reviews of design documents occurring as routine management practice during the project development process.
- The QC review is not the Independent Technical Review (ITR) and is typically completed before the ITR.
- The QC review shall be performed by each discipline's supervisor or senior Architect/Engineer.
- The QC review shall document review comments. The DOR shall work with the QC reviewer to incorporate all resolutions/corrections into the design prior to the submittal package to the Government.

- If the DOR chooses to annotate QC review comments with “will incorporate in the next submittal”, they will be responsible to follow through with the changes and comments will not be closed until the changes can be verified in the next submittal.

The QC review serves to:

- confirm that calculations are correct (a complete math check);
- confirm that appropriate formula(s) from reference manuals are used correctly;
- confirm that input to design software is reasonable;
- confirm that results of calculations and investigations are correctly displayed on the contract documents (plans and specifications);
- confirm that contract documents are technically complete and correct; and
- ensure that intent and delineation of design documents are clear to all parties. Confirms that all typos, spelling, and drawing coordination is complete.

5.3.8 INDEPENDENT TECHNICAL REVIEW (ITR)

Independent Technical Review (ITR) is a holistic, comprehensive review of the project design. The ITR process acts as the DOR’s “DrChecks” review prior to submission to the Government.

- The ITR is to be completed prior to the printing (or electronic) of the submittal package at each deliverable design phase to the Government.
- ITR review shall be accomplished by an ITR team composed of experts in the disciplines involved in the development of the design product.
- The ITR team is technically knowledgeable with U.S. codes, laws, regulations and requirements.
- Reviewers shall be experienced and be capable of focusing on potential problem areas of the design and identifying conflicts between discipline designs.
- The ITR is intended to ensure that a technically competent design has been produced but does not relieve the DOR of responsibility for the design.
- The ITR shall document review comments and the DOR shall work with the ITR reviewer(s) to incorporate all resolutions/corrections into the design prior to the submittal (or electronic submittal) package to the Government.
- This process shall be repeated as required until all ITR comments have been resolved/corrected and incorporated in the design package.
- If the DOR chooses to annotate ITR review comments with “will incorporate in the next submittal”, they will be responsible to follow through with the changes and comments will not be closed until the changes can be verified in the next submittal.
- Completed ITR annotated comments, marked up drawings/specifications/design analysis shall be included at each deliverable design phase submittal.
- At each design submittal to the Government, the DOR shall provide a signed certification by the ITR reviewer, team leader, Project Manager, and Principal

certifying that an ITR was accomplished and all comments resulting from the ITR have been incorporated into the design documents (a sample certification template is available from the Far East District upon request).

The ITR serves to verify:

- the project meets the Stakeholder's scope, intent and quality objectives;
- the formulation and evaluation of alternatives are consistent with applicable regulations and guidance;
- the concepts and project costs are consistent with expectations and market trends;
- the recommended alternative is feasible and will be safe, functional, constructible, environmentally sustainable, economically justified, and within the U.S. Government interest;
- the relevant engineering and scientific disciplines have been effectively integrated and coordinated without conflict;
- there is consistency within the contract documents among disciplines;
- the appropriate computer models and methods of analysis were used and basic assumptions are valid;
- the source, amount, and level of detail of the data used in the analysis are appropriate for the complexity of the project;
- the project complies with accepted industry practices and materials; construction methods and materials are appropriate for local implementation; and
- the content and documentation are sufficiently complete for the current phase of the project and provide an adequate basis for future development efforts.

5.3.9 QUALITY ASSURANCE REVIEW

The Far East District shall perform a Quality Assurance (QA) review of all designer work to confirm that Quality Control (QC) processes were followed during the project design process. During the QA review, Far East District performs a technical review to determine whether the designer met quality requirements and utilized quality control processes. Far East District review of the designer-developed QC documentation (DQCP, QC review and ITR comments and responses) is part of the QA review process. The designer shall be solely responsible for conducting a thorough QC review in accordance with their DQCP and for completing a quality design product.

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CHAPTER 6 - ANTITERRORISM

6.1 GENERAL

Design for antiterrorism refers specifically to UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings. This UFC seeks effective ways to minimize the likelihood of mass casualties from terrorist attacks against DoD personnel in the buildings in which they work and live.

This chapter provides guidance for applying appendix B and C of UFC 4-010-01, when applicable. The Installation Antiterrorism Officer's Design Basis Threat analysis will determine whether appendix B and C are applicable to the project. It is the Installation's responsibility to determine the level of protection and the additional protective measures required for a project by using the process in UFC 4-020-01 DoD Security Engineering Facilities Planning Manual. Physical security, force protection, and access control points /entry control facilities are separate design considerations not covered in this chapter.

6.2 DESIGN CRITERIA

ASTM INTERNATIONAL (ASTM)

ASTM E1300	Standard Practice for Determining Load Resistance of Glass in Building
ASTM F2247	Standard Test Method for Metal Doors Used in Blast Resistant Applications (Equivalent Static Load Method)
ASTM F2248	Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass
ASTM F2927	Standard Test Method for Door Systems Subject to Airblast Loadings

DEPARTMENT OF DEFENSE: UFC 1-200-01 DoD Building Code

UFC 4-010-01	DoD Minimum Antiterrorism Standards for Buildings
ECB No. 2019-1	Revisions To Antiterrorism Criteria For Buildings
USINDOPACOM Instruction 0536.2 (FOUO)	Antiterrorism Program Interim Policy

US ARMY CORPS OF ENGINEERS PROTECTIVE DESIGN CENTER

PDC TR 06-08	Antiterrorism Response Limits
PDC TR 10-02	Blast Resistant Design Methodology for Window Systems Designed Statically and Dynamically

Memorandum outlining Design Base Threat (DBT) for each base (if it exists)

6.3 DEFINITIONS

- CCSD – Conventional Construction Standoff
- Glazed Door – Door that has any amount of glazing
- IGU – Insulated Glazing Unit
- PVB – Polyvinyl Butyl Interlayers
- SBEDS_W Single degree of freedom Blast Effects Design Spreadsheet for Windows
- SBEDS_5 Single degree of freedom Blast Effects Design Spreadsheet for Building Elements

6.4 BLAST ANALYSIS

The designer shall coordinate with the Installation AT Officer to verify if the project has an identified Design Basis Threat (DBT) and Level of Protection (LoP) and conduct a blast analysis if necessary. The designer shall apply provisions necessary to mitigate the effects of explosives at the achievable standoff distance to the appropriate level of protection, as defined in defined in UFC 4-010-01, DoD Minimum Antiterrorism Standards for Buildings. The blast analysis shall be conducted by an engineer experienced in blast-resistant design and is to be based on the structural design of the building. Building elements to be analyzed include windows, doors, and roof where applicable per UFC. Blast analysis shall be included in the Design Analysis.

6.5 STRUCTURAL COMPONENTS

Structural components that do not conform to table C-5 of the UFC 4-010-01 shall be analyzed dynamically using SBEDS or others developed by Protective Design Center (PDC) in Omaha, NE.

6.6 STANDOFF DISTANCES

For projects where the minimum AT standards can be applied, i.e. where no identified threat or level of protection has been determined in accordance with UFC 4-020-01, Standoff Distances are effectively eliminated except for clear zone and Geographic Combatant Command requirements between buildings and installation perimeters.

Where specific threat and level of protection are identified, Standoff distance for buildings can be determined by using appendix B and C of UFC 4-010-01. Standoff is based on applicable charge weight and building construction parameters.

6.7 PROGRESSIVE COLLAPSE RESISTANCE

All new buildings, three stories or more shall comply with UFC 4-023-03 *Design of Buildings to Resist Progressive Collapse*. For renovation of existing buildings 3 stories

or more, apply Progressive Collapse Resistance when recommended/determined by threat analysis and risk.

Penthouse or floors below grade will be considered a story if any portion is designated for human occupancy. If penthouse or floors below grade are not occupied, they will be eliminated from the calculation of the number of stories.

Progressive collapse resistant buildings on US Installations in Korea are predominantly cast-in-place reinforced concrete buildings. Buildings composed of precast concrete elements will only be allowed with approval from PDC.

Progressive Collapse design requirements employ three different types of design/analysis approaches: Tie Force Method, Alternate Path Analysis and Enhanced Local Resistance. The selection of design requirements are based on “Occupancy Category” in table 2-1 and table 2-2 of UFC 4-023-03.

- Tie Force Method is a prescriptive way of enhancing the buildings structural integrity only used for Occupancy Category II. This method applies to framed and two way load bearing wall structures with four or more bays in both directions. One way load bearing wall structures shall have four or more bays in the one way span direction.
- Alternate Path Analysis shall be three dimensional computer model, two dimensional models are not permitted. Within Alternate Path there are three different analysis procedures: Linear Static (LSP), Non-linear Static (NSP) and Non-linear Dynamic (NDP). In order of usage, LSP is used most often, NDP is used when analyzing irregular structures and NSP is hardly used. NDP requires more advanced computer software. LSP is permitted for irregular structures if Demand Capacity Ratio (DCR) for the components are less than 2.0.

As much as possible avoid irregular structures per UFC 4-023-03. Alternate Path model shall be entirely load bearing wall or entirely space frame. Space frame may include shear walls. When a building has access control, only exterior columns are removed.

6.8 STRUCTURAL ISOLATION

“Inhabited” building classification applies to the entire building envelope, although portions of the above buildings may be “low occupancy” if they are structurally isolated. For example, a “low occupancy” hangar may be structurally isolated from the “inhabited” administration areas. Note that isolated adjacent structures shall have the same risk category. The most stringent risk category shall be used.

6.9 WINDOWS AND SKYLIGHTS

UFC 4-010-01 presents requirements for New Construction, Existing Buildings, and Window, Skylight, Glazing, and Door Replacement Projects. In all cases, where specific Design Basis Threat (DBT) and Level of Protection (LoP) are identified, the additional guidance in Appendix B and C must be applied.

New construction or existing buildings that are not identified DBT and LoP of project must be applied the prescriptive provisions in the Standard 10 and 12 of UFC 4-010-01 for exterior glazing and exterior doors.

6.9.1 BLAST REQUIREMENTS - WINDOWS

To minimize hazards from flying debris from windows and skylights, apply the provisions in the Appendix B of UFC 4-010-01 for glazing, framing, connections, and supporting structural elements for all new and existing buildings for which there is an identified explosive threat. These provisions apply to window systems at all standoff distances, even those that meet or exceed the wall conventional construction standoff distances. The specific requirements in the Appendix C will result in window and skylight systems that provide for effective hazard mitigation. Windows will be inclusive of storefronts, clerestories, and similar glazed construction.

Monolithic glass or monolithic acrylic used as a single pane or as the inner pane of a multi-pane system is not allowed as glazing when there is an identified explosive threat.

6.9.2 DRAWING REQUIREMENTS

Antiterrorism (blast) window requirements shall be indicated in the architectural set of the design drawings. Any exterior windows that need to be blast-resistant should be clearly marked on the window schedule, and they must include comprehensive information about dynamic blast loads (including peak pressure and impulse) as well as equivalent static loads (determined by the 3-second duration equivalent design load per ASTM F 2248). NOTE: Based on Korean construction practices, Korean contractors consider window design work to be part of the architectural drawing set, not the structural drawing set.

CHAPTER 7 - CIVIL

7.1 GENERAL

This chapter provides guidance and instructions for the civil design submittals (paragraphs 7.3 through 7.6) and for the design of facilities and infrastructure (paragraph 7.7). Items covered in this section include topographic survey and geotechnical report requirements, site layout, pavement, grading, drainage, water distribution system, sewer system, and landscaping.

7.2 DESIGN CRITERIA

The following are commonly used design criteria documents not included on the Whole Building Design Guide (WBDG) website:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

- Roadside Design Guide

ACCESSIBILITY STANDARDS

- DoD Policy Memorandum 31 October 2008, Subject: Access for People with Disabilities
- Architectural Barriers Act Standard for Department of Defense Facilities (ABA)

GREAT LAKES – UPPER MISSISSIPPI RIVER BOARD OF STATE AND PROVINCIAL PUBLIC HEALTH AND ENVIRONMENTAL MANAGERS (GLUMRB)

- Recommended Standards for Water Works
- Recommended Standards for Wastewater Facilities

MILITARY SURFACE DEPLOYMENT AND DISTRIBUTION COMMAND TRANSPORTATION ENGINEERING AGENCY (SDDCTEA)

- SDDCTEA Pamphlet 55-17: Better Military Traffic Engineering

7.3 DESIGN SUBMITTAL REQUIREMENTS

7.3.1 PLANNING CHARRETTE

The planning charrette is a meeting to gather information and prepare programming documents. The designer shall provide a preliminary site plan showing the project site and approximate location of the new site work for inclusion with the programming documents.

7.3.2 PRE-DESIGN MEETING

7.3.2.1 PRE-DESIGN CONFERENCE

The purpose of the conference is to provide an opportunity for the designer to gather

project information and requirements.

Preliminary site analysis shall be performed in accordance with UFC 3-201-01 at a minimum for all contracts unless otherwise directed by the Far East District. The preliminary site analysis should be completed through preliminary site visit, data review and analysis. A site visit is performed, and base mapping, utility and other pertinent site data is gathered during the conference. Research and obtain Installation's master plan, utility maps, and as-built record drawings for information related to topography, utility, and storm drainage availability, including design approaches used in the project vicinity. Installation's Environmental personnel shall be contacted to determine if the site has environmental concerns, such as radon, pesticides, or known contamination.

Site information and requirements compiled during the meeting shall be included in the meeting minutes that are prepared by the designer upon completion of the conference.

7.3.2.2 DESIGN CHARRETTE

The design charrette is a meeting to exchange design ideas and present requests and requirements. A charrette may be performed to initiate design of the project. The charrette shall typically be held at the project's Installation with representatives from the base, their command headquarters, Far East District, and the designers attending. The designer shall coordinate with all the representatives and strive to incorporate ideas, requests, and requirements into the site design. Base mapping and utility and other pertinent site data shall be gathered during or prior to the charrette. Check if topographic surveys, geotechnical reports, as-built drawings, and environmental reports (e.g., asbestos, lead based paint) are furnished by Far East District.

Typically, a site visit is performed on the first day of the charrette. A site study of existing manmade, environmental, and natural conditions shall be made prior to initial site concepts to determine whether existing site parameters such as storm drainage limits and slopes, transportation patterns, soil types, wind direction, solar exposure, etc., will affect the site and building design.

During the charrette several schemes for the site layout shall be presented for consideration and commented on by attendees. The site plan resulting from the attendees' combined efforts, suitable for presentation to representatives from the base, shall be presented during a formal out brief on the last day of the charrette. A copy of the site plan and a narrative of the site requirements shall be included in the charrette report, or meeting minutes, that are prepared by the designer upon completion of the charrette.

7.3.3 PARAMETRIC DESIGN

7.3.3.1 DRAWINGS

VICINITY MAP AND LOCATION PLAN

The vicinity map is a small-scale drawing showing the location of the installation, area, or community in relationship to surrounding cities and roads, similar with a road map.

The location plan shall show the project's location, fire station, DPW (or BCE, FMO), FED Resident Office, access routes, and staging areas on the installation or within the area or community.

DEMOLITION PLAN

The demolition plan shall show the existing site before construction and deconstruction for accurate bidding and project construction. This plan shall include the field survey (or designer's developed CADD file if the survey has not been completed) to show all above and below ground utilities, buildings, roads, parking, sidewalks, trees, turf, fence, storage tanks, foundations, athletic facilities, and existing contours. Label and hatch all items that require removal, relocation, or modification.

SITE PLAN

The site plan shall show the basic site layout and existing site features and structures to remain on the project site. Proposed structure, pavement, and fence shall be labeled to indicate material types. Plan sheets shall clearly differentiate between new and existing pavements and different pavement types (bituminous, concrete, or gravel). Dimensions shall be shown. Proposed work will be evident clearly from existing features. The plan shall incorporate applicable regulations and restrictions for clearances and setbacks: e.g., antiterrorism, airfield and explosive clearance zones, etc. Orientation shall generally be with north pointing to the top (or to the left) of the sheet.

DRAINAGE PLAN

The drainage plan shall include a conceptual layout design of the storm drainage system. The plan shall be based on existing condition and proposed drainage analysis. All proposed drainage systems shall be indicated at their locations and include tentative sizes.

UTILITY PLAN

The utility plan shall show the site layout including all existing utilities (e.g., storm, water, sewer, gas, etc.) with sizes. All proposed utilities shall be shown at proposed locations with tentative sizes. Utilities shall be shown from tie-in point with the existing utilities to the building. All potential interferences with utility routings including any existing infrastructure shall be depicted and noted.

DESIGN ANALYSIS

Give the basis and reasons for design, e.g., goals, objectives, and priorities. Clearly explain the recommended site development concept. The DA typically includes:

- The general geology of the project site, its history, and whether hazardous and toxic waste contamination may be present.
- Any available and relevant existing subsurface data at the site and whether additional subsurface investigation is required for the design of the project.
- The status of any on-going subsurface investigation.
- The entities responsible for providing any required additional subsurface investigation and the geotechnical report.

- Criteria used to design utility.
- Adequacy of water distribution system. Shall the information prove unobtainable, the designer shall promptly contact the Far East District Design Manager.
- The capacity of the existing storm drainage and sewer system to accept additional flow generated by the proposed project.
- Parking analysis and stall count requirements.
- Whether concrete curb and gutter will be used.
- Pipe size that will be used for the cost estimate and a rough estimate of earthwork quantities.
- If borrow material is available on site.
- Approximate amount of fill under buildings and roads.
- Minimum and/or maximum grades (% slope).
- Pollution prevention measures and other environmental constraints identified in the environmental documentation.

7.3.4 CONCEPT DESIGN

7.3.4.1 DRAWINGS

VICINITY MAP, LOCATION PLAN, DEMOLITION, AND SITE PLAN

Include vicinity map, location plan, demolition plan, and site plan requirements from previous submittal with review comments incorporated.

GRADING AND DRAINAGE PLAN

The grading and drainage plan shall show the basic site layout including all existing utilities to remain and existing contours. The plans shall be prepared in accordance with paragraphs 7.7.6 through 7.7.7. Tentative finished floor elevations of new buildings shall be shown. Uniform grades shall be labeled using slope arrows. New culverts, storm drains, and sub drains shall be labeled with tentative sizes.

UTILITY PLAN

Include utility plan requirements from previous submittal and include locations of proposed valves, manholes, lift stations, fire hydrants, and fire department connection (FDC) on the building.

For water, sewer, force main, and gas lines:

- Provide layout sheet showing new routing with tentative sizes.
- Existing utilities and aboveground features which could affect construction.
- Right-of-way for off-base portions; and locations of manhole, valve, blowoff, etc.
- For pumping stations:
  - Provide site plan showing structure location and exterior piping.
  - Coordinate with architecture and plumbing for point of connection of single line piping with tentative sizes.

- Cross section drawing through showing pertinent elevations.

For water and wastewater treatment plants:

- Provide site plan showing major unit treatment items including their relationship to existing facilities and exterior piping.
- Schematic flow diagrams for process flow, solids handling, chemical feed, and service water.
- Hydraulic profile flow rates per scope of services.
- Coordinate with architecture and plumbing for point of connection of single line piping with tentative sizes.
- Cross section drawing through structure showing pertinent elevations.

PLAN AND PROFILES

Provide profiles of new roadway alignments. Profiles shall show all new and existing utilities. Horizontal curve information shall be shown on plans and vertical curve information shall be shown on profiles.

GRADING SECTIONS

Provide a minimum of two grading sections through each building, embankment, or road showing existing and finished grade lines.

7.3.4.2 DESIGN ANALYSIS

The design analysis typically includes the following:

- List of design criteria.
- The goals, objectives, and priorities. Clearly explain the recommended site development.
- Composition and volume of anticipated traffic.
- Pavement design calculations and results using soil data provided in the geotechnical report.
- For water systems, provide narrative description (including operation and control), available flow and residual pressures, average and peak demands, allowable pipe materials, and calculations to support pipe sizing, tank sizing, flow demands, etc. If applicable, provide well capacities, chemical analyses and treatment requirements, storage availability and requirements, storage tank type and size, pump types, sizes, electric and control requirements, and insulation and/or heating requirements.
- For sewer systems, provide narrative description (including operation and control), capacity of existing system, design flow rates, allowable pipe materials, and all calculations necessary to support pipe sizing, tank sizing, flow demands, etc. If applicable, provide pump types, sizes, and electric and control requirements with pertinent information, pumping rates, hydraulic transient (surge) analysis, wastewater effluent analysis, and any special requirements of industrial wastewater systems. Document pollution prevention measures and other

environmental considerations made during design.

- Provide landscape design considerations for site conditions, climate, soils, water, erosion, in selection of materials.

7.3.5 PRELIMINARY FINAL DESIGN

7.3.5.1 DRAWINGS

VICINITY MAP, LOCATION PLAN, DEMOLITION, AND SITE PLAN

Include vicinity map, location plan, demolition plan, and site plan requirements from previous submittal with review comments incorporated.

GRADING AND DRAINAGE PLAN

New grading contours shall be provided on the grading and drainage plan. New spot elevations shall be provided at the corners of buildings and entrances, tops of drainage, sewage, and other utility structures, parking areas, changes in grade (high and low points in grading scheme), top and bottom of retaining walls and curbs, etc.

Utilize abbreviations next to spot elevations when the elevation pertains to a specific feature (e.g., FF: finished floor, TC/BC: top/bottom of curb). New slope arrows with percentages (%) or slope ratios (H: V) shall be provided at locations not covered by typical sections or as needed.

UTILITY DRAWINGS

Generally, the corrected and approved concept plans may be used as the basis for the intermediate plans; however, all details necessary for completion shall be included.

- Provide preliminary profiles of all water, sewer, force main, and gas lines.
- Profiles may be omitted for short waterline unless necessary to assure adequate cover or avoid interference with other underground facilities.
- Indicate existing pipe material where new lines connect.
- Indicate type of connection and elevation.
- Provide location of all valves, fire hydrants, and similar appurtenances.
- For pavement crossings, indicate installation method (open cut, boring, jacking, etc.). Where lift stations are required, provide appropriate details showing piping required, pumps, valves, and accessories. Include at least one cross section showing all required elevations.
- For water, sewer, force main, and gas lines, include survey ties and/or bearings, stationing in both plan and profiles, contours in plan, and appropriate notes, etc. for pavement crossings.
- For water and wastewater treatment plants, provide preliminary equipment layout showing all required piping, valves, meters, pumps, etc.
- Provide preliminary equipment schedules showing capacity, head, etc. for major items of equipment.

PLAN AND PROFILES

Profiles of new roads, streets, and railroads may be provided on separate drawings or on plan and profiles drawings. Plan and profile drawings shall show new and existing contours.

GRADING SECTIONS

Grading sections through new buildings and parking areas shall show existing and finished grades, existing and new utilities, pavement sections in detail, spot elevations, dimensions, slope percentage, ditches, etc.

SITE DETAILS

Provide detailed drawings of site furnishings, accessories, handicapped parking and provisions, water and sewer details, and specific construction techniques, applications, and finishes. Provide pavement details showing interface between existing and new pavements and new pavements of different sections. Use FED standard detail drawings.

7.3.5.2 SPECIFICATIONS

Draft specifications shall be submitted for review in redlined form. Special sections shall be prepared to cover those subjects for which no pattern FED Guide Specifications are available.

7.3.5.3 DESIGN ANALYSIS

It is recommended that the DA also include a summary of the basic information and conclusions presented in the previous submittal. Provide preliminary earthwork quantity calculations with a discussion of the earthwork balancing. Provide drainage area map showing boundaries of specific drainage areas tributary to their respective drain inlets or culverts. Include storm runoff calculations for each drainage area. Provide preliminary pipe sizing calculations. In addition to water and sewer items required in the concept or preliminary final design provide, if applicable, narrative and calculations for ultimate disposal to wastewater facilities, pilot testing for treatment plants, and hydraulic transient (surge) analysis for pumping stations for potable and fire water systems. If the project utilizes non-government facilities for water supply and/or wastewater treatment, provide documentation showing coordination. Provide copies of pertinent correspondence and conversation summaries.

7.3.6 FINAL DESIGN

The final design documents shall include all information for bidding and construction of the project. Specific requirements for plans, specifications and design analysis are as follows:

7.3.6.1 DRAWINGS

The corrected and approved plans from previous submittals (with review comments incorporated) may be used as the basis for the final plans. All details necessary for

bidding and complete construction shall be included. The following information is required (when applicable) in addition to the previously stated requirements for drawings.

In the boring logs, the lines designating the interface between soil layers or rock materials are determined by interpretation of drilling, sampling, and testing results. The transition between the materials may be sharp or gradational. Only at boring locations and at the time of drilling should subsurface material types and their depths be considered as reasonably accurate, and then only to the degree implied on the boring logs.

LOCATION PLAN

The location plan shall show:

- **Contractor's Access and Haul Routes:** Show access and haul routes with any load limits. Coordinate requirements with FED Resident Office.
- **Waste and Borrow Sites/Areas:** The designer shall determine the waste and/or borrow sites for all non-hazardous/toxic/radioactive waste (HTRW) materials for the project. Waste and/or borrow areas shall be clearly identified on the location plan showing the material acceptable for borrow or waste. Areas selected shall meet all regulations for pollution control and environmental quality as established by the Government. The designer shall check waste areas for types of materials which may, or may not, be disposed of.
- **Contractor's Staging Area and Parking:** Show areas for contractor storage, temporary fence, shed, and parking for subcontractors and their employees. Coordinate requirements with FED Resident Office.

BORING LOGS

The designer shall provide soil boring logs on the final design drawings. Soil boring or test pit locations shall also be shown on the final design drawings, preferably on the site plan where exploration locations may be referenced to structural features of the project. Elevations of the top of borings and the water table, if encountered, shall be shown on the drawings if they are known. If not known, they shall be referenced to the existing ground surface. Do not include the narrative portion of the geotechnical report or any sections or profiles containing interpretations of subsurface data in contract drawings or specifications.

EROSION AND SEDIMENT CONTROL PLANS

Provide erosion and sediment control plans for projects. Show the location of permanent and temporary best management practices required to minimize erosion and retain sediment within the boundaries of the site. This plan shall show methods of controlling erosion and sediment control during and after construction. When this plan is not required, temporary erosion and sediment controls shall be the responsibility of the construction contractor unless otherwise indicated.

DEMOLITION PLAN

The demolition plan shall show the existing site before construction and the demolition required by construction of this project. This plan shall include the field survey to show all above and below ground utilities, buildings, parking, roads, sidewalks, fence, storage tanks, foundations, athletic facilities, trees, turf, and existing contours. Demolition required by all aspects of the design have been fully coordinated at final design and are shown on the demolition plan. All items to be removed, relocated, or modified shall be appropriately labeled and hatched. The extents of demolition shall be clearly marked.

Site Plan

The site plan shall be fully dimensioned and labeled as necessary to field locate each item to be constructed. The site plan will show all existing physical features within and adjacent to the work site that will remain after the proposed construction has been completed. New work will be evident clearly from existing features. Applicable regulations and restrictions for clearances and setbacks shall be met.

Pavement Joint Layout Plans

Provide pavement joint layout plans with spot elevations at joint intersections for all new concrete roads and parking areas. Each type of joint shall be shown with a different symbol and a joint legend provided. Pavement joint layout plan shall not be combined with any other plans.

Grading And Drainage Plan

New grading contours shall be provided on the grading and drainage plan. New spot elevations shall be provided at the corners of buildings and parking areas, changes in grade, etc. New slope arrows with percentages (%) or slope ratios (H: V) shall be provided at locations not covered by typical sections or as needed.

Storm Drains, Culverts, And Subdrains

Profiles of all new storm drains, sub-drains, and culverts shall include new and existing grades, new and existing utilities, pavement sections in detail, pipe diameters and lengths, pipe slopes, invert elevations, etc. This information may also be included in the storm drain and sub-drain schedule drawings.

Utility Plan

The utility plan shall be fully stationed and labeled as necessary to field locate each item to be constructed. New work will be evident clearly from existing features. Provide finalized profiles and sufficient sections and details to permit construction.

Plan And Profiles

Provide profiles of new roads on separate drawings or on plan and profiles drawings. Plan and profile drawings shall show new and existing contours. Profiles shall show all new and existing utilities. New grade elevations shall be provided at the beginning and end stations and at 15 meters minimum intervals along profiles for roads.

Site Grading Sections

Grading sections through new buildings and parking areas shall show existing and finished grades, existing and new utilities, pavement sections in detail, spot elevations, dimensions, slope percentage, ditches, etc.

ROAD SECTIONS

Provide grading sections at 15 meters intervals along major roads, and streets.

SITE DETAILS

Provide detailed drawings of site furnishings, accessories, handicapped parking and provisions, water and sewer details, concrete pavement joint details, fence details, and specific construction techniques, applications, and finishes. Provide pavement details showing interface between existing and new pavements and new pavements of different sections. Use FED standard detail drawings.

LANDSCAPE PLAN

The landscape plan shall show plants and sodding.

- **Plants:** The landscape plan shall show all trees, shrubs, plant beds, landscape-related furnishings. Show beds or areas that are to receive decorative mulches. The landscape plan shall include a plant materials list. The list shall include: botanical names; common names; the appropriate size in caliper, height or size of container, e.g., 3 meters high or 20 liters container, method of transplanting, balled and burlapped, container grown, and special comments such as 1-year old seedlings, or “symmetrical form with branching at 2 meters height minimum”. This plan shall also show any wetlands plantings or any other re-vegetation requirements necessary for the project.
- **Sodding/Seeding:** Show all unsurfaced ground areas disturbed by construction to be sodded and/or seeded on the landscape plan. When a landscape design is not being provided with a project, unsurfaced ground areas to receive sodding or erosion control will be shown on the site plan.

LANDSCAPE DETAILS

Provide details for installing plants and constructing plant beds, landscaping furnishings and accessories. The standard landscape details shall be used where applicable. The designer shall verify the methods of planting to meet the project site requirements and modify the generic landscape details as local practices dictate. The designer shall provide all additional designs and details as necessary for furnishings and accessories not included in the standard details.

SPECIFICATIONS

The specifications shall be complete, accurate and fully coordinated with the plans and details.

DESIGN ANALYSIS

The design analysis shall include the information presented in the previous submittal, corrected to reflect changes.

GEOTECHNICAL REPORT

Incorporate recommendations stated in the geotechnical report into the design. Provide geotechnical design calculations using parameters outlined in the geotechnical report and include a copy of the geotechnical report in the design analysis as an appendix. Include laboratory test data as an appendix. Identify and resolve any conflicts between the geotechnical report and the design. Contact the author of the geotechnical report for assistance in resolving such conflicts if needed or if the geotechnical report needs to be modified.

DRAINAGE AND STORMWATER MANAGEMENT

Provide tabulation of capacities of new storm drains and culverts including diameter and slope of storm drainage pipe, design storm discharge and velocity for each storm drainage pipe, maximum discharge capacity of each storm drainage pipe, erosion control at each outlet if required, headwater depth of each culvert during design storm discharge. Provide hydraulic capacity calculations for each new curb and area inlet.

7.3.7 CONTRACT DESIGN

7.3.7.1 GENERAL REQUIREMENTS

Plans, specifications, and design analysis shall have all comments incorporated.

7.4 DRAWING COMPOSITION

7.4.1 PREPARATION

Drawings of the project site shall be prepared by assembling a CAD file specifically for the purpose of plotting. The file shall reference the survey file; removal plan, site layout file, as applicable; and a border file. CAD file naming conventions and drafting standards shall be followed. Scales between 1:100 and 1:400 meters are acceptable drawing scales for site drawings. Other drawing scales shall be approved by the Far East District. CAD files of actual field survey data shall be used design.

7.4.2 COMBINING PLANS

Some combinations of plans on a drawing sheet may be made when plans have relatively small amounts of data that can be legibly combined with another plan. The location plan and vicinity map may be combined on the cover sheet with the index or placed on the same sheet as the site plan. The site plan and the utilities plan may be combined as one plan with the approval of the Far East District, or they may appear as separate plans on the same sheet of drawings. Under no circumstances shall the site plan be combined as one plan with the grading and drainage plan, although they may appear on the same sheet of drawings. Projects having little or no existing facilities to be removed may not require a separate removal plan, and the small amount removals may be shown on the site plan.

7.4.3 NOT-IN-CONTRACT

Any work (construction, relocation, and/or removal) shown on the drawings, that is to be performed by others shall be identified on the site plan, removal, utilities and/or grading and drainage plans as “N.I.C.” (for “Not in Contract”). Note on each plan that there is information on the plans for work that is not in the contract.

7.5 GEOTECHNICAL INVESTIGATION AND REPORT

Geotechnical subsurface investigation at the project site shall be included in a comprehensive geotechnical report. Geotechnical report shall indicate the results of the subsurface investigation, including boring locations, boring logs, groundwater observations, a summary of laboratory test results, and any details required to convey requirements for site preparation on the contract documents. The designer shall be responsible for design considering all utility clearances. The geotechnical report shall be prepared and provided in accordance with UFC 3-220-01 at a minimum for all contracts unless otherwise directed by the Far East District. All computations, studies, analyses, and recommendations shall be incorporated with the geotechnical report.

When subsurface soil/groundwater contamination is encountered during geotechnical investigation, preliminary environmental report should be prepared to address potential impact of site contamination on the proposed construction. Recommendations for further environmental investigations, environmental mitigation measures, and other requirements are also provided in the report.

In accordance with the latest UFC 3-201-01, “Require geotechnical site investigation for soil corrosivity, when existing operating records, visual observations, inspections, or testing indicate corrosive soil conditions. Provide an evaluation of existing soils at the proposed depths and locations of piping in accordance with AWWA M27, chapter titled *Evaluating the Potential for Corrosion*.”

7.6 TOPOGRAPHIC SURVEYS

A topographic survey shall be prepared for all projects that require grading and utility work. The survey shall incorporate the basic criteria of EM 1110-1- 1005 table 6-1.

7.6.1 TOPOGRAPHIC MAPPING

Topographic mapping typically conforms to A/E/C CAD Standards.

7.6.2 ANNOTATION AND SYMBOLOGY

General annotation typically includes street names, building numbers, feature descriptions, and surface types.

7.6.3 TYPICAL SCALE

Typical scale for engineering design site surveys is 1:200.

7.6.4 CONTOUR INTERVAL

Contour interval will be typically 0.200 meter. Each 5th contour will be bolder than

others.

7.6.5 SPOT ELEVATIONS

Spot elevations are to be displayed to the nearest 0.001 meter.

7.6.6 SURVEY LIMITS

Extend survey limits a minimum 10 meters beyond project limits for clarification of existing drainage patterns.

7.6.7 UTILITIES

Show the source of utility information in the legend area of mapping. Above and below ground utilities will be located and shown on the final mapping. Underground utility information to be shown includes but is not limited to sanitary sewers, storm sewers, electrical, communications (including fiber optic), cathodic protection, gas, and water. Utility lines extending outside the indicated mapping area shall be shown to logical conclusions (adjacent manhole or potential connecting point) even if that end point is outside the mapping area. All underground information will be shown at proper elevations in the CAD files and thoroughly annotated.

7.6.8 ABOVE AND BELOW GROUND UTILITIES (ELECTRIC)

Utilities include, but are not limited to, power lines and communication lines, street light poles, guy wires, vaults (including handholes and manholes), transformers and substations.

7.6.9 ABOVE AND BELOW GROUND UTILITIES (WATER, GAS, ETC.)

Locate all water, gas, and other above and below ground pressure pipes. Locate all fire hydrants, hose bibs, valve meter, regulators, etc., within the limits of the area to be surveyed. Include location of pressure pipes on the topo map. Use sketched inserts where needed for detail and clarity. Utility lines extending outside the indicated mapping area shall be shown to logical conclusions (adjacent manhole or potential connecting point) even if that end point is outside the mapping area. Open all manholes even if they are locked. If the facility will not assist, notify FED immediately.

7.6.10 STORM DRAINAGE AND SEWER

Locate sanitary and industrial sewer manholes and storm drainage structures, such as culverts, headwalls, inlets, cleanouts, and manholes. Always obtain an elevation at the manhole rim and at the flow line at the bottom of all the pipes connected to a manhole culvert or inlet (invert elevations). Clearly identify the size, direction of flow and type of each pipe. Obtain the pipe invert elevation upstream and downstream of all manholes and inlets even if beyond the limits of the required topo. Provide sketches where needed for detail and clarity.

7.6.11 ROADS, DRIVES, PARKING LOTS, WALKS AND TRAILS

All roads shall have spot elevations at 10 meters intervals along the centerline and each edge of road. The top-back of curbs and gutter flow lines shall be collected for elevation purposes. The back of curb shall be shown in plan without gutter lines for

this mapping. Dimensions of curb height and width shall be annotated on each respective detail. Centerlines will be shown on two-lane roads or wider. The surface type and road name will be shown by text.

7.6.12 BUILDINGS AND STRUCTURES

All permanent and temporary buildings, foundations, and structures will be identified. Structures higher than ground elevation shall be collected from their roof lines and shown at zero elevation. This outline will be used to define an obscure zone for eliminating contour display. All buildings and similar structures will have ground elevations determined adjacent to them using the minimum number of points defining the structure's footprint. Elevations shall be collected photogrammetrically where possible.

7.6.13 FENCES

All fences, walls, and other similar obstructions shall be shown. Chain link fences shall be shown with a double X, rather than a single X.

7.6.14 TREES, SHRUBS AND LANDSCAPING MATERIAL

Show all landscape materials, shrubs, trees over 1 inch caliper, and types (evergreen or deciduous), how limits of turf types (field or lawn), also show irrigation systems.

Show all wetlands or marshy areas. If the trees are so dense (obscured) as to prevent adequate contouring, then tree lines will be treated exactly as buildings and structures.

7.6.15 DITCHES, STREAMS, CANALS, PONDS AND SCOUR HOLES

Show water's edge if visible. Water shall be considered an obscured area and treated as buildings and structures with the exception that water's edge shall be at proper elevation and shall be collected as visible break lines. Areas with active erosion shall be noted.

7.6.16 OTHER VISIBLE SURFACE FEATURES

Locate any storage tanks, radio antennas, or other surface structures visible and located within the area to be mapped.

7.7 SITE LAYOUT

7.7.1 BUILDING LOCATION

Consider the dimensional, environmental, orientation, and visual determinants, as discussed in UFC 3-201-01, when determining the building location.

7.7.2 SITE ACCESS AND CIRCULATION

The design shall provide for the safe, efficient movement of pedestrians and vehicles. Consider travel routes and areas of pedestrian concentration when planning walks. Follow the ABA for accessibility requirements. Follow UFC 4-010-01 when drop-off lanes and loading docks are included in the project scope. Access drives shall be designed to accommodate the full range of vehicles using the site. Service drives shall

be designed to accommodate only for command and operations support vehicles using the drive. Setbacks between roads, drives, and buildings as required by UFC 4-010-01 shall be met. Entrances to and from access drives shall have a minimum turning radii for the largest vehicle expected to use the drive. Throat widths and lengths shall accommodate incoming and outgoing traffic.

7.7.3 PARKING

7.7.3.1 PRIVATELY-OWNED VEHICLE (POV) PARKING

Off street parking facilities shall be located near the facilities served. Setbacks required by UFC 4-010-01 shall be met.

7.7.3.2 SIZE AND LAYOUT OF PARKING

Most POV parking shall be designed with 90-degree stalls. Angled parking may be used when it is the only practical method or is requested by the user. Follow the ABA for the design of accessible parking stalls.

7.7.3.3 CRITERIA FOR QUANTITY OF PARKING

Criteria for determining the appropriate number of parking stalls for POV authorized vehicles is either given in the Project DD Form 1391, government furnished project documents, or can be found in UFC 3-201-01. The quantity of handicapped stalls shall be as determined by the ABA.

7.7.3.4 GOVERNMENT VEHICLES (GOV) VEHICLE PARKING

Space allowances for design of GOV parking shall be determined by size of the vehicles and their maneuvering capabilities. Vehicle types and sizes are normally available from the user. The designer will document vehicle parking design considerations in the design analysis.

7.7.4 DUMPSTER ENCLOSURE

If the user requires a dumpster on site, a concrete dumpster pad will be provided. The chosen location shall consider the aesthetics of the building, accessibility by maintenance personnel, and the maneuverability of the servicing vehicle. Dumpsters may be screened with walls, landscaping and/or berms, as requested by the user. Typical practice is to have walls on three sides, with a swing gate for access. Minimum setbacks as required by UFC 4-010-01 shall be met.

7.7.5 ROADS

Pavement for roads and parking areas shall be designed using Pavement Transportation Computer Assisted Structural Engineering (PCASE). Determine appropriate design vehicle size and loading from Installation’s traffic study. A particular type of pavement may be required based on anticipated types of vehicular traffic or other considerations.

7.7.5.1 GEOMETRY

UFC 3-201-01 references SDDCTEA Pamphlet 55-17 for design of vehicle circulation and parking systems.

7.7.5.2 ROADWAY SAFETY

Roadside safety shall be considered in design of new roads and streets. Clear zone distances shall be determined based on traffic volumes and speeds, and on roadside geometry in accordance with the AASHTO Roadside Design Guide. Warrants, selection, and placement of roadside barriers, such as guardrails, crash cushions, etc., shall be in accordance with the AASHTO Roadside Design Guide.

7.7.5.3 SIGNAGE AND STRIPING

Traffic signage and striping shall be provided for all new roads and streets. The designer shall address traffic signage with the Installation at the pre-design conference. When replacing pavement due to resurfacing, utility excavations, etc., ensure that roadway markers are replaced.

7.7.5.4 SIDEWALKS

Sidewalks leading to main building entrances shall be designed with slopes meeting ABA requirements. Limit the use of separate ramps. The use of steps in walks will be avoided whenever possible. The use of single riser steps is especially discouraged. When steps are unavoidable, they shall have at least three risers and will be provided with handrails. For curb ramps along ABA accessible paths, ABA standards shall govern.

7.7.6 GRADING

UFC 3-201-01 provides minimum and maximum requirements and best practices for various surfaces. Positive drainage shall be provided for all areas and existing drainage ways shall be utilized to the extent possible. It is desirable to direct drainage away from buildings to curb and gutter or road ditches. Swales between buildings and parking areas or roads shall be avoided, if possible. Parking areas shall be graded such that storm water is directed off to the sides, with curbs and gutter to control drainage, and not down the center of the parking area, where possible. Required excavation and embankment quantities shall be balanced to the extent possible without compromising the design. Include hydraulic calculations justifying building finished floor elevations.

7.7.6.1 PARKING AREA GRADES

Follow UFC 3-201-01 and ABA requirements for ABA accessible stalls and paths.

7.7.6.2 LONGITUDINAL SIDEWALK GRADES

The maximum longitudinal sidewalk grade adjacent to the roadway shall be less than or equal to the adjacent roadway grade.

7.7.7 STORM DRAINAGE

Design of storm drainage facilities shall conform to the requirements in UFC 3-201-01. Protection of military installations against flood flow originating from areas exterior to the installation will normally be based on 100 year rainfall, depending on operational

requirements, cost-benefit considerations, and nature and consequences of flood damage resulting from the failure of protective works. Potential damage or operational requirements may warrant a more severe criterion.

7.7.7.1 DETERMINATION OF STORM RUNOFF

Determination of peak discharges may be accomplished using the Rational Method for drainage areas smaller than 200 acres or TR-55 curve number method, described in UFC 3-201-01.

7.7.7.2 STORM DRAINAGE SYSTEM LAYOUT

The storm drainage system shall be designed to minimize the number of drainage structures required. Structures shall be located at all vertical and horizontal changes in direction of storm drain lines, at the intersection of two or more storm drain lines, and where required to intercept rainfall runoff. Storm drain lines shall be located outside of paved areas to the extent possible. Under no circumstance shall storm drain lines be located beneath buildings. Existing storm drain lines located beneath new building sites shall be relocated around the building. Curb inlets shall be spaced along roadways with curbs and gutters so that the width of flooded areas does not exceed half the outside lane width.

7.7.7.3 MINIMUM COVER UNDER PAVEMENTS

The minimum cover for storm drains and culverts beneath road and airfield pavements shall be in accordance with UFC 3-201-01.

7.7.8 FENCING

Design security fences in accordance with UFC 4-022-03. Bolts/nuts used for security fencing can be easily removed, which presents a security risk. Provide spot welding of gate hinge pins and bolts attaching the fence fabric to the fence support posts for physical security.

7.7.9 SPECIAL SITE SECURITY REQUIREMENTS

The designer shall coordinate with the Installation to determine any special site security or screening requirements. All special security requirements that will impact the Contractor shall be included in the design documents.

7.7.10 LANDSCAPE

Design landscape in accordance with UFC 3-201-02. Provide a design that is both commensurate with the building's function and complementary to the architecture. Place emphasis on using plantings that require minimum maintenance. The designer shall specify types of plant materials that are locally grown, commercially available and acclimated to the project environment. Large, dense trees and shrubs shall be planted outside of the facility’s antiterrorism unobstructed space.

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CHAPTER 8 - STRUCTURAL

8.1 GENERAL

The instructions in this chapter provide guidance for the structural design criteria to be used and for the scope and content of the structural portion of the design documents required for each phase of the design. The structural design, including the resulting design documents, shall conform to the applicable criteria and instructions set forth below.

8.2 DESIGN CRITERIA

The designer is responsible for determining the applicability of design criteria to each project and incorporating any appropriate Service Component criteria in order to comply with all necessary design requirements.

The Unified Facilities Criteria (UFC) and Service Component specific Technical Manuals, Engineer Manuals, Engineering Instructions, Technical Instructions, Engineering Technical Letters, and Military Handbooks are available electronically at the Whole Building Design Guide (WBDG) website at http://www.wbdg.org.

Commonly used criteria documents required for design and not included at the WBDG website include the following:

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318	Building Code Requirements for Structural Concrete ACI 530
	Building Code Requirements for Masonry Structures ACI 350
	Environmental Engineering Concrete Structures.
ACI 360R	Guide to Design of Slabs-on-Ground ACI SP-66 Detailing Manual

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC) PUBLICATION

Steel Construction Manual

Seismic Provisions for Structural Steel Buildings

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE) PUBLICATION

ASCE 7	Minimum Design Loads for Buildings and other Structures
ASCE 41	Seismic Evaluation and Retrofit of Existing Buildings

AMERICAN WATER WORKS ASSOCIATION (AWWA) PUBLICATION

AWWA D100	Welded Carbon Steel Tanks for Water Storage

AMERICAN WELDING SOCIETY (AWS) PUBLICATION

AWS D1.1	Structural Welding Code
AWS D1.4	Structural Welding Code – Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless
ASTM A185	Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000psi Tensile Strength
ASTM A325	Standard Specification for High-Strength Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints
ASTM A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A446	Standard Specification for Steel Sheet, Zinc Coated (Galvanized) by Hot Dip Process, Structural (Physical) Quality
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563A	Standard Specification for Carbon and Alloy Steel Nuts
ASTM A572	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A992	Standard Specification for Structural Steel Shapes
ASTM E1996	Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impacted by Windborne Debris in Hurricanes
ASTM F436	Standard Specification for Hardened Steel Washers
ASTM F844	Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

INTERNATIONAL CODE COUNCIL (ICC) PUBLICATION

International Building Code (IBC)

International Existing Building Code (IEBC)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO) PUBLICATION

ISO 16932	Glass in Building – Destructive – Windstorm – Resistant Security Glazing – Test and Classification

KOREAN INDUSTRIAL STANDARDS (KS)

KS B 1002	Hexagon Head Bolts and Hexagon Head Screws
KS B 1010	Set of High Strength Hexagon Bolt, Hexagon Nut and Plain Washers for Friction Grip Joints
KS B 1012	Hexagon Nuts and Hexagon Thin Nuts
KS B 1016	Foundation Bolts
KS B 1037	Stud Bolts
KS B 1326	Plain Washers
KS B 2819	Sets of Torque-Shear Type High Tension Bolt, Hexagon Nut and Plain Washer for Structural Joints
KS D 3502	Dimensions, Mass and Permissible Variations of Hot Rolled Steel Sections
KS D 3504	Steel Bars for Concrete Reinforcement
KS D 3506	Hot-Dip Zinc-Coated Steel Sheets and Coils
KS D 3515	Rolled Steels for Welded Structures
KS D 3530	Light Gage Steels for General Structure
KS D 3552	Low Carbon Steel Wires
KS D 3566	Carbon Steel Tubes for General Structural Purposes
KS D 3705	Hot Rolled Stainless Steel Plates, Sheets and Strip
KS D 7004	Covered electrodes for mild steel
KS D 7017	Welded Steel Wire and Bar Fabrics
KS F 2538	Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction
KS F 2560	Chemical Admixtures for Concrete
KS F 3021	Structural Glued Laminated Timber
KS F 3113	Plywood for Structure
KS F 4002	Hollow Concrete Blocks
KS F 4004	Concrete Bricks
KS F 4044	Hydraulic Cement Grout (Nonshrink)
KS F 4306	Pretensioned Spun High Strength Concrete Pile

8.3 STRUCTURAL LOADING

Structural loading shall be developed for each building and structure using the site and project specific criteria and following the procedures indicated in the criteria

sources referenced below.

8.3.1 DEAD LOADS

Dead loads shall be selected in accordance with ASCE 7, as applicable.

8.3.2 FLOOR LIVE LOADS

Design live loads for floor areas shall be as indicated in Scope of Services. Where floor loads are not provided, uniformly distributed floor live loads for common building usage shall be obtained from UFC 3-301-01 and ASCE-7. Unusual loads and loads for usage not listed in that publication can be obtained from other recognized sources.

8.3.3 VEHICULAR LOADS

For vehicles exceeding 4,536 kg (10,000 lbs) design in accordance with UFC 3-301-01 and AASHTO Bridge Design Specification.

8.3.4 HANGARS

See design requirements in UFC 3-301-01.

8.3.5 SNOW LOADS

Snow loads shall be calculated in accordance with the procedures outlined in ASCE

7. Ground snow load, and other pertinent snow load criteria, shall be obtained from the UFC 3-301-01.

8.3.6 WIND LOADS

Wind loads shall be calculated in accordance with the procedures outlined in ASCE 7. Wind speed shall be obtained from the UFC 3-301-01.

In “Wind Borne Debris Region (Ultimate Design Wind speed greater than 225 km/h)” glazing shall be impact resistant per UFC 3-301-01. Glazing in windows and storefronts shall be impact resistant meeting the requirements of ASTM E 1886 and ASTM E 1996 (Missiles A & D except for Essential Facilities) or ISO 16932-2007 (Missiles A & C except for essential Facilities).

8.3.6.1 INTERIOR PARTITIONS

Interior partitions in structures that are defined as "partially enclosed" for wind loads by ASCE 7 shall be designed for 10 psf lateral pressure. Interior partitions in structures that are defined as "enclosed" for wind loads by ASCE 7 shall be designed for 5 psf lateral pressure. Interior partitions around mechanical room spaces shall be designed for 10 psf lateral pressure regardless of whether the structure is classified as "enclosed" or "partially enclosed". The deflection of interior partitions under wind load shall be not more than 1/360 the span of wall for walls with brittle finishes and 1/240 for walls with flexible finishes.

8.3.7 SEISMIC LOADS

All facilities shall be designed to withstand seismic loading in accordance with UFC 3-301-01 and ASCE 7. Spectral response accelerations shall be obtained from UFC 3-301-01.

8.3.7.1 SEISMIC SCREENING AND EVALUATION OF EXISTING BUILDINGS

The evaluation of existing buildings and the design of the mitigation of structural deficiencies shall be in accordance with ASCE 41 and IEBC. Seismic evaluation and retrofit are required for buildings assigned to Seismic Design Category C where renovation costs total more than 50% of the replacement value of the building. Seismic evaluation and retrofit are required for buildings assigned to Seismic Design Category D, E, or F where renovation costs total more than 30% of the replacement value of the building.

8.3.7.2 SEISMIC ANALYSIS

Calculations shall include horizontal and vertical building irregularity checks in accordance with ASCE 7-10 tables 12.3-1 and 12.3-1 and 12.3-2. For seismic design categories C-F, apply the orthogonal combination procedure in accordance with ASCE 7-10 section 12.5.

8.3.8 ANTITERRORISM (AT) STANDARDS

The structural design shall incorporate the minimum requirements for Antiterrorism (AT) as given in UFC 4-010-01 DOD Minimum Antiterrorism Standards for Buildings. Progressive collapse design shall be in accordance with UFC 4-023-03 Design of Buildings to Resist Progressive Collapse. For additional requirements regarding window blast calculations, see chapter 6 Antiterrorism.

8.4 BUILDING CONSTRUCTION

Buildings on US Military Installations in Korea are predominantly constructed of cast-in- place reinforced concrete. Hangars and warehouses are typically steel construction.

Buildings constructed of precast/prestressed concrete elements and masonry are uncommon in Korea, except for piles. Precast piles are common in Korea.

8.5 FOUNDATION DESIGN

The designer will verify the subsurface investigation and the foundation analysis in coordination with Far East District's Geotechnical Engineer. The foundation analysis includes but is not limited to the recommended type of foundation and design depths, allowable soil bearing pressure, equivalent fluid density and lateral earth pressure coefficients, frost depth, modules of sub grade reaction, depth of effective bearing layer, seismic site class determination and evaluation of liquefaction potential.

For new construction in close proximity to an existing structure, involving activities that could impact the existing structure (i.e., excavations and pile installations), the condition of the existing structure shall be inspected and documented prior to the work as a baseline for any future claims of damage. When excavation near existing foundations is required, an assessment shall be conducted in accordance with the IBC.

Designer shall include all pertinent soils information in the contract documents. The Geotechnical Report shall not be provided to the Contractor.

8.5.1 DEEP FOUNDATIONS

Pretensioned spun high strength concrete (PHC) pile conforming to Korean Industrial Standard KS F4306 is the most common pile in Korea. Typical installation is by driving the pile to the bearing layer. In case, considering noise/vibration and in close proximity to an existing structure, installation is by pre-drilling to the bearing layer then driving the pile for the last meter. Other types of pile are applicable upon providing the foundation design request including all related information to Far East District's Geotechnical Engineer.

8.5.2 SHALLOW FOUNDATIONS

Verify the required design soil bearing capacity for shallow foundations in coordination with Far East District's Geotechnical Engineer.

8.6 CONCRETE DESIGN

Concrete design shall be in accordance with UFC 3-301-01, UFC 3-320- 06FA, and current ACI publications that are applicable to the design. The water cement ratios at KS certified plants are typically over 0.50 and have historically met performance requirements. Ensure specifications incorporate standard water cement ratios from KS certified plants, or provide justification for using non-standard mix design and incorporate additional costs into the cost estimate. The following detailed design instructions also apply.

8.6.1 TYPICAL KOREAN CONCRETE STRENGTHS AND USAGES

Table 6: Concrete Strengths and Usages

28-DAY STRENGTH	USE AND APPLICATION
24 MPa (3,481 psi) and 27 MPa (3,916 psi) Compressive Strength	Most reinforced concrete structures not exposed to freezing-and-thawing cycles, such as slabs, beams, girders, columns, exposed walls, footings, foundations, and sidewalks. For slabs-on-grade not subjected to heavy vehicular or stationary loads.
30 MPa (4,351 psi) Compressive Strength	Most water reservoirs and tanks for sulfate resistant structures not exposed to freezing-and thawing cycles. For other structures where economy consistent with good practice will result.

8.6.2 REINFORCING BARS

8.6.2.1 KOREAN REINFORCING BARS

Table 7: Korean Reinforcing Bars

BAR SIZE DESIGNATION	**NOMINAL AREA** (cm^2)	**NOMINAL WEIGHT** (kg/m)	**NOMINAL DIAMETER** (mm)
D10 (#3)	0.713	0.56	9.5
D13 (#4)	1.267	0.995	12.7
D16 (#5)	1.986	1.56	15.9
D19 (#6)	2.865	2.25	19.1
D22 (#7)	3.871	3.04	22.2
D25 (#8)	5.067	3.98	25.4
D29 (#9)	6.424	5.04	28.6
D32 (#10)	7.942	6.23	31.8
D35 (#11)	9.566	7.51	34.9

8.6.2.2 REBAR AVAILABILITY

For concrete design, the following reinforcing are locally available in Korea:

Table 8: Rebar Availability

BAR SIZE DESIGNATION	**ASTM**	**KS**	**STRENGTH**
D10 to D35	ASTM A615 ASTM A706	KS D3504 SD400 & SD500	SD400 390 MPa (56 ksi) SD500 490 MPa (71 ksi)

Reinforcing strength 490 MPa (71 ksi) listed in the table above is the minimum requirement for accidental explosion.

8.6.2.3 USAGE LIMITATIONS

Except for stirrups, ties and bars used in slabs-on-grade, the minimum reinforcing bar size shall be D13.

8.6.2.4 SPLICES

The three methods of splicing in Korea are lap, mechanical and welded splices. Lap and welded splices are the most common. Weld shall develop 125% of the minimum yield tensile strength of the spliced bar. Perform mechanical testing of steel in accordance with ASTM A370.

8.6.3 BUILDING SLABS-ON-GRADE

Design of slabs shall be in accordance with UFC 3-301-01 and the following detailed instructions. Floor slabs to be subjected to heavy loads shall be designed in

accordance with UFC 3-320-06A.

Slabs shall be designed as floating slabs without rigid edge support and unrestrained lateral and vertical movement, or where structural slabs are required for soil/site conditions. All interior slabs shall be designed and constructed in accordance with ACI 360R. The requirement and location of vapor barriers shall be determined per figure 4.7 of ACI 360R. If a vapor barrier is required, the minimum thickness shall not be less than 10 mil. A 150mm (6-inch) thick compacted capillary water barrier shall be on compacted subgrade. Crack control measures shall be incorporated in the slab design. Control joint spacing and details shall be as delineated in UFC 3-301-01 and UFC 3-320-06FA, as applicable.

8.6.3.1 SLABS SUBJECT TO HEAVY LOADS

Slabs subject to heavy loads are typically used in warehouses, vehicle maintenance shops, hangars, industrial plants, and similar buildings with heavy stationary or wheel loads. Slab thickness shall be determined in accordance with the Portland Cement Association (PCA) Slab Thickness Design for Industrial Concrete Floors on Grade and UFC 3-320-06A. The "k" factor shall be furnished by the foundation analysis and adjusted for the type of soil and saturated conditions without frost.

8.6.3.2 SLABS-ON-GRADE IN FREEZER AREAS

Slabs in freezer areas shall be designed with special measures to prevent sub-grade freezing. Such measures include insulation, vent pipes, heat coils, or heat pipes placed beneath slabs in these areas.

8.6.3.3 STRUCTURAL CONCRETE STOOPS

Exterior doorways require structural stoops where exterior slabs are susceptible to frost heave, and slab movement could render outward-swinging doors inoperable. Stoops shall have Non-Frost-Susceptible Material (N.F.S.M.) to frost depth under the slab.

8.6.3.4 EXTERIOR SLABS FOR RAMPS, DOCKS & APRONS AT VEHICULAR DOORS

Where movement of the floor slab with respect to a door can cause operating difficulties, preventive measures shall be taken. Such measures would include making the floor a structural slab supported on a foundation that extends below frost line, depressing the foundation wall at door openings and doweling the interior and exterior slabs together, or depressing the foundation wall at door openings and thickening the edges of interior and exterior slabs at their interface. The thickened edge shall be 1.25 times the slab thickness and shall begin 10 times the slab thickness from the edge of the slab.

8.6.3.5 CONCRETE FLOOR SLAB FINISHES

Concrete floor slab finishes shall comply with those indicated in Far East District Guide Specification (UFGS) 03 30 00 CAST-IN-PLACE CONCRETE.

8.6.4 CONCRETE WALL THICKNESSES

Typical wall thicknesses in Korea are 120 mm, 150 mm, 180 mm, 200 mm, 250 mm, 300 mm, 350 mm, 450 mm, 500 mm, and 600 mm. 120 mm and 150 mm are non-structural walls and structural walls begin from 180 mm thick. Walls thicker than 150 mm and greater have double layer of reinforcing. 150 mm thick walls have a single layer of 100 mm spacing vertical and horizontal bars.

8.7 MASONRY

Masonry as a structural building element is uncommon in Korea. In Korea, masonry is typically used for property walls, trash enclosure walls and plumbing walls in buildings. Korean blocks typically have three cells instead of two and are constructed using stack bond.

In the instances where masonry is used, design shall be in accordance with ACI 530 (as modified by the International Building Code and UFC 3-301-01. Type S mortar shall be specified for all masonry. Reinforcement shall be sufficient to satisfy the calculated and prescriptive requirements for strength, shrinkage crack control, and seismic design. Connections between walls and structural steel frames shall be designed to allow frame movement with minimum influence on the adjoining walls.

Concrete masonry crack control measures comprised of masonry control joints, joint reinforcement, and bond beams shall be incorporated in the design of concrete masonry walls and partitions. Masonry control joints shall be judiciously located at a spacing no greater than the maximum recommended in UFC 3-301-01. Masonry control joints shall not be placed closer than 600mm from openings. Brick expansion joints for brick faced buildings 15m and longer, shall be located as recommended by UFC 3- 301-01. Masonry control joint (MCJ) locations shall be shown on the architectural plan sheets. Brick expansion joint (BEJ) locations shall be shown on the architectural exterior wall elevations and floor plans.

8.8 STRUCTURAL STEEL

Structural steel shall be designed in accordance with UFC 3-301-01, AISC, and AISC Seismic Provisions for Structural Steel Buildings. All structural steel members shall be designed by the structural engineer to support all applicable loads. Structural drawings shall clearly show all structural members and their locations, locations of connections using pre-tensioned bolts, Fatigue detail requiring nondestructive testing, indication of complete-joint penetration (CJP) welds subject to tension. Where conditions are not covered by the specification, alternate methods of analysis and design are permitted subject to the approval of the authority having jurisdiction. Types of connections shall be consistent with the design assumptions for the basic type of steel construction used. Connections shall be designed and detailed to provide adequate capacities for the applied forces and moments. Connection design shall be the responsibility of the structural engineer and shall not be delegated to the steel fabricator.

8.8.1 STANDARD KOREAN STRUCTURAL STEEL

Table 9: Standard Korean Structural Steel

SHAPE	ASTM	KS	STRENGTH
H Shape	ASTM A36 ASTM A572 & A992	KD D 3515	235 MPa (34 ksi) 315 MPa (45 ksi) 355 MPa (51 ksi)
Channels Angles Plates	ASTM A36	KD D 3515	235 MPa (34 ksi) 315 MPa (45 ksi) 355 MPa (51 ksi)
Tubes	ASTM A500, Grade B	KS D 3568	245 MPa (35 ksi) 325 MPa (47 ksi)
Pipe	ASTM A53, Grade B	KS D 3566	235 MPa (34 ksi) 315 MPa (45 ksi) 390 MPa (56 ksi)
Bolt	ASTM A307	KS B 1002	
High-Strength Bolt	ASTM A325	KS B 1010	
Anchor Bolt	ASTM F1554	KS B 1016	235 MPa (34 ksi)
H WF WT Shapes	ASTM A992	KS D 3502	
Nuts	ASTM A563M, Gr A	KS B 1012	
Washers	ASTM F844	KS B 1326	
Tension Control Bolts	ASTM F1852	KS B 2819	

8.8.2 KOREAN STRUCTURAL STEEL DESIGNATION

Table 10: Korean Structural Steel Designation

SHAPE	DESIGNATION	EXAMPLE
H Shape	H (height) x B (width) x t1 (web thk) x t2 (flange thk)	H400x200x8x13

Channels	H (height) x B (width) x t1 (web thk) x t2 (flange thk)	C200x90x8x13.5
Angle	A (height) x B (width) x t (thickness)	L 100x75x7
Tube	A (height) x B (width) x t (wall thickness)	Tube 60 x 30 x 1.6
Pipe	D (outside diameter) x t (wall thickness)	Pipe 139.8 dia. x 6

8.8.3 CONNECTION DESIGN

Types of connections should be consistent with the intended performance of the connection and the design assumptions used in the structural analysis. Connections should be designed and detailed to provide adequate capacities for the applied forces and moments. Connection design should be the responsibility of the structural engineer and should not be delegated to the steel fabricator. Korean fabricators do not typically design connections and prefer bolted connections for most structures including trusses. Specify galvanized anchor bolts for columns.

8.8.4 WELDING

Korean fabricators prefer field welding to be minimized. Structural Welding shall be in accordance with AWS D1.1 except for provisions that the engineer or contract document specifically modifies or exempts. Weld size and design, and NDT requirements shall be indicated in the contract drawing. While radiographic testing is uncommon in Korea, ultrasonic testing is the typical method used for welding inspection.

8.9 STEEL JOISTS AND JOIST GIRDERS

Structural steel beams are typically used in lieu of steel joists in Korean construction. In Korean steel, joists are not structurally reliable and typically used for temporary construction.

8.10 STEEL DECKING

Metal roofing and siding shall not be used as a diaphragm. Lateral loads are typically resisted by tension rods.

Floor decking is typically 50 mm or 75 mm depth with a maximum of an additional 100 mm concrete topping.

8.11 COLD-FORMED LOAD BEARING STEEL STUD WALLS

Design and detailing of wall systems using cold-formed steel members as load-

bearing systems shall be in accordance with the provisions of UFC 3-301-01. Wall systems shall be specified using UFGS 05 40 00 Cold Formed Steel Framing Design assumptions and details shall be coordinated with specifications.

Metal stud spacing is typically 450 mm and 300 mm.

- Studs (Non-structural) ASTM A446 245 MPa (35.5 ksi)
- Studs (Structural) ASTM A36 235 MPa (34 ksi)

8.12 SPECIAL CONSTRUCTION

8.12.1 STANDING SEAM METAL ROOFING SYSTEMS

Structural standing seam metal roof systems typically comply with UFGS 07 61 14.00 20 Steel Standing Seam Roofing and UFC 3-110-03. Drawings shall include diagrams of the calculated design wind uplift pressures for the various regions of the building roof(s), as determined from ASCE 7.

8.12.2 ELEVATED WATER TANKS

Elevated water tanks and other structures commonly constructed in accordance with manufacturer's proprietary designs are likely to be contractor designed or redesigned. For such structures the design shall include a tabulation of loading criteria (roof live load, wind velocity, seismic design data, allowable soil bearing pressure, minimum foundation depth, coefficients for active and passive lateral soil pressure, etc.) and the load combinations necessary for design or completion of design by the contractor; a statement of the commercial design codes (ACI 318, AISC Specifications, AWWA D100 etc.) which govern the design of the structure, its supporting steel, and foundations; a complete design for the supporting structure and the foundations; and a drawn-to-scale graphical representation of the completed structure, including any dimensional requirements or limitations.

8.12.3 BLAST RESISTANT CONSTRUCTION

8.12.3.1 CONCRETE STRUCTURES

Concrete structures to be used for the manufacture, maintenance, inspection, or storage of explosive materials are typically designed in accordance with UFC 3-340-02. The following information will be required for such designs: Sketches or drawings defining the configuration and construction of the facility; the category of protection that is required; the amount, type, and location of explosive in each area; the TNT equivalence for each explosive; and the sensitivity of each explosive in terms of a minimum fragment velocity, if required.

Concrete structures located within the Blast ESQD (Explosive Safety Quantity Distance) arc shall be designed in accordance with UFC 3-340-02. Blast analysis shall be performed by the designer. Hardening requirements for structures, windows, and doors shall be incorporated into the design.

8.12.3.2 MUNITIONS STORAGE IGLOOS AND MAGAZINES

When munitions storage igloos and magazine type facilities are included in the project, standard drawings are available for the designer to edit in accordance with the Designer Notes on the drawings. Other revisions may also be required for adaptation of the drawings to the site, climatic, and foundation conditions.

8.12.3.3 STEEL FRAMES AND COLD-FORMED STEEL COVERINGS

Steel frames and cold-formed steel items are required to be blast resistant (including blast doors) and shall be designed in accordance with UFC 3-340-02.

8.12.3.4 ARMS STORAGE ROOMS

Criteria for arms storage rooms shall be obtained or verified by the Stakeholder's Provost Marshal or Security Office through the Far East District's Project Manager.

8.12.3.5 WATER STORAGE RESERVOIRS

When the design of concrete water storage reservoirs include construction joints with water stops, the designer may stipulate that the reservoirs be tested for leakage prior to backfilling. When such testing is required, the reservoir structural design shall include the loading condition of internal hydraulic head on the reservoir due to filling for testing purposes with no backfill in place.

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CHAPTER 9 - ARCHITECTURE

9.1 GENERAL

Facilities shall be designed in harmony with the surrounding base architecture, judiciously employing the style and character of architecturally and historically significant facilities, as appropriate.

Careful attention shall be given to the Stakeholders' functional requirements; an aesthetic solution compatible with the local environment and the installation design guide or facilities excellence plan; sustainability; antiterrorism/force protection; siting; interior and exterior details; energy efficiency/performance; safety; and economy of design including life cycle cost. Facility design shall conform to applicable criteria and standards and be consistent with applicable congressional cost limitations. Provide the appropriate quality of construction that is appropriate for the type of facility being designed, within funding limitations, considering life cycle cost considerations. Include design economies that are affected using suitable local and regional construction methods, materials, and skills that are consistent with the intent of these criteria. Design shall utilize commercially available standard or stock equipment, fixtures and materials when they meet functional requirements.

This chapter describes requirements and guidance for more typical aspects of architectural design. Specific project conditions may dictate the need for design that exceeds these requirements. The architectural design efforts shall result in code compliant, functional, life-cycle cost effective, buildable, discipline coordinated, and sustainable design solutions throughout all phases of project programming and design.

9.2 DESIGN CRITERIA

Design criteria will include a wide variety of codes, regulations, standards and other applicable requirements depending on the project type. The designer shall coordinate the design closely with the Installation Fire Chief/Marshal and Installation for design requirements particular to the project location. The latest revision of each document will be used, unless otherwise noted. In cases where two or more design requirements appear to conflict, the designer shall notify the Corps of Engineers Project Manager who will coordinate with the appropriate technical discipline for resolution. Most U.S. Army Corps of Engineers technical publications are available electronically at the Whole Building Design Guide website: http://www.wbdg.org. New documents found at the sites, which are not listed in this design guide but appear to apply shall be brought to the attention of Corps of Engineers Project Manager who will coordinate with the appropriate technical discipline for resolution.

9.2.1 UNIFIED FACILITIES CRITERIA (UFC)

UFC documents provide planning, design, construction, sustainment, restoration, and

modernization criteria, and apply to Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with DoD Directive 4270.5 (Military Construction) and USD (AT&L) Memorandum dated 29 May 2002.

UFC 1-200-01 is the overarching document for buildings and facilities used by DoD. UFC 1-200-01 directs the use of the International Building Code (IBC), the International Existing Building Code (IEBC), Core UFC, other UFC as applicable to the building, facility, structure, or system, and Facility Criteria (FC) as they pertain to the applicable DoD Component.

Architectural Core UFCs are criteria that provide architectural requirements for the majority of conventional building systems that are prevalent on FED construction projects.

Comply with the Architectural Core UFC listed here as applicable.

- UFC 1-200-01DOD BUILDING CODE
- UFC 1-200-02HIGH PERFORMANCE AND SUSTAINABLE BUILDING REQUIREMENTS
- UFC 3-101-01ARCHITECTURE
- UFC 3-110-03ROOFING
- UFC 3-120-01SIGN STANDARDS
- UFC 3-120-10INTERIOR DESIGN
- UFC 3-190-06 PROTECTIVE COATINGS AND PAINT
- UFC 3-420-01PLUMBING SYSTEMS
- UFC 3-600-01FIRE PROTECTION ENGINEERING FOR FACILITIES
- UFC 4-010-01DOD MINIMUM ANTITERRORISM STANDARDS FOR BUILDINGS
- UFC 4-010-02DOD MINIMUM ANTITERRORISM STANDOFF DISTANCE FOR BUILDIGNS

Comply with other UFC as applicable to the system, structure, or facility type defined in the scope of the construction project.

9.2.2 FACILITIES CRITERIA (FC)

The designation “FC” is for criteria that are not applicable to all DoD Components. Comply with the FC for the designated facility type and the DoD Components.

9.2.3 AIR FORCE CRITERIA

The Air Force Civil Engineer Center (AFCEC) is responsible for providing responsive, flexible, full-spectrum installation engineering services for the Air Force worldwide. AFCFC missions include facility investment planning, design and construction,

operations support, real property management, energy support, environmental compliance and restoration, audit assertions, and acquisition and program management.

AFMAN 32-1084, *Standard Facility Requirements* provides guidance for determining space allocations for Air Force facilities and may be used to program new facilities or evaluate existing spaces.

9.2.4 NAVY/MARINE CORPS CRITERIA

The Facility Criteria publication, UFC 2-000-05N *Facility Planning Criteria for Navy/Marine Corps Shore Installations* provides the space planning factors, criteria and techniques for use in developing Basic Facility Requirement calculations and assessments.

9.2.5 IMPLEMENTATION OF NEW CRITERIA

New criteria will be implemented as soon as possible consistent. Routine application requires the use of new criteria in future projects and in current project, if received prior to initiation of site adaption of standard drawings or at the 35 percent concept design stage. Other implementations shall be complied with the ER 1110-345-100.

9.2.6 MISCELLANEOUS

Most military installations and/or service design agencies have publish design guidelines that contain criteria relative to achieving, maintaining and emphasizing a positive exterior visual environment. Follow the design guidance contained in these documents carefully since these are published under the authority of the Secretaries of the military services.

9.3 CENTERS OF EXPERTISE

U.S. Army Corps of Engineers has Corps-wide Centers of Expertise (CX) Program for establishing and maintaining expert designations. The program provides an inventory of specialized knowledge and skills within the USACE that can furnish beneficial and expert assistance to all Corps element.

A two-tiered CX program has been established, mandatory use and voluntary use. The mandatory portion is designated Mandatory Centers of Expertise (MCX), and the voluntary portion is named Technical Centers of Expertise (TCX).

MCXs that has been approved by HQUSACE are:

- Ballistic Missile Defense System Program – U.S. Army Engineering and Support Center Huntsville (HNC)
- Electronic Security Systems – HNC
- Environmental and Munitions CX – HNC

- Facilities Explosive Safety - HNC
- Fuel Facilities (Petroleum, Oils and Lubricants) – Omaha District (NWO)
- Marine Design Center – Philadelphia District (NAP)
- Medical Facilities – HNC
- Protective Design Center (PDC) – NWO
- Range Training Land Program - HNC
- Transportation Systems Center (TSMCX) – NWO

ER 1110-1-8158 states that a Center of Standardization (COS) can be a MCX or a TCX. When a COS has a mandatory component requiring a product or service to be used by all USACE elements, it is designated as an MCX. Absent a mandatory component, a COS is designated as a TCX.

FED designs shall comply with COS requirements and COS shall be consulted in each design phase as applicable. For the list of COS Points of Contact visit https://mrsi.erdc.dren.mil/cos/poc.

9.4 ACCESSIBILITY

Design features to accommodate people with disabilities shall be in accordance with the Architectural Barriers Act (ABA) Accessibility Standards for Department of Defense Facilities. In general, all facilities designed, constructed, or funded by DoD that are open to the public or that may be visited by the public in the conduct of normal business, shall be designed and constructed to be accessible to people with disabilities. The designer shall be sensitive to the special needs of people with disabilities, and shall ensure the incorporation of accessible features into the design. The Design Analysis shall clearly document the ABA Design Guidelines and/or contain written exemptions.

9.5 BUILDING ENVELOPE REQUIREMENTS

UFC 3-101-01, CHAPTER 3 identifies the basic requirements for building envelope design. Apply all the requirements of the UFC as a minimum as applicable. Design the building envelope to control the transfer of the following elements: heat, air, moisture, light/radiation, and noise. Design each control strategy holistically and use an integrated approach.

9.5.1 AIR BARRIERS

For new construction, design the building enclosure with a continuous air barrier to control air leakage in accordance with the 3-6, UFC 3-101-01, except where only inspection is required in the 3-6.3 of the UFC.

When a renovation/repair/alteration project, identify the modification type of air barrier from the A-5.4, UFC 3-101-01, and apply the requirements according to each type of modification.

9.5.2 ACOUSTICS

Design the facility to provide a comfortable inside acoustical environment that limits exterior noise intrusion to noise sensitive spaces in accordance with the 3-8, UFC 3-101-01. Determine if any of the noise sources listed in the section are within the distances.

Design for interior acoustics carefully, in order to coordinate with the architecture, mechanical and structural design in accordance with the 2-3.2, UFC 3-101-01.

For required the acoustical performance and the STC, FED highly recommends to use tested walls, partitions and floor-ceiling assemblies to avoid field test considering the construction environment in Korea.

A performance-based alternative approach with verifiable basis for meeting the required STC ratings may be accepted very limited.

9.5.3 ENVIRONMENTAL SEVERITY CLASSIFICATIONS

The architectural design shall incorporate systems and details to meet the environmental corrosivity conditions for the specific project location, as defined by its Environmental Severity Classification (ESC).

Areas of Korea peninsula are classified ESC C3 or C5 in accordance with UFC 1-200-01.

The humidity conditions shall also be considered during design.

9.6 ROOFS

UFC 3-110-03 describes application of NRCA Manual and the MBMA Roofing Manual for design of Military projects including Army, Navy and Air Force.

Apply all the requirements of the UFC as a minimum as applicable.

For the purpose of the UFC, roofing is categorized as low-slope, steep-slope and metal roofing. Low-slope roofing systems are weatherproof membrane roof systems installed with slopes at or less than 3:12 (14 degrees). Steep-slope roofing systems are water-shedding roof coverings installed on slopes greater than 3:12 (14 degrees). Standing-seam metal roofing (SSMR) systems are either hydrostatic that are designed and constructed to be totally water resistive (like a roof membrane) or hydrokinetic that are not totally resistive to water intrusion and rely on slope to shed water.

The roof design shall incorporate systems and details to meet the environmental corrosivity conditions for the specific project location as well as building envelope.

All the requirements relating to Environmental Severity Classification (ESC) and humid locations shall be incorporated to the design.

CHAPTER 10 - INTERIOR

10.1 GENERAL

This chapter provides general guidance and outlines technical requirements that apply to both building-related and furniture-related interior design projects, new construction and renovation projects. The information provided in this chapter will be used by interior designers and architects and will serve as the minimum interior design requirements.
Excellence in design is the primary goal for all projects. Reaching this goal requires a commitment by the Government and designers to a level of quality that includes the coordinated relationship of interior design with the building design, as well as the details of design that affect the users of the facilities. Quality interior design is value added to a project as it vitally improves facility operating efficiency, attractiveness, livability, functionality, life-cycle economics, and the productivity of the users. Project conditions may dictate the need for design that exceeds these minimum requirements.

The Structural Interior Design (SID) involves the design, selection and specification of applied finishes and building interior features including, but not limited to, walls, floors, ceilings, trims, doors, windows, window treatments, built-in items and installed equipment, lighting, and signage. The SID package includes furniture floor plans, finish schedules, color boards and any supporting interior elevations, details or plans necessary to communicate the building finish design and build out. The SID provides basic space planning for anticipated FF&E design requirements in conjunction with the functional layout of the building and design issues such as life safety, privacy, acoustics, lighting, ventilation, and accessibility.

SID Binder shall be submitted in the Preliminary Design and Final design to supplement the description of finishing materials for which brand name and model number are prohibited.

A Comprehensive Interior Design (CID) will be provided, unless otherwise directed, and will include the Structural Interior Design (SID) and the Furniture, Fixtures and Equipment (FF&E) Design. The two types of services cover different aspects of the interior environment and are funded through different sources.

The Comprehensive Interior Design (CID) is a combination of two elements, the Structural Interior Design (SID) and the Furniture, Fixtures and Equipment (FF&E) specification and procurement package. The SID includes building-related design elements and components generally part of the building itself, such as walls, ceilings, floor coverings, primary window treatments (blinds, shades and drapery hardware), signage and built-in casework. The design of the FF&E includes the layout, selection, specification and documentation of furniture, such as workstations, seating, tables, storage, filing, accessories, and artwork.

The FF&E package shall ideally be developed concurrently with the building design to

ensure that there is coordination between the electrical outlets, switches, J-boxes, communication outlets 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.

A stand-alone SID or FF&E design may be required depending on project requirements. Verify actual submittal phases required on a project-by-project basis as each agency will have its own specific requirements. The project scope of work must reflect project specific requirements.

10.2 INTERIOR DESIGNER QUALIFICATIONS

Design shall be performed by professional interior designers or architects with significant interior design experience for both Structural Interior Design (SID) and Furniture, Fixtures and Equipment (FF&E). Qualification of designers is based on education, experience and examination. Interior designers or architects shall have complete a program accredited by the Council for Interior Design Accreditation (CIDA) or equal accreditation program of academic training in interior design.

For contracted interior design services, the interior designer or architect shall also have attained National Council for Interior Design Qualification (NCIDQ) certification or state licensure, certification or registration and shall not be affiliated with a furniture dealership, vendor or manufacturer.

The qualified interior designer or architect shall be included in the project Design Quality Control Plan (DQCP).

10.3 DESIGN CRITERIA

UFC 3-120-10 *INTERIOR DESIGN* applies to all agencies of the Department of Defense and their contractors that prepare Structural Interior Design (SID) and Furniture, Fixtures and Equipment (FF&E) design packages for all DoD-owned facilities.

The UFC covers requirements for schematic design, design development and construction documents including drawings and specifications, procurement documentation and project presentations for all projects.

Apply all the requirements of the UFC as a minimum as applicable.

10.4 SUBMITTAL REQUIREMENTS

The comprehensive CID package shall comply with UFC 3-120-10, Tables B4-1 and B5-1. The tables describe what components are typically included in each submittal.

10.5 CLASSIFICATION OF EQUIPMENT

10.5.1 CONTRACTOR FURNISHED CONTRACTOR INSTALLED (CFCI)

Installed building equipment includes items of real property affixed to or built into a facility that are an integral part of the facility. The contractor may procure and install the FF&E package, known as CFCI.

This type of equipment shall be indicated in the drawings and specifications. Installation details shall be provided.

Examples of supporting CFCI equipment are listed below:

- Bedside headwall units
- Bleachers (built-in)
- Benches (built-in)
- Boilers
- Bookcases (built-in)
- Cabinets (built-in)
- Carpet (wall to wall)
- Chapel seating, baptisteries, altars, pulpits, communion rails and tables, and raised platforms (built-in)
- Closets
- Correctional facility equipment
- Desk and table (built-in)
- Dishwasher equipment (built-in)
- Drinking water coolers (built-in)
- Electoral components (built-in electrical lighting fixtures and power utilization, and distribution equipment)
- Elevators and elevator doors
- Escalators
- Exhaust system
- Fire alarm and detection systems, including built-in cabinets
- Food service equipment (built-in)
- Gas fittings
- Hardware and fixtures for disabled personnel access
- HAVC equipment and control systems
- Hoists (crane and crane rails) attached to the building structure
- Incinerators
- Key control systems
- Kitchen units
- Laboratory sinks, tables, and benches (built-in)

- lockers (built-in)
- meat cutting equipment
- panel boards
- plumbing
- pot and pan washing equipment
- protective construction features
- refrigeration equipment (built-in)
- storm sash and doors
- screens
- shelving and racks (built-in)
- signage
- sprinklers
- sterilizers (built-in)
- storage bins (built-in)
- theater and auditorium railings
- theater seating (bolted in place)
- theater stage and fire curtain
- traffic railings
- utility monitoring and control systems
- vaults
- vehicle and pedestrian traffic control, and direction signs
- venetian blinds and window shades
- wardrobes (fixed)
- waste disposers
- other similar non-severable items

10.5.2 GOVERNMENT FURNISHED GOVERNMENT INSTALLED (GFGI)

Equipment that is movable and not affixed as an integral part of the facility is generally accounted for as personal property rather than real property.

The Government may procure and install the FF&E package independently of the building construction or renovation, known as GFGI.

Examples of GFGI are listed below:

- Automated data processing equipment
- Filling cabinets and portable safes
- Fire extinguishers (portable)
- Food service equipment (portable)
- Furnishings, including rugs

- Furniture (such as chairs, tables, beds, desks, and partitions)
- Office machines
- Photographic equipment (portable)
- Pre-wired workstations
- Shop equipment
- Training aids and equipment, including simulators
- Wall clocks

10.5.3 GOVERNMENT FURNISHED CONTRACTOR INSTALLED (GFCI)

The Government may have the contractor install government furnished new or existing equipment as part of its scope of work, known as GFGI. A design may be required for reconfiguration of existing equipment and for additional equipment to match existing equipment. Consider costs required for equipment inventory, storage, relocation, planning, phasing and temporary office space when planning to re-use existing equipment. The design team shall research the availability of any new equipment required to match existing and coordinate the construction schedule and new equipment delivery schedule.

10.5.4 COMMISSARY EQUIPMENT

Commissary project specifically included in the MILCON program by the DeCA and commissary store equipment, both movable and fixed or built in as an integral part of a facility, will normally not be financed from project funds, or included in the project cost.

10.5.5 MEDICAL AND DETAL EQUIPMENT

Procedures for planning and budgeting for medical and dental supporting equipment are contained in MIL-STD-1691F. Guidance on construction-funded equipment for medical projects is also contained in MIL-STD-1691F.

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CHAPTER 11 - LIFE SAFETY & FIRE PROTECTION

11.1 GENERAL

This chapter provides instructions for the preparation of fire protection and life safety construction documents and design analysis. Fire protection construction documents and design analysis shall be prepared by a Qualified Fire Protection Engineer as defined by UFC 3-600-01, Fire Protection Engineering for Facilities fire protection, paragraph 2-1.16.2, and provide all engineering services as described in paragraph 1-7. All fire protection construction documents falling under the engineering services of the fire protection engineer is to be provided within fire protection sheets not general, architectural, civil, or any other discipline's sheets.

11.2 DESIGN CRITERIA

The design publications listed below shall be used as sources of criteria for fire protection design. The criteria from these sources may be supplemented by applicable criteria contained in nationally recognized codes, standards, and specifications.
Government engineering publications are located in the Whole Building Design Guide website at http://www.wbdg.org.

UNIFIED FACILITY CRITERIA (UFC)

UFC 3-600-01 Fire Protection Engineering for Facilities, Most Recent Edition

UFC 4-021-01 Design and O&M: Mass Notification Systems, Most Recent Edition

UFC 4-211-01 Aircraft Maintenance Hangars

UNIFIED FACILITIES GUIDE SPECIFICATIONS (UFGS)

See the Whole Building Design Guide website for the most current UFGS fire protection specification sections.

INTERNATIONAL CODE COUNCIL (ICC)

International Building Code (IBC), Most Recent Edition

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) PUBLICATIONS

Most Recent Editions

11.3 FIRE PROTECTION RELATED ITEMS THAT SHALL BE U.S. PRODUCTS

The following fire protection related items shall be U.S. products with U.S. testing labels as required. These items CANNOT be substituted with Korean manufactured products:

- Fire Suppression System including valves, alarm valves, sprinkler heads (pipes

and fittings of a Korean manufacturer may meet the functional requirements)

- Fire Pumps including motors, controllers, drives, and valves
- Fire Alarm and Mass Notification Systems including panels, initiating devices, notification appliances, smoke alarms (conductors and conduits of Korean manufacturers may meet the functional requirements)
- Engineering Technician requirements for development of fire suppression systems and alarm shop drawings, calculations, and material submittals
- Fire doors and frame assemblies
- Fire Dampers and Smoke Dampers
- Interior Finishes with Flame Spread and Smoke Development ratings
- Insulation with Flame Spread and Smoke Development ratings
- Plenum rated cables

This list shall be included in the Life Safety Fire Protection drawings and in the project specifications.

11.4 FIRE SUPPRESSION SYSTEMS

Fire suppression systems shall be provided for facilities in accordance with UFC 3-600-01 and applicable NFPA criteria. System designs shall be the performance-based type with detailed shop drawings, materials submittals, and hydraulic calculations prepared by qualified technicians. Installation of as required by UFC Standpipe and Hose Systems and NFPA standards Installation of Sprinkler Systems.

Tailor the sprinkler design criteria (occupancy, design area, density, hose demand, etc.) specifically for each building.

Identify all of the performance criteria for the warehouses and hangars. The criteria shall be specific. For the warehouse, simply stating ESFR is not enough. The drawings shall identify the storage arrangement, storage height, clearance, commodity being stored, K-factor, number of heads operating, minimum pressure, hose demand, etc. such that the Government or Contractor does not have search NFPA 13 for the criteria or argue about the commodity, maximum storage height, etc.

Show the incoming water supply line location and risers. The riser has to be fully detailed complete with identifying all valves, switches, and piping. The conceptual design begins downstream of the riser and not at the pump. Important items need to be shown pictorially to indicate the design intent. All pump rooms will be required to be submitted with an isometric diagram showing the intended routing of all equipment and piping, including maintaining the necessary maintenance clearance spaces for all equipment as required by UFC 3-600-01. All fire pump rooms shall be sized large enough to accommodate all requirements and be carefully coordinated with the architect. The detail callouts on the plan need to match detail sheets. Show the layout and size of all piping and equipment from the point of connection to the water supply, to the sprinkler cross mains. Numerical callouts with notes will not be acceptable. The contract drawings shall include a detailed sprinkler riser diagram. Show location and

size of service mains, interior feed mains, control valves, sprinkler risers, drain lines, sectional valves, and inspector's test valves and switches on the drawings. Specify water flow data including hydrant flow results, including the location where the hydrant flow test was conducted, on the drawings. Indicate the location and size of existing mains and new water supply lines that will serve the sprinkler system (including all supervisory valves), and the location and size of all risers on the plans. Highlight or clearly indicate the area(s) to be protected by sprinklers on the drawings. Specify waterflow requirements including the design density, design area, the hose stream demand (including location of the hose stream demand), the duration of supply, and sprinkler spacing and area of coverage on the drawings. Show the location of the backflow preventer (including provisions for a drain and access for maintenance) where the potable water supply system is at risk of contamination by the sprinkler system on the drawings.

When connecting to an existing water distribution system, waterflow tests will be conducted in accordance with UFC 3-600-01 to determine available water supply for the sprinkler system. The Designer of Record shall either perform, witness the waterflow test or performed under the direction of the QFPE. Performing under the direction of the QFPE requires the QFPE to approve locations of the hydrant's tests, number of outlets flowed, etc.… that complies with the procedure listed within NFPA 291. The waterflow test results (including date test is performed) shall be included in be included in the design documents no later than the concept submission.

Provide hydraulic calculations and sketches complete with nodes, pipes, sprinklers, etc. The hydraulic calculations to follow the format of NFPA 13 to support the conceptual design and submitted in the Basis of Design. The designer (a fire protection engineer) shall provide hydraulic calculations demonstrating that the design will provide an adequate water supply for the fire extinguishing system. Hydraulic calculations shall be submitted before the first submittal. The A/E needs to provide hydraulic calculations based on a conceptual layout. Not rough conceptual calculations.

11.5 FIRE ALARM, DETECTION, AND MASS NOTIFICATION SYSTEMS

Fire alarm, detection and mass notification systems shall be provided in accordance with UFC 3-600-01 and UFC 4-021-01. System designs shall be the performance-based type with detailed shop drawings, materials submittals, and hydraulic calculations prepared by qualified National Institute for Certification in Engineering Technologies technicians.

Do not show "conceptual locations" for the fire alarm control panels. The A/E needs to locate the panels. The panels need to be accessible to the fire department and in an air-conditioned space where humidity and temperature are controlled. The power to the panel needs to be coordinated with the electrical design drawings and indicated on plans. The Contractor cannot be allowed to move the panels because it is a "conceptual" drawing, and we have to argue later to move it back during the

acceptance testing. The conceptual layout begins at the panel.

Show all fire alarm initiating devices, including associated modules and relays identifying which equipment they are tied too, and notification appliances. Numerical callouts with notes will not be acceptable. For hangar projects, show manual foam releasing stations, foam stop stations, optical detectors complete with coverage cones and ensure 3 detectors can “see” each area of the hangar floor (For Air Force project, follow the “Sundown Policy for Foam Fire Suppression Systems”). Show all monitor modules for tamper switches and control modules for system controls such as elevator shunt-trips, water flow switches, and tamper switches. Show location of control panel, batteries, and charger (if remotely mounted), transmitter, annunciator, primary power supply, remote trouble device, remote annunciator, detectors, notification appliances, and each alarm initiating device including fire extinguishing system switches. Show single-line fire alarm/mass notification systems riser diagram, device, and zone schedules. Each device on the riser diagram shall be identified by type and location. Conceptual riser diagram will not be acceptable. Indicate connection of equipment by circuit runs, or conduit/cable runs. A fire alarm operating matrix/mass notification system shall be placed on the drawings, as well as separate zone signals from the transmitter. Show actions of detectors, manual initiators, water flow contacts, etc. on one axis and bells, door releases, smoke control fans, elevator relays, etc. on the other. Entries which require descriptions, explanation of processes, sequences, interfaces, etc. can be flagged by symbols keyed to supplementary notes. Show all devices to indicate a complete and functional conceptual design.

11.6 LIFE SAFETY

Refer to UFC 3-600-01 for requirements for the minimum requirements. All information identified within UFC 3-600-01, 1-7.2.3 shall be provided on the same plans and not separated.

11.7 CODE COMPLIANCE SUMMARY SHEET & SITE PLAN

Refer to UFC 3-600-01 for requirements. Non-compliance code issues identified during the analysis of the project and not within the scope of work shall also be noted on plans.

11.8 HANGAR SUPPRESSION SYSTEMS

Specify all the foam system performance design criteria. The drawings need to clearly specify the discharge criteria and simultaneous operation of the overhead system. For Air Force projects, follow the “Sundown Policy for Foam Fire Suppression Systems”. The design needs to indicate a minimum number of generators and a provable conceptual system to avoid Contractors supplying two when five are required. Provide calculations/catalog data showing how the sizes and locations were selected including

the minimum operating pressure for the generator.

Show the incoming water location, risers, and main piping. The riser shall be fully detailed complete with identifying all valves, switches, surge suppressors, strainers, and piping. The conceptual design begins downstream of the riser and not at the pump. Provide isometric diagrams and/or one-line schematic diagrams of pump/foam rooms. For Air Force projects follow the “Sundown Policy for Foam Fire Suppression Systems”. The foam tank size and interconnection to the flow control valve needs to be shown. The Contractors here in Korea rely on diagrams and equipment on the drawing. Notes describing the equipment and system requirements are difficult for the Contractor to understand. Numerical callouts with notes will not be acceptable. Important items need to be shown pictorially to indicate the design intent. The detail callouts on the plan need to match detail sheets.

Show location and detail of each foam system supply riser, deluge, or pre-action valve, water motor alarm, fire department inlet connection, foam hydrant, hand hose station, monitor nozzle, air compressor(s), and associated electrical connections. Indicate point of connection to the existing water distribution system. Show location of foam system control valves and post indicator valves. Indicate areas of foam system coverage, with zone designations (if multiple zones). Show location and design of draft curtains as required by NFPA 409 for aircraft hangar. For pipe larger than 12 inches, detail methods of anchoring pipe including pipe clamps and tie rods. Show location of foam proportioning equipment and storage tank. Show locations of control panel, annunciator(s), alarm devices, manual actuation stations, point of connection to the building fire evacuation alarm system, remote trouble device, point of connection to the incoming power supply and fusible safety switch. Do not show conduit sizes or number of conductors for DC circuits. Show single line riser diagram for all detection, activation, and alarm circuits, a conceptual riser diagram will not be acceptable. Connection of equipment shall be indicated by circuit runs and not conduit runs. Do not indicate number and size of conductors for interconnection of fire alarm components. Show the conceptual locations of the optical detectors and indicate a complete working conceptual design.

Provide detailed hydraulic calculations for the foam system. The general spreadsheet calculations are only estimates. Calculations shall include the foam generators operating simultaneously with the overhead sprinkler system activation. Provide hydraulic calculations and sketches complete with nodes, pipes, sprinklers, etc. The hydraulic calculations to follow the format of NFPA 13 to support the conceptual design and be submitted in the Basis of Design.

11.9 MISCELLANEOUS FIRE PROTECTION ISSUES

The UFGS specifications need to be project and scope specific. The specifications shall match the UFGS format with Part 1 general requirements, Part 2 products, and Part 3 execution. Specifications have been submitted with all three sections in Part 1.

The A-E is required to use and modify the Unified Facilities Guide Specifications as

provided in the Whole Building Design Guide website (http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs) and as edited by FED, consistent with the Section Format organizational structure as described in Construction Specifications Institute's (CSI) Project Resource Manual. Additionally, specifications will need to be written and edited in SpecsIntact (.sec) format. Standards/codes/criteria shall be properly referenced (not copied verbatim into the specifications) as indicated in the SpecsIntact guide (page 33). This allows proper verification of references, saves the total paper count of the specifications package, and eliminates conflicts between specs and standards/codes/criteria. Tech Services section is available to anyone who needs guidance/assistance in implementing and following these processes.

For projects warranted by system complexity, a single fire protection specialist is required to be provided to oversee all aspects of fire protection design and construction for suppression and alarm systems. Specifications will require editing to identify this individual. It is recommended that all projects have this requirement, regardless of complexity.

For hangar projects, coordinate with the Activity to provide vestibule/cut-off rooms to separate the hangar and the adjacent areas to minimize large Class I Division 2 areas in accordance with UFC 4-211-01, 3-7.1. It is not practical for the Activity to have large rooms where electrical equipment cannot be placed at or near the floor especially in areas where there are workstations complete with desks and chairs. The service members unknowingly may expose themselves to a hazardous/explosive environment simply by placing a power strip on the ground near their workstation, installing a small refrigerator or creating a coffee mess. Careful coordination can minimize the classified areas with small changes to the floor plans or impact to the use of the facility.

For hangar projects, ensure plans show exit doors at maximum spacing of 150 feet around the entire perimeter of the hangar bay in accordance with UFC 4-211-01, 3-3.1.9. Also provide exit doors within 20 feet of each end of the hangar bay door.

For hangar projects, show door swings from the hangar bay into adjacent areas such that the door swings in the direction of travel to comply with UFC 4-211-01, 3-3.1.9. Provide fire exit hardware on rated doors exiting through the buildings. Doors terminating directly to the outside are permitted to have panic hardware.

For hangar project, provide exit doors directly to the outside for rooms exceeding 100 sf in accordance with UFC 4-211-01, 3-3.1.9.

For hangar projects, add a note to require all fire alarm circuiting in the hangar bay shall be in watertight conduit with watertight connections. Provide NEMA 4 junction boxes, back boxes, and enclosures. Initiating devices such as Start Stations, Stop Stations, and Flame Detectors require the conduit to enter the bottom of the back box, and the low point of the conduit be provided with a drain in accordance. These are commonly missed items that have caused false alarms and accidental activations.

Show the control valve, water flow switch and test valve for the elevator hoist way and

machine room sprinklers. The architect may need to provide an access panel on their drawings.

For buildings with smoke exhaust systems, provide calculations for the smoke exhaust system and makeup air to show the means of egress doors forces to release the latch and set the leaf in motion do not exceed the requirements in NFPA 101, 7.2.1.4.5.

Fire extinguishers are required in buildings in accordance with UFC 3-600-01, 9-17.1. The Air Force directive is to not provide fire extinguishers as the extinguishers are an unnecessary recurring maintenance cost.

11.10 WATER SUPPLY

The water supply for water-based fire suppression systems typically complies with UFC 3-600-01. The Qualified Fire Protection Engineer (A-E) shall perform fire hydrant flow tests at the start of the design phase to determine the available water supply, prior to the first design submission. Fire pumps and/or water tanks shall be provided as required if the fire sprinkler and hose stream demands exceed the available water supply.

11.11 HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) SYSTEMS

All ventilation systems shall be designed to conform to the requirements of NFPA 90A Installation of Air-Conditioning and Ventilating Systems, NFPA 90B Installation of Warm Air Heating and Air-Conditioning Systems, and NFPA 91 Exhaust Systems fir Air Conveying Gases, etc.

In general, HVAC ducts penetrating 2-hour fire rated wall or floor assemblies shall be provided with fire-dampers. HVAC transfer ducts penetrating 1-hour fire rated walls shall be as per NFPA requirements.

11.12 INSULATION

For U.S. funded projects. All insulation to include Thermal (interior, exterior, loose, and rigid types), Acoustical, Spray-on, Plumbing, and HVAC typically comply with UFC 3- 600-01, paragraph 8-3 insulation.

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CHAPTER 12 - MECHANICAL

12.1 GENERAL

The design of all mechanical systems shall meet the instructions and requirements contained herein, the other government furnished criteria, and the requirements of the FED Guide Specifications. Where conflicts between the above documents exist, these instructions shall take precedence.

Mechanical designs shall be economical, maintainable, sustainable and energy conservative with full consideration given to the functional requirements and planned life of the facility. Mechanical design shall also consider life cycle operability, maintenance and repair of the facility and real property installed equipment components and systems.

12.2 DESIGN CRITERIA

The design publications listed below shall be used as sources of criteria for mechanical design. The criteria from these sources may be supplemented, but not supplanted, by applicable criteria contained in nationally recognized codes, standards, and specifications.

Many of the referenced government engineer publications can be found in the Whole Building Design Guide website at http://www.wbdg.org.

American National Standards Institute (ANSI) Air Force Manuals (AFM)
Air Force Engineering Technical Letters (ETL)
American Society of Sanitary Engineering Standards (ASSE)
Army Regulation (AR)
American Society of Heating, Refrigerating, & Air Conditioning Engineers (ASHRAE)
American Society of Mechanical Engineers (ASME)
ASTM International (ASTM)
Army Architectural & Engineering Instructions Design Criteria (ARMY AEI)
Director of Central Intelligence Directive (DCID)
Energy Independence and Security Act of 2007 (EISA 2007)
Energy Policy Act of 2005 (EPAct 2005)
Engineering Manuals (EM)
Executive Order 13423 Greening the Government through Efficient Energy Management
Technical Manuals (TM)
Code of Federal Regulations (CFR)
Instrument Society of America Standard (ISA)
Military Handbook (MIL-HDBK)
National Fire Codes (NFPA)

Unified Facilities Criteria (UFC)
Underwriters Laboratories (UL)
International Code Council International Building Code (IBC)
International Code Council International Mechanical Code (IMC)
International Code Council International Plumbing Code (IPC)

12.3 DESIGN CONSIDERATIONS

Conditions used in designing the mechanical systems shall be obtained from UFC 3-400-02 or ASHRAE Guide Books. Utilize ASHRAE 169 Table A-6 to determine the appropriate climate zone for the installation in Korea.

12.3.1 OUTDOOR DESIGN CONDITIONS

Outdoor design conditions shall be in accordance with UFC 3-410-01, Heating, Ventilating and Air Conditioning.

12.3.2 INDOOR DESIGN CONDITIONS

Indoor design conditions shall be in accordance with UFC 3-410-01, Heating, Ventilating and Air Conditioning.

12.3.3 MECHANICAL ROOM LAYOUT REQUIREMENTS

Mechanical equipment room layout shall be provided with ample floor space to accommodate routine maintenance of equipment and have head-room to accommodate specified equipment. Space provided in rooms for service and/or replacement of coils, tubes, motors, and other equipment items shall be dimensioned on the drawings.
Provisions for installation and future replacement of equipment shall be coordinated with the architectural design. The arrangement and selection of mechanical equipment shall allow complete with removal of the largest piece of equipment without dismantling adjacent systems or structures. Doors shall be located to facilitate such service. Mechanical rooms located above and/or adjacent to normally occupied spaces shall be avoided to the greatest extent possible to avoid noise and vibration transmission.

12.3.4 ELECTRICAL EQUIPMENT / PANEL COORDINATION

Arrangement of all mechanical equipment and piping shall be coordinated with electrical work to provide dedicated space for location of electrical panels, conduit, switches, etc. Clearance required by NEC above and in front of electrical panels and devices shall be provided. Mechanical equipment (pipes, ducts, etc.) will not be installed within space which is dedicated to electrical switchboards, motor starters, disconnect switches and panel boards (See NFPA 70 Article 408.18 A & B). When electrical equipment is located in a mechanical equipment room, the dedicated electrical space shall be indicated by a dashed line and noted "Electrical equipment space".

12.3.5 ROOF MOUNTED EQUIPMENT

Except for intake or relief penthouses, locating mechanical equipment on sloped roofs shall be avoided. Equipment requiring maintenance shall be located on sloped roofs only with specific concurrence from the Installation and DPW/BCE. Where equipment requiring maintenance is located on a flat roof, provisions shall be made for accessing the equipment for maintenance. Provisions shall also be made for protecting the roof from physical damage while the equipment is be accessed.

12.3.6 VIBRATION ISOLATION / EQUIPMENT PADS

Provide vibration isolation devices on all floor mounted and suspended mechanical equipment that could transmit operational noise to occupied areas. All floor mounted mechanical equipment shall be provided with a 150 mm (6 in) thick, reinforced concrete housekeeping pad. Pads shall extend 150 mm (6 in) beyond the edges of the equipment installed.

12.3.7 SECURITY

Acoustic protection and man-bars shall be provided for all HVAC ducts serving SCIF areas. Provide acoustic protection for these ducts equivalent to the STC rating of the wall in which the duct penetrates. SCIF design shall follow the guidance of DCID 1/21 unless other guidance has been provided. HEMP and TEMPEST shielding shall follow that outlined in the ELECTRICAL SECTION.

12.3.8 INSTRUMENTATION

Provide sufficient instrumentation to aid maintenance personnel in balancing and/or troubleshooting mechanical systems. Instrumentation shall be provided in the media at each change in temperature and at all mixing points in hydronic systems and air handling systems. Discharges of air handling units and hydronic blending stations shall be provided with instrumentation. Hydronic zone return mains shall be provided with instrumentation. HVAC design drawings, shall show all thermometers on HVAC control drawings, for all AHU's, ERU's, HV's, etc. Drawings shall show thermometer installed on all air sources to the unit, such as SA, RA, Mixed Air, EA, etc., as would apply to the equipment selected. HVAC and Plumbing systems, provide Supply, Return, and if using DDC control, show a thermometer installed next to each DDC liquid temperature sensor on Design Drawings. Pressure gauges, thermometers, flow indicators, sight glasses, etc. shall be easily read from the adjacent floor. Provide an isolation valve on each pressure gauge.

Thermometers shall have separable socket thermo-wells. Allow for the removal, repair, or cleaning of flow measuring devices without having to shut down the system. Provide a portable meter, with appropriate range, for each type of flow measuring device installed. Pressure gauge(s) shall be installed to allow reading of pump suction and discharge pressure and strainer differential pressure.

12.3.9 REDUNDANCY

Redundancy shall be as contained in this document and supplemented by other furnished criteria.

12.3.10 SPARE PARTS

Spare parts that are difficult to obtain or are manufacturer unique, and any special service tools, shall be provided to the Government prior to acceptance of the system. Designer shall edit equipment specifications as necessary to ensure contract requirement for the provision of spare parts is provided.

12.3.11 INTERIOR DESIGN COORDINATION

All mechanical items located in finished areas and on exterior walls or roofs, shall be coordinated with and painted to match the color scheme requirements of the FED Guide Specifications.

12.3.12 ANTITERRORISM

Antiterrorism requirements shall be provided in accordance with UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings.

12.4 EQUIPMENT IDENTIFICATION

Provide a brass nametag for each valve, temperature control device, direct digital controls (DDC) device, etc., installed in all mechanical systems.

12.4.1 HAZARDOUS FACILITIES

Defined as structures housing, supporting or containing sufficient quantities of toxic or explosive substances to be dangerous to the safety of the general public if released.

12.4.2 SPECIAL OCCUPANCY STRUCTURES

Special Occupancy structures shall be as defined in UFC 3-310-01 Table 1 and UFC 3-301-01.

12.4.3 STANDARD OCCUPANCY STRUCTURES

All structures having occupancies or functions not listed above.

12.4.4 DUCTWORK IN BUILDING

Ductwork in buildings is categorized as critical ductwork in essential and hazardous facilities, and all other ductwork design shall follow Appendix B and D of UFC 3-310-04.

12.4.5 MISCELLANEOUS EQUIPMENT

Equipment shall be supported and braced in accordance with Appendix B and D of UFC 3-301-01. Items such as boilers, chillers, cooling towers, engine-driven generators, etc. which consist of a number of individual components built into an assembly by the manufacturers that may require additional internal reinforcements to meet the requirements of this guide. Where possible and practical, these internal reinforcements shall be performed by the equipment manufacturer.

12.4.6 SEISMIC DESIGN REQUIREMENTS

AE shall develop performance requirements per UFC 3-301-01 Structural Engineering and ASCE 7-10, Chapter 13 on the construction documents within General Notes.

12.5 THERMAL INSULATION OF MECHANICAL SYSTEMS

This section contains requirements for the insulation of mechanical systems; including insulation of plumbing systems and equipment, roof storm drain system, hot water piping systems and equipment, chilled water piping and equipment, and the insulation of the duct systems. Insulation of installed systems shall meet the requirements of the FED Guide Specifications.

12.5.1 DUCTWORK

All heating and air conditioning supply ducts shall be insulated in accordance with UFC 3-410-01 and IMC Sections 604.2 and 604.3. Air conditioning return ducts located in ceiling spaces used as return air plenums do not require insulation. All outside air ducts above finished ceiling spaces will be insulated to prevent condensation during winter. All ducts that are exposed to the weather shall be insulated up to and including the control damper or up to 3 m (10 ft) from the outside wall, whichever is greater.

12.5.2 PUMPS

Hot water and chilled water circulating pumps shall be insulated.

12.5.3 INSULATION COVERS

Provide reusable insulation covers at all check valves, control valves, strainers, filters, and other piping component requiring access for routine maintenance. Insulation exposed to the weather or possible physical damage shall be covered by an appropriate metal or polyvinylchloride (PVC) jacket. PVC jackets will only be allowed in the building interior. All piping with metal jacket shall be identified on the drawings.

12.6 COMPRESSED AIR SYSTEMS

This portion of the guide provides guidance for designing low pressure compressed air systems with a maximum design operating pressure of 1.38 MPa (200 psig), including piping and compressors. Where special conditions and problems are not covered in this guide, industry standards will be followed. Compressed air systems will be designed in accordance with the requirements of UFC 3-420-02FA Compressed Air.

12.6.1 COMPRESSOR SELECTION

A central compressed air system will be utilized to serve multiple points of use. Compressors and all accessories will conform to the ASME Boiler and Pressure Vessel Code Section VIII, PTC-9 & PTC-10, and Instrument Society of America (ISA) S7.3, as applicable. Where lubricating oils cannot be tolerated at the point of use, oil-free air compressors will be used. For isolated areas where oil-free air is required in a non oil- free compressed air system, coalescing filters may be used to remove solids, moisture, and oil from the air stream in lieu of providing an oil-free compressor.

12.6.2 ANALYSIS

An analysis will be made for each compressor selection to ensure that the best value is obtained. Comparisons of such items including, but not limited to, brake horsepower (bhp) per 100 cfm, unloaded horsepower, expected compressor life, and expected operation and maintenance costs, shall be made between the different types of compressors before final selection is made. The analysis shall be included in the Design Analysis.

12.6.3 COMPRESSOR CAPACITY

Total air requirement will not be based upon the total of individual maximum requirements, but upon the sum of the average air consumption of air operated devices. Determination of the average air consumption is based on the concept of load factor (the ratio of actual air consumption to the maximum continuous full-loaded air consumption). The Compressed Air and Gas Institute (CAGI) Compressed Air and Gas Handbook explains the procedure for using load factor to determine compressor capacity. After making the calculation, add 10 percent to the estimated consumption for leakage. The total is the compressor capacity required for design. More capacity may be added to allow for future growth of the facility or serviced area over the next 2 years.

12.6.4 COMPRESSOR LOCATION

Compressors are to be located within a ground floor utility or mechanical equipment room with adequate space to permit easy access for cleaning, inspection, and any necessary dismantling. Adequate aisle space is also needed between items of equipment for normal maintenance as well as for equipment removal and replacement.

12.6.5 FOUNDATION

Foundations, which are isolated from the building structure, shall be provided for all compressors.

12.6.6 MAKE-UP AIR

For large air compressors located in closed mechanical rooms, a wall opening shall be provided for make-up air. Exterior wall openings shall be provided with louver and motorized damper.

12.6.7 PIPING

Compressed air piping will be Schedule 40, galvanized or black steel or Type K copper as allowed by the FED Guide Specifications Plumbing, General Purpose. Pipe fittings will be galvanized steel, black steel or copper, to match piping used. When copper pipe or tubing is used, brazed joints will be used for connections.

Soldered joints shall not be used. Thermoplastic piping systems for transport or storage of compressed air will not be allowed.

12.6.7.1 UNDERGROUND PIPING

Underground metallic compressed air piping shall be provided with a coating/wrapping system and cathodic protection.

12.6.7.2 PIPE SIZING

Compressed air piping shall be sized in accordance with standard commercial practices to avoid excessive losses and supply air at the pressure and flow rate required to meet equipment demands.

12.6.8 COMPRESSED AIR OUTLETS

A ball valve, pressure reducing valve, filter, drip leg and a quick-disconnect shall be provided at each compressed air outlet. Type of compressed air quick-disconnect shall be coordinated with the Installation.

12.6.9 REFRIGERATED DRYER

Some compressed air applications require moisture removal in addition to that provided by an after cooler. Such applications include paint spraying, sandblasting, use of air- operated tools and devices, pneumatic automatic temperature controls, lines run outside in cold or subfreezing locations, and lines passing through cold storage rooms. Where moisture removal is required, provide a refrigerated type air dryer located downstream of receiver.

12.7 ENGINE-GENERATOR SYSTEM

Guidance contained herein addresses the engine and its accessories while guidance on the generator and its accessories is given in the electrical chapter.

12.7.1 GENERATOR SET SELECTION

Designer notes contained in UFC 3-540-01 and the FED Guide Specifications shall be reviewed and understood prior to initiating design. It is common for manufacturer's standard cataloged generator sets to not meet the requirements of the guide specifications. Engines larger than those cataloged with standard generator sets are often required to conform to the guide specifications. The designer shall ensure that adequate space is provided to accommodate a generator set that conforms to the specifications. A minimum of three generator sets shall be selected which conform to the specifications. The selections shall be included in the Design Analysis. Space for the generator set shall be based on the largest of the selected generator sets.

12.7.2 GENERATOR SET LOCATIONS

Generator sets shall be located inside except when an exterior location is specifically requested and/or approved by the Installation. When generator sets are located inside, consideration shall be given to locating the radiator outside the building to eliminate the ventilation problems associated with an interior radiator. If the radiator must be located indoors, provisions shall be made to ventilate the room. Consideration shall be given to recirculating the discharge air from the radiator into the room to heat the room. The recirculation dampers shall be controlled to maintain the space temperature during the heating season. Interior generator sets shall be located on concrete equipment pads isolated from the building. Generator sets located outside shall be housed in a factory-fabricated enclosure.

12.7.3 MECHANICAL VENTILATION

Rooms containing generator sets shall be provided with mechanical ventilation to prevent excessive interior temperatures.

12.7.4 JACKET WATER HEATERS

Jacket water heaters will be specified for all generator set applications installed inside or outside. Glow plugs will be required for all units installed exterior.

12.7.5 FUEL OIL SYSTEM

The design and installation of fuel oil systems shall conform to NFPA 31 and NFPA 37.

12.7.6 EXTERIOR FUEL OIL STORAGE TANK

Fuel oil storage tanks shall be installed above ground. Tanks will be double wall or provided with other leak and spill containment and leak detection conforming to Federal and local regulations. Piping shall be double walled with leak detection to meet all Federal and Local regulations. Fuel oil storage tanks shall be sized per UFC 3-540-01 unless directed otherwise.

12.7.7 FUEL OIL DAY TANK

An auxiliary or day tank shall be provided to ensure a ready supply of fuel to the engine. Day tanks shall be sized to provide a minimum of two hours operating supply for the engine but in no case will the fuel storage capacity exceed that permitted by NFPA 31 and NFPA 37. Each day tank shall be provided with a vent to the exterior, an overflow piped to the main storage tank, and a valve drain. Day tanks shall be located so that when full, the fuel level is below the engine fuel injectors. Day tanks shall be provided with high, low, and low-low level switches which provide alarm inputs to the Installation UMCS.

12.7.8 FUEL OIL PIPING

Fuel oil piping in prime power plants will be installed in floor trenches with removable covers. Fuel oil piping in standby plants will be installed to minimize tripping hazards and will be installed in floor trenches if practical.

12.7.9 MUFFLERS AND EXHAUST PIPING

When generator sets are installed inside, the muffler shall be installed inside to eliminate unsightly exterior muffler installations. Mufflers and exhaust piping installed inside shall be insulated. Exhaust pipe outlets shall discharge horizontal, be directed away from buildings, and shall be a minimum 3 m (10 ft) above the ground. The discharges shall be mitered to minimize entry of snow and rain.

12.8 INTERIOR GAS PIPING SYSTEM

The interior gas piping system shall extend from the outlet of the meter set and service regulator assembly to the point of connection of each gas utilization device. The gas piping system shall be steel, designed in accordance with ANSI Z223.1 and NFPA 54.

12.8.1 GAS PIPE SIZING

Calculate the gas demand, in terms of cubic feet per hour, for each appliance connected to the piping system. Gas piping shall be sized in accordance with NFPA 54 to supply the demand without excessive pressure drop between the point of delivery and the gas utilization equipment. Minimum interior gas pipe size shall be 15 mm (1/2 in). The calorific value of the natural gas to be used in calculations for sizing equipment and piping shall be obtained from the local utility, the Directorate of Public Works or the Base Civil Engineers office. If this information cannot be obtained the approximate value of 1000 Btu/ft³ shall be used.

12.8.2 EQUIPMENT CONNECTIONS

In general the final connection to gas equipment shall be made with rigid metallic pipe and fittings except flexible connectors can be used if not expected to be vulnerable to physical abuse. Flexible connectors shall be used for residential kitchen ranges and shall be at least 1000 mm (40 in) long. Flexible connectors can be used for residential dryers. Other acceptable uses of flexible connectors include equipment located where accessibility will be limited to qualified personnel. Acceptable examples include equipment in locked equipment rooms, equipment suspended at least 3 m (10 ft) above floor, and equipment in remote buildings. Flexible connectors shall conform with ANSI Z21.45 except flexible connectors for movable food service equipment shall conform to ANSI Z21.69. In addition to cautions listed in instructions required by the ANSI standards, flexible connectors will not be allowed to pass through equipment cabinets. Accessible gas shutoff valve and coupling are required for each piece of gas equipment.

12.9 BOILER FUEL OIL SYSTEM

The fuel oil system for hot water and steam boilers shall be designed in accordance with NFPA 31.

12.9.1 EXTERIOR FUEL OIL SYSTEM

Normally, a 30-day operational storage of fuel oil will be provided for individual building heating systems. Existing bulk storage facilities will be considered in reducing the 30-day requirement. For new buildings, demand calculations will be made using ASHRAE degree-day method, while existing buildings will use actual consumption by previous delivery and burning records.

12.9.1.1 FUEL OIL STORAGE TANK

Fuel oil storage tanks shall be installed above ground. All tanks shall be provided with secondary containment and a leak detection system. Fuel selection shall be compatible (non-gel) with the climate of the installation. Where bottom of fuel oil storage tank is above boiler room floor elevation, an anti-siphon check-valve shall be installed in the fuel oil supply line.

12.9.1.2 EXTERIOR PIPING

Exterior piping shall be double walled in accordance with Local and Federal regulations.

12.9.2 INTERIOR FUEL SYSTEM

12.9.2.1 FUEL OIL DAYTANK

Fuel oil day tanks shall be provided when necessary to reduce the suction head at the fuel oil inlet to fuel burning appliances. An operating supply fuel oil day tank will be provided and located in the same room as the fuel burning appliances. The fuel oil day tank shall be sized for a minimum 4 hour oil supply. The day tank will not larger than that permitted by NFPA 31. Fuel oil day tanks shall be provided with minimum 100 percent secondary containment and an overflow line which returns to the main fuel oil storage tank. Installation of fuel oil day tank shall be in accordance with NFPA 31.

Day tanks shall be provided with high, low and low-low level switches which provide alarm inputs to the Installation UMCS.

12.9.2.2 APPURTENANCES

Provide level indicators, pressure gauges and flow measuring devices on all fuel oil equipment to facilitate system trouble shooting.

12.9.2.3 INTERIOR PIPING

Fuel oil piping in large boiler plants will be installed in floor trenches with removable covers. Fuel oil piping serving facility boilers will be installed to minimize tripping hazards and will be installed in floor trenches if practical.

12.10 HEATING SYSTEM

Gas- or oil-fired hot water boilers, Installation high temperature hot water or steam distribution system and geothermal heat pumps shall all be considered, as applicable, as the facility heating source. Circulating pump, water supply distribution system, and associated heating equipment will comply with the recommendations of the ASHRAE Handbooks. System selection shall be based upon energy source available, life cycle cost, and energy efficiency.

When utilizing the Installation HTHW or steam distribution system, the piping in the mechanical room shall be designed to accommodate the pressures and temperatures of these systems without using expansion joints. A finite element analysis computer program shall be conducted on all piping of these systems to ensure the stresses, forces and moments are within allowable limits presented in ASME B31.1, Power Piping Code. This shall include the distribution piping from the building entrance to the appliance using the heating media (converters, unit heaters, sterilizers, etc.). The analysis shall be conducted early in the design process in the event that additional mechanical room space is required to accommodate routing of piping. The designer shall obtain information from the manufacturer to incorporate into the finite element analysis program to ensure stresses are not excessive at the control valve. Various design methods may be incorporated, such as piping bends and loops or control valve

isolation, to maintain pressures and stresses to acceptable levels. Where boilers are provided, consideration shall be given to providing multiple boilers, with a combined capacity meeting the facilities heating requirement, to increase system reliability.

12.10.1 BOILERS

Type of fuel or firing rate required will be factored into the decision on what type of boiler will be used. All boilers over 120 kW (400,000 Btu/hr) Net Output capacity shall be of the forced draft type with modulating burner. Sealed combustion, condensing boilers will be considered, where possible, due to their higher efficiency. Where high efficiency boilers are utilized, the design supply and return water temperatures shall allow for full utilization of the boilers condensing capability.

12.10.1.1 BOILER CONNECTION

Design of boiler connection and auxiliary equipment shall conform to the requirements of ASME Boiler & Pressure Vessel Code, where applicable.

12.10.1.2 LOW-WATER CUTOFF

Float-type safety water feeders with low water cutoffs shall be provided for hot water forced draft boilers where required by the ASME Boiler & Pressure Vessel Code or by the manufacturer. For condensing boilers, electronic type LWCO’s is acceptable.

12.10.1.3 WATER COLUMN CONNECTIONS

Provide crosses at right-angle turns on water column connections to boilers.

12.10.1.4 VENT AND STACK CONNECTIONS

Boiler vent or stack connections shall be in accordance with UL 441, NFPA 54, NFPA 211, and Paragraph entitled "Vents and Stacks".

12.10.2 COMBUSTION AIR

For facilities where sealed combustion boilers are utilized, combustion air and vent piping shall be provided in accordance with the manufacturer’s requirements. Where non-sealed combustion boilers are utilized, Boiler Rooms shall be provided with combustion air openings in accordance with the requirements of NFPA 54. Do not provide combustion air openings in Boiler Room doors. To prevent mechanical room freeze-up when outside air quantities are large, the combustion air louver shall be equipped with a combustion air heating coil or a unit heater may be installed with air flow directed at the combustion air louver. If a boiler burner is to be cycled during normal operation, provide motorized damper interlocked with burner. Ductwork shall be provided at the louvers to prevent cold air from “dumping” into the Mechanical Room and to control entry of snow through the outside air louvers. The bottom of the ductwork shall be sealed watertight and shall be provided with a drain line piped to the nearest floor drain.

12.10.3 HIGH TEMPERATURE WATER SYSTEMS

High temperature hot water material and equipment with their accessories and

controls shall comply with the requirements of the applicable UFGS. For facility heating applications, high temperature hot water shall be converted to hot water; unless otherwise approved by the Far East District.

12.10.4 FREEZE PROTECTION

Where any portion of the heating water system is subject to freezing conditions, that portion or system shall be provided with freeze protection.

12.10.5 DISTRIBUTION PIPING

Heating water system piping shall grade down in the direction of flow where possible. Piping shall be designed without pockets, which will permit accumulation of air, and venting shall be provided at a minimum number of high points. Manual drains and vents shall be provided at all low and high points in the piping system.

12.10.6 FIN TUBE RADIATION

In buildings heated by radiators, indicate on the drawings the mounting height from bottom of radiator cover to floor. Height shall be coordinated with installation of electrical outlets to prevent any interference. Where necessary to clear electrical receptacles, fin-tube radiators will be installed with the bottom of the radiator cover 400 mm (16 in) above the floor, space permitting. Space allocation shall be carefully coordinated with architectural design where radiation is installed in toilet rooms. In Quarters and Administrative buildings, hot water fin-tube radiators shall be provided with individual room temperature control and shall be equipped with solid front, slotted, sloping top covers. In vestibules, toilets and non-occupied spaces, thermostatically controlled valve with built in temperature controls are acceptable for use.

12.10.7 SPACE HEATERS

Space heaters employing open flame, glowing elements, or heated surfaces over 232°C (450°F). in contact with recirculated air shall not be installed in hangars, garages, or other spaces where there is a possibility of explosive mixtures of gases reaching the open flame, glowing element, or hot surface, unless installed in accordance with NFPA 409, NFPA 88A or NFPA 88B. Closed flame infra-red heaters using outside air for combustion and outside exhaust may be considered for hangars and garages. High or medium temperature water or steam is desired wherever practicable. Motors, drives, controls, fans, and ductwork employed in connection with space heaters for such areas shall be in accordance with NFPA 409 and NFPA 70, NFPA 88A or NFPA 88B. Direct fired heaters are prohibited in areas subject to hazardous concentrations of flammable gas, vapors, or dust.

12.10.8 INFRARED RADIATION HEATING

Infrared radiant heating will be considered for high bay areas or where spot heating is required. Gas, oil, and electricity may be considered as fuel sources. Night setback of these systems will be considered where experience has demonstrated that it is cost effective.

12.10.9 ELECTRIC RESISTANCE HEATING

Electric resistance heating is not permitted except by USACE approval.

12.10.10 HEAT PUMPS

Where geothermal heat pumps (water-to-air or water-to-water) are being considered, the size and location of the well field shall be discussed with and approved by the Installation prior to the finalizing the decision to use heat pumps.

12.10.11 VESTIBULES

Vestibules may be heated to 10°C (50°F) to melt tracked-in snow in locations where conditions warrant. Otherwise, vestibules will not be heated or air-conditioned. Special attention shall be given to type of vestibule sprinkler type used to prevent freezing when not heated.

12.10.12 HANGAR DOOR TRACKS

Readiness, Alert, Maintenance and Multi-Purpose Hangars shall be provided with either raised door tracks or with ice-melting coils for the doors where the annual snowfall is 500 mm (20 in) or more. Coils shall be used only on the apron side of Alert hangars. Condensate-return-pipe door-loop trenches shall be located on architectural floor plan and detailed on the structural plans.

12.10.13 STEAM SYSTEM

This section contains instructions and engineering information relating to the design of the steam system. The steam system design shall meet the requirements of the applicable Unified Facilities Criteria and, unless otherwise stated, will comply with the ASHRAE Handbooks. Low-pressure steam boilers shall be provided only when there is an end use requirement for steam (i.e. humidification, sterilization, etc.).

12.10.14 STEAM CAPACITY

Steam at a pressure of 0.1 MPa (15 psig) shall be provided for the air handling unit humidification systems. The entire facility will be provided with humidification to maintain a minimum of 30 percent relative humidity (RH). Provide gross humidity control through the central air handling unit systems to maintain 30% RH. No areas within the facility require precise humidity control.

12.10.15 BOILERS

Low pressure steam 0.1 MPa (15 psig) shall be generated by a cast iron type steam boiler rated for a pressure of 0.2 MPa (30 psig) and provided with a combination natural gas and #2 diesel fuel oil burner. Boiler shall be provided with furnace draft regulator operating a damper by a power cylinder or equal designed to maintain required furnace draft within 0.01-inch water column, and flame failure protection of electronic type with separate supervision of pilot and main flame. Controls shall be programmed for pre-purge and post-purge of combustion chamber.

12.10.15.1 BOILER CONNECTION

Design of boiler connection and auxiliary equipment shall conform to the requirements of ASME Boiler Code, where applicable.

12.10.15.2 SAFETY CONNECTIONS

Float-type safety water feeder with low water cutoff shall be provided.

12.10.15.3 WATER COLUMN CONNECTIONS

Provide crosses at right-angle turns on water column connections to boiler.

12.10.15.4 VENT AND STACK CONNECTIONS

Boiler vent or stack connections shall be in accordance with UL 441, NFPA 54, NFPA 211, and Paragraph entitled "Vents and Stacks".

12.10.15.5 BOILER LOCATION

The steam boiler and all fuel burning equipment shall be located in the same room as the hot water boiler.

12.10.15.6 DISTRIBUTION PIPING

Distribution Piping shall follow the guidance in ASHRAE.

12.10.15.7 CONDENSATE PIPING

Condensate Coolers shall follow guidance in ASHRAE.

12.10.15.8 STEAM TRAPS

Steam traps shall be sized in accordance with UFC 3-430-01FA. Capacities shall be scheduled on the drawings. Schedule shall include flow capacity, type of trap, inlet pressure, and differential pressure.

12.10.15.9 WATER TREATMENT

Makeup water for the steam system will be treated to prevent corrosion and scale buildup. The water treatment system will consist of a water softening system and automatic blowdown.

12.10.15.10 WATER SOFTENER

Makeup water will be softened to reduce the hardness to less than 5.0 mg/l. Two softener tanks will be provided with a single regeneration tank. Investigate other considerations.

12.10.15.11 AUTOMATIC BLOWDOWN

The boiler will be provided with an automatic boiler blowdown to control and monitor dissolved solids. The controls will incorporate a timer, which will initiate blowdown and a conductivity sensor to control the length of blowdowns.

12.10.16 COMBUSTION AIR

Combustion air intake for the hot water system shall be sized to handle the steam boiler also.

12.10.17 HUMIDIFIERS

Packaged steam dispersion tube type injection humidifier panels will be provided for each Air Handling Unit.

12.10.18 FREEZE-PROOF COILS

Steam distributing non-freeze type coils shall be used for combustion air, makeup air, or preheat coils, in steam systems.

12.11 VENTS AND STACKS

Stacks shall be in accordance with NFPA 211 and shall be installed with minimum separation distance from any air intakes per ASHRAE Standard 62.1. Generally, all stacks will be of the prefabricated type with an individual stack provided for each appliance. Stacks are generally used for forced draft applications. Vents shall conform to UL 441 and shall be type B. Vents are generally used for atmospheric burners. Vents can be tied together to a main vent. Combined stacks will not be used for appliances with power burners or draft fans. Stacks and vents cannot be tied together. Height of stacks and vents shall be as required by NFPA 54 and shall be provided with a rain cap.

12.12 REFRIGERATION SYSTEM FOR COLD STORAGE FACILITIES

This portion provides guidance in the design of refrigeration for cold storage facilities. The refrigeration system shall follow the guidance in ASHRAE. The materials will comply with the FED Guide Specifications.

12.12.1 COMPRESSORS

Compressor capacity shall be selected, divided, and cross-connected to provide a stand-by unit to protect frozen food. Provide oil traps and double risers on suction and hot gas risers when compressor capacity modulation is used.

12.12.2 EVAPORATORS

Freezer room evaporators shall be fan-type unit coolers provided with electrical defrost. These shall be wired, as necessary, and piped to floor drain. Condensate drain shall be insulated and heat traced.

12.12.3 CONDENSERS

Provide head pressure control on all refrigerant condensers.

12.12.4 PREFABRICATED REFRIGERATORS

Prefabricated refrigerators to be mounted on concrete curb or 100 mm (4 in) concrete blocks with vent opening 50 mm (2 in) above finished floor, equipped with insect screens. Drain from unit cooler to discharge outside of refrigerator base.

12.12.5 DRAIN LINES

Defrost-water drain lines shall be provided for each unit cooler.

12.12.6 COLD STORAGE PLANTS

Where external wall areas are exposed to outside temperature, provide heat to

prevent temperatures in storage spaces from dropping too low during extended periods of extreme cold weather.

12.12.7 FROST MITIGATION

Frost migration through freezer room floors shall be prevented by a ventilation system under the floor or by a circulating glycol system which uses recovered heat from the refrigeration system.

12.13 REFRIGERATION/CHILLED WATER SYSTEM

This section contains instructions and engineering information relating to the design of the facility refrigeration/chilled water, including the exterior air-cooled condensing unit, air-cooled condenser, chiller unit, interior reciprocating chiller, interior piping distribution system, and the pumping system. Conceal piping in permanent-structures. Exposed piping attached to or near equipment, or subject to high heat or frequent washing, shall be copper, brass, or chromium plate. The cooling system shall be meet the requirements of the FED Guide Specifications.

12.13.1 DESIGN TEMPERATURES

Outside design temperatures for 1% plus 3°C (5°F) shall be for air-cooled condensers and condensing units per UFC 3-410-01 paragraph 3-4.2.5. For cooling towers and evaporative condensers, use 1% wet bulb temperature as obtained from UFC 3-440-05N Table 3.

12.13.2 BUILDING SYSTEM

The building chilled water system shall consist of one of the following: chilled water, DX, system using steam absorption, centrifugal, reciprocating equipment with a cooling tower, air cooled condenser, condensing unit. System selection shall be based upon a life cycle cost analysis and any other criteria furnished.

12.13.3 REFRIGERATION EQUIPMENT

DX evaporators shall be provided with double suction risers where suction line is trapped or rises above the evaporator and the compressor is provided with capacity reduction. Use of direct evaporative cooling is prohibited because of the possible health problems with aspergillus fumigatus and legionella pneumophila. Where systems will be used for mid-season and/or year-round operation, provide head pressure control or appropriate cooling tower control. "One time" pump-down cycles will be required, where applicable. R-22 refrigerant is not permitted for U.S. facilities in Korea.

12.13.4 CIRCULATING PUMPS

Two circulating pumps shall be provided for the secondary system, each sized for 100 percent of the load, with one of the pumps being standby. Pumps shall be located in the mechanical room and shall be base mounted, horizontal split-case centrifugal type with mechanical seals.

12.13.5 PIPE MATERIALS

Hydronic piping (chilled, hot water, etc.) shall utilize materials and fittings per the FED Guide Specifications.

12.13.6 WATER TREATMENT

Determination of the local water composition is essential to the design of water treatment for mechanical systems. A water analysis may be available from the using agency. If an analysis is unavailable, the designer will obtain a sample of the raw water. The sample will be tested and the results will be included within the specifications.

Water treatment systems for cooling towers will provide for prevention of corrosion, scale, and biological formations. Closed chilled water systems, and dual temperatures systems will be treated for initial fill with allowance for the addition of chemicals as needed.

12.14 AIR SUPPLY AND DISTRIBUTION SYSTEM

This section contains instructions and engineering requirements relating to the design of the air conditioning supply and distribution systems. The design of all systems will comply with the ASHRAE Handbooks, to the requirements of NFPA 90A, NFPA 90B, and NFPA 91, and shall meet the requirements of the FED Guide Specifications.

12.14.1 BASIC DESIGN PRINCIPLES

All designs will be based on the following basic principles:

- Interior design conditions selected, including temperature, humidity, filtration, ventilation, air changes, etc., will be suitable for the intended occupancy.
- The designer will evaluate all energy conservation items that appear to have potential for savings such as heat recovery for HVAC and service water heating, economizer cycles, and plastic door strips for load docks and include those items in the design that are life cycle cost effective.
- The design will be as simple as possible.
- Adequate space will be provided to access items that require maintenance such as filters, coils and drain pans, and strainers.
- Recovered heat will be used for reheat where possible.
- Utilize energy recovery to the greatest extent that a life cycle cost analysis finds feasible.

12.14.2 TEMPERATURE SETTINGS

HVAC Sequence of Control shall include procedure for Base personnel to reset HVAC Control settings in occupied zones if future energy conservation actions are required. The design relative humidity will conform to the recommendations in ASHRAE unless other direction has been provided.

12.14.3 AIR CONDITIONING LOADS

Air conditioning loads shall be calculated using ASHRAE methods. Hourly Analysis

Program (HAP) by Carrier Corporation, Trace 700 by Trane Corporation, DOE-2 by the United States Department of Energy, or EnergyPlus by the United States Department of Defense and the United States Department of Energy computer programs are acceptable for calculating loads and/or energy consumption.

12.14.4 INFILTRATIONS

Where acceptable, air distribution systems for central HVAC systems will be designed to maintain a slight positive pressure within the area served in order to reduce or eliminate infiltration. A slight positive pressure in relationship to the outdoors shall be designed.

12.14.5 OUTDOOR AIR INTAKES

Outdoor air intakes will be located in areas where the potential for air contamination is lowest. Basic guidelines include the following:

- Maximize distance between intakes and cooling towers, plumbing vents, loading docks, traffic, etc.
- Maintain a minimum distance of 10 m (30 ft) between intakes and exhausts, more if possible.
- Locate intakes and exhausts on different building faces.

12.14.6 FILTRATION

For administrative facilities, commercial facilities, and similar occupancies where indoor air quality is of primary concern, the combined supply air, including return and outside air, will be filtered by a combination of 25 to 30 percent efficient prefilter(s) and 80 to 85 percent efficient final filter(s) as determined by the dust spot test specified in ASHRAE Standard 52.1. Due to the decrease in system airflow as the pressure drop across the filters increases, fans shall be sized for the "dirty" filter condition. This will ensure that the fan has adequate capacity to deliver the design airflow as the filter becomes loaded. In addition, in order to ensure that this fan capacity is "available", test and balance criteria in the appropriate the FED Guide Specifications shall be followed.

12.14.7 DUCTWORK DESIGN

All ductwork for heating/ventilating only systems shall be insulated per the FED Guide Specifications for air conditioned ductwork where future air conditioning of building is anticipated.

- Supply air duct systems for variable air volume (VAV) systems shall be sized using the static regain method.
- Return air ductwork shall be routed into each area isolated by walls which extend to the above flooring or roof structure; the use of transfer ducts or openings shall not be used.
- The use of the T-Method for duct design is encouraged due to its ability to optimize both first and operational costs of the entire air distribution system. Either the T-Method or the Static Regain method will be used to design ducts for VAV systems. The use of round or oval prefabricated duct is recommended. Round/oval prefabricated duct reduces leakage and friction losses, therefore

reducing the amount of conditioning and fan energy required. The additional material cost for round/oval prefabricated duct would be at least partially offset by reduced installation cost and time.

The following types of construction will not be used where subterranean termite infestations are known to exist:

- Buildings with sub-slab or intra-slab HVAC ducts.
- Buildings with plenum-type, subfloor HVAC systems, as currently defined in Federal Housing Administration minimum acceptable construction criteria guidance.
- Buildings with HVAC ducts in enclosed crawl spaces that are exposed to the ground.
- Buildings with other HVAC systems where any part of the ducting is in contact with or exposed to the ground.

12.14.8 VARIABLE AIR VOLUME (VAV) SYSTEMS

VAV air handling systems and their associated HVAC control systems, because of their complexity, require more critical and thorough design. If a VAV system is selected (with the designer considering Stakeholder maintenance capability, simplifying controls, and energy conservation), designer shall provide a detailed discussion in the Design Analysis on why VAV was selected over other types of systems. This detailed discussion shall include:

- What other HVAC systems were considered and why they were not selected?
- Was a constant volume system with VAV bypass boxes considered?
- How will outside ventilation air be controlled during periods of low cooling loads?
- How will adequate heating be provided along outside wall, perimeter zones including the need for supplemental baseboard heat?
- Was a Multizone system with space discriminator reset of hot and cold deck temperatures or Single zone system with space discriminator control of supply air temperature considered?

12.15 SPECIAL CRITERIA FOR HUMID ENVIRONMENTS

Humid areas are defined as those areas where: The UFC 3-400-02 engineering weather Air Conditioning/Humid Area Criteria data for the wet bulb temperature is 19.5°C (67°F) or higher for over 3,000 hours or where the wet bulb temperature is 23°C (73°F) or higher for over 1500 hours. The following criteria shall be used in the design of air conditioned facilities located in humid areas; ITG FY05-2 NAVFAC Humid Area HVAC Design Criteria and/or Air Force ETL 04-03, Design for Prevention of Mold in Air Force Facilities.

High Humidity areas are defined as those where the 1 percent ambient dewpoint (DP) temperature exceeds 70 degrees F (21.1C). These locations shall use UFC 3-440-05N Tropical Engineering for the design of HVAC systems. Dewpoint design data can be found by accessing the additional content in the PDF version of the ASHRAE Fundamentals Handbook.

See Chapter 16 - CLIMATE DATA for more information.

12.15.1 SYSTEM SELECTION

Air-conditioning will be provided by an all air system. The system may consist of a central air-handling unit with chilled water coils or a unitary direct expansion-type unit(s) capable of controlling the dew point of the supply air for all load conditions. Systems such as variable volume constant temperature, bypass variable air volume, variable temperature constant volume, and terminal air blenders shall be considered. In addition to life cycle costs considerations, system selection will be based on the capability of the air-conditioning system to control the humidity in the conditioned space continuously under full load and part load conditions. System selection will be supported by an energy analysis computer program that will consider the latent-heat gain due to vapor flow through the building structure, to air bypassed through cooling coils, and to the dehumidification performance of the air-conditioning system under varying external and internal load conditions. Low sensible loads and high latent loads (relatively cool cloudy days) will, in some cases, cause inside relative humidity to be higher than desired. If analysis indicates that this condition will occur, reheat will be used. Currently available Variable Refrigerant Flow (VRF) systems do not meet the open control requirements in UFC 3-410-01. Until manufacturers are able to provide open control system that meet these requirements, VRF system are not allowed.

12.15.2 FAN COIL UNITS

Room fan coil units will not be used unless dehumidified ventilation air is supplied to each unit or separately to the space served by the unit and positive pressure is maintained in the space.

12.15.3 AIR HANDLING UNITS

Draw-through type air handling units will be specified in order to use the fan energy for reheat. Air distribution system will be designed to prevent infiltration at the highest anticipated sustained prevailing wind.

12.15.4 VENTILATION

Outside air will be conditioned at all times through a continuously operating air-conditioning system.

12.15.5 AIR AND WATER TEMPERATURES

The supply air temperature and quantity, and chilled water temperature will be based on the sensible heat factor, coil bypass factor, and apparatus dew point.

12.15.6 OUTDOOR DESIGN TEMPERATURES

Refer to the UFC/s for direction on the correct outdoor design temperatures to be used in cooling load calculations and equipment selections.

12.15.7 CLOSETS AND STORAGE AREAS IN AIR CONDITIONED FACILITIES

These area shall be either directly air conditioned or provided with exhaust to transfer conditioned air from adjacent spaces.

12.15.8 REHEAT

Where reheat is required to maintain indoor relative humidity below 60 percent, heat recovery, such as reclamation of condenser heat, shall be considered in life cycle cost analysis.

12.15.9 ECONOMIZER CYCLE

Economizer cycle will generally not be used due to the high moisture content of outside air.

12.16 VENTILATION AND EXHAUST SYSTEMS

This section contains instructions and engineering requirements relating to the design of the mechanical ventilation and exhaust systems. The design of all systems shall comply with ASHRAE Handbooks, ASHRAE Standard 62, to the requirements of NFPA 90A, NFPA 90B, and NFPA 91, and shall meet the requirements of the FED Guide Specifications.

12.16.1 OUTDOOR INTAKES, RELIEF AND EXHAUSTS

Outdoor air intakes shall be located in areas where the potential for air contamination is lowest and where applicable, the locations shall be in accordance with the requirements of UFC 4-010-01. Maximize the distance between intakes and exhausts by maintaining a minimum distance of 10 m (30 ft) between intakes and exhausts, more if possible. Provide each outside air intake, relief and exhaust with a fixed louver with bird screen. If feasible, locate intakes and exhausts on different building faces.

12.16.2 SUPPLY AND EXHAUST FANS

Exterior wall and roof mounted supply or exhaust fans shall be avoided; provide interior fans with ductwork connected to a louver. Except for interior wall mounted propeller units, all fans shall be centrifugal type and connected directly to weather-proof louvers or roof vents using ductwork. Fan type (air foil, forward/backward curve, propeller, etc.) and drive type (direct or belt) shall be specified on the mechanical fan equipment schedules on the design drawings. Care shall be taken to ensure that the noise level generated by exhaust fans and associated relief louvers is not transmitted to the exterior of the building. All possible steps shall be taken to keep the noise below NC60. Any in-line fans located outside the main mechanical and electrical areas shall be the provided with acoustical enclosures to inhibit noise transmission to the adjoining occupied spaces.

Where possible, exhaust fans in all buildings in housing, recreational, hospital, and administrative areas shall be of the centrifugal type, discharging through louvers in the side wall of the building using ductwork, as necessary. Roof-mounted fans of the low- silhouette type may be used in shop, flight line, or warehouse areas. Where exhaust ventilating fans or intakes are provided in buildings, a positive means (gravity dampers are not acceptable) of closing the fan housing or ducts shall be provided in order to prevent heat loss in cold weather, except as prohibited by NFPA Standard 96.

12.16.3 GENERAL ITEMS Incorporate the following as applicable:

- Ventilation for variable air volume systems will ensure proper ventilation rates at low and high system air flow.
- Year-round supply (make-up) air shall be provided to equal the total quantity of all exhaust hoods.
- Where desirable, designer may incorporate a purge mode into system design. This mode could be used, for example, to purge the building with outside air during off-hours or to purge the affected zone during building maintenance, such as painting.
- Utilize energy recovery to the greatest extent possible. In general, all ASHRAE 62.1 Air Class 1 & 2 exhaust air shall be balanced with the outdoor ventilation rate requirements to be used for air to air energy recovery such as enthalpy wheel or plate frame heat exchangers. Where energy recovery is utilized, outside air heating coil capacities shall be sized based on minimum 50% energy recovery (i.e. outside air heating coil capacities shall not be sized based on Winter Design entering air temperature). Where energy recovery is utilized, ensure proper control sequence and/or bypass is provided so as not to increase the mechanical cooling load. For enthalpy wheels, the wheel shall stop when OSA temperature is less than return air temperature but the OSA temperature is still higher than the desired supply air setpoint. For plate frame heat exchangers, bypass pathways with dampers shall be provided.
- Make up air for highly negatively pressurized/exhausted areas, such as kitchens and labs, shall be provided locally via proper mechanical transfer air from adjacent spaces (ducted or wall transfer grilles) or direct make up air units where adjacent spaces cannot provide the required make up air quantity.

12.16.4 TOILET / JANITOR ROOMS

The toilet rooms and janitor closet(s) shall be exhausted at a rate specified in ASHRAE 62.1. The required make-up air for the exhaust system shall be from undercut doors or, if necessary, through door or wall transfer grilles. Exhaust registers, in lieu of grilles, shall be provided in areas with rigid ceilings.

12.16.5 SHOWER AREAS

Shower areas shall be exhausted at the rate specified in ASHRAE 62.1.

12.16.6 COPY ROOMS

Where practical, photocopiers and laser printers shall be located in a separate room. Copy rooms with photocopiers and laser printers and shall be maintained at a negative pressure relative to adjacent areas. All conditioned supply air to the room shall be exhausted and not returned to the air handling unit system due to contaminants.

12.16.7 MECHANICAL/ELECTRICAL ROOMS

Mechanical and electrical equipment rooms shall have a thermostatically controlled ventilation system in accordance with UFC 3-410-01, Chapter 4-2.4.5. Wall or door intake louvers shall be provided to ensure adequate make-up air is provided.

The ventilation fan will have a two-speed motor, which is sized, at the high speed, to have adequate capacity to limit the room dry bulb temperature to a maximum of 6°C (10°F) above the outdoor dry bulb temperature when both equipment and ambient loads are at their maximum peaks. The high speed will be activated 6°C (10°F) below the maximum temperature at which the most sensitive item of equipment in the room can operate. The low speed will operate at 11°C (20°F) below that of the high speed.

12.16.8 BOILER AND FURNACE ROOM

The boiler room shall be cooled via ventilation of outside air to a temperature of no greater than 6°C (10°F) over ambient conditions by a thermostatically controlled supply or exhaust fan set to operate when temperature exceeds 30°C (85°F). Supply fans shall be used when atmospheric burners are permitted. Combustion air shall be provided by louvers sized and located in accordance with NFPA 54.

12.16.9 FIRE PROTECTION ROOM

The Fire Protection room shall be cooled via ventilation of outside air to a temperature of no greater than 6°C (10°F) over ambient conditions by a thermostatically controlled fan set to operate when temperature exceeds 30°C (85°F).

12.16.10 LAUNDRY ROOMS

Ensure exhaust fan in laundry room are sized for appropriate air change. Cloth dryer exhaust venting shall be adequate to prevent accumulation of lint in dryer exhaust systems, and provided with access for inspection and cleanout. Individual exhausts are preferred but where not possible, a manifold exhaust maybe used. Booster fans may be used where required to maintain adequate velocity. Make up air shall be provided for the dryers. Design shall follow the requirements of ETL 1110-3-483. (See ECB 2008- 9)

12.16.11 AUTOMOTIVE MAINTENANCE SHOPS

Shops will be provided with a suitable engine exhaust ventilating system. General ventilation shall be provided per NFPA 30A.

12.16.12 BATTERY ROOMS

Battery rooms shall be ventilated at four air changes per hour.

12.16.13 VEHICLE EXHAUST SYSTEMS

The design shall comply with ASHRAE, NFPA 90A, NFPA 90B and NFPA 96 and meet all the requirements of the FED Guide Specifications.

12.16.14 COMMUNICATIONS ROOM

Provide split type heat pump unit in each Communication room for cooling/heating and relative humidity requirement in accordance with TIA-569-B-1, Table 18 “Temperature and Humidity Requirements for Telecommunication Spaces”. OA shall be provided in order to maintain a positive pressure differential with respect to surrounding areas as required by TIA-569-B, 5.5.2.2.5.

12.17 FOOD SERVICE FACILITY REQUIREMENTS

Dining hall ventilation shall be designed in accordance with the requirements of ASHRAE and NFPA 96 and other criteria as furnished.

12.18 MEDICAL FACILITY REQUIREMENTS

Design requirements shall be in accordance with UFC 4-510-01, ASHRAE, and other furnished criteria.

12.19 HVAC TEMPERATURE CONTROL SYSTEM

HVAC Temperature control systems shall utilized direct digital controls in accordance with UFC 3-410-02 and the FED Guide Specifications. Temperature control system shall consist of standard components. Temperature controls shall be provided for the operation of each item of mechanical equipment (i.e., boilers, air handling units, pumps, chillers, unit heaters, exhaust fans, fin tube radiation, etc.). The controls shall be designed to reduce energy consumption and consider year-round control of both heating and air-conditioning. Where applicable, night setback, building warm-up temperature reset, economy cycle, and other techniques shall be used.
Control systems shall be as required by this document or other furnished criteria, as agreed upon by all parties during design. Proprietary systems will require a request for waiver from the User and approval by the Competition Advocate. Where applicable, HVAC control systems shall be integrated into the Installation wide Utility Monitoring and Control System (UMCS) / Energy Monitoring and Control System (EMCS) such that all monitoring and control points in the building HVAC control system can also be monitored and / or controlled from the UMCS / EMCS. The DOR shall coordinate in the early design phases with the installation for project specific DDC/UMCS requirements. In general, for MILCON projects in the USFK, BACnet is preferred.

12.19.1 DESIGN REQUIREMENTS

The preliminary sequence of control shall be on the early preliminary drawings or in the Design Analysis narrative while the final design drawings shall provide the following for each item of mechanical equipment:

12.19.1.1 CONTROL SCHEMATICS

Control schematics shall comply with UFC 3-410-01 and UFC 3-410-02. Schematics shall be complete, easily understandable control schematics of each system being controlled and functional interface of control components to the system shall be provided and shall be drawn to a scale that will be legible and tolerate one-half scale reduction. Ample space shall be allowed to indicate all performance parameters such as set point, throttling range, and action. This large scale drawing shall be easily read by the mechanic who will be using these drawings as part of the maintenance documentation. Each control component shall be identified by an alphanumeric

designator, such as T1 and R1. These designators shall be used for cross-referencing to all other HVAC control items. Control schematic drawings shall clearly identify all of the equipment based on the indicated Mark Type/Equipment ID as shown on the mechanical equipment schedules. Control schematics shall include DDC system architectural drawing to show how to configure DDC system as well as building level M&C system detail and specification of M&C system. Each piece of controlled equipment shall have a control schematic on the drawings. Points schedule and SOO shall be provided on same sheet as control schematic or on sequential sheets considering space requirements. In no case shall a collective sheet for all equipment SOO or points schedules be provided. Shall be in same format as shown "UFGS Forms, Graphics and Tables" page at the Whole Building Design Guide at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables.

12.19.1.2 SEQUENCE OF CONTROL

The sequence of control shall be a narrative statement of the sequence of operation and shall be detailed in discussion and address seasonal operations and shall be sub-sectioned to completely describe all applicable items such as safety controls, timed controls, mixed air section, fan, coil, and terminal unit coil control. Include interface to fire/smoke/detection and alarm systems and to UMCS / EMCS. Sequence of control shall identify the conditions for on/off and open/close position of valves, actuators, motors, etc. (i.e., normally closed CW valve shall be fully closed at 13°C (55°F) and fully open at 15°C (58°F) SA temperature), in sufficient detail to establish final control action, setpoint, and throttling range. In addition, all modes of operation shall be described to include how the equipment operates in hand, off, auto, and for VFD's include bypass operation, occupied, unoccupied, etc.

12.19.1.3 POINTS SCHEDULE

Control drawings shall include Points Schedules for all DDC controlled HVAC equipment. Points Schedules shall comply with UFC 3-410-01, UFC 3-410-02 and the FED Guide Specifications. The schedules shall use same format as sample drawings available online at the "UFGS Forms, Graphics and Tables" page at the Whole Building Design Guide at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables. Drawings and points schedules shall be in same format as shown in link.

12.19.1.4 LEGENDS

A controls legend defining all symbols and abbreviations used on submittal drawings and documents shall be provided. The controls legend shall be a separate sheet(s) from that of the general mechanical legend sheet(s). For the unification of Legends, the legends and symbols should be same as FED in-house drawing.

12.19.1.5 SYSTEM OPERATING SCHEDULE

Tabular presentation of control system operation shall be provided. The operating

schedule shall compare temperature or other air conditions with valve or damper position and signal input to the controlled device.

12.19.1.6 READABILITY

As many of the above items pertaining to the same HVAC system shall be included on the same drawing without compromising readability. If above items can't be on same sheet, due to size, the additional items shall be shown on the next sheet.

12.19.1.7 CONTROL SETTINGS

DDC systems shall include operator ability to adjust all setpoints (temperatures, pressures, flow rates, etc.). The system shall perform supervisory monitoring and control functions including but not limited to: scheduling, alarm handling, trending, overrides, report generation, and electrical demand limiting.

Utility Control System/Energy Monitoring and Control Systems

The facility shall be monitored and controlled by the base-wide UMCS / EMCS where one is available. The design of the UMCS / EMCS system shall be in accordance with UFC 3-401-01 and the FED Guide Specifications, unless otherwise stated.
For projects that require the building system to provide UMCS functionality (i.e. standalone without connection to a UMCS), include the necessary requirements from UFGS 25 10 10 Utility Monitoring and Control System (UMCS) Front End and Integration in the project specifications.

12.19.1.8 MECHANICAL EQUIPMENT SCHEDULE

In the notes section of the mechanical equipment schedules, notes should be complete to the point that one discipline can review and select equipment without the need to go into electrical or other drawings. These types of notes will typically include the note for a unit mounted disconnect for exhaust fans, if VFD drive is required, it will be noted, if using VFD drive specify with EMB Bypass, additional note of inverter rated motor or VFD motor shall be applied, single point power connection, thermally protected motors etc., as they apply to the design. For equipment connected to the DDC, e.g. for VAV's, boilers, chillers, etc., notes shall include the requirement for surge suppressor, any unit mounted disconnect and fused IAW NEC as they apply to the design. Also included in the notes will be any requirement for communication boards, controllers, etc., that need to interface with the DDC controls system. All design parameters such as static pressure, airflows, coil capacity, filters efficiency (MERV Rating), static pressure losses, etc. shall be calculated by AE and put into the schedule table for the equipment.

12.19.1.9 REQUIRED CONTROL SYSTEM DRAWINGS

As required by UFC 3-410-02 the following drawings are required, index (title sheet), symbols and legend drawings, points schedule instructions for installing contractor, control schematics, ladder diagrams, SOO, points schedule, thermostat and occupancy sensor schedule, occupancy schedule, Control Damper Schedule, Control valve schedule, and basic System Architecture Drawing all components connected to the BMS backbone and requirements for computer hardware shown on drawing,

workstation, printer, monitors, UPS etc. that meets UFGS requirements. This guide in conjunction with UFC3-410-02 shall be used to develop HVAC control drawings.

12.19.2 STAKEHOLDER COORDINATION

The Designer shall work with the Stakeholder to determine the following:

- The type of existing UMCS / EMCS system.
- Justification of proprietary specifications.
- Lonworks / BACnet compliance. (BACnet is preferred in the USFK installations)
- The existing EMCS system expansion capabilities.
- The new building Input/Output (I/O) point selection shall be determined with input and approval from the UMCS / EMCS system manager or the Base Civil Engineer.
- Of the selected Input/Output (I/O) points, determine which points will be for control and which points will be for monitoring purposes only.

12.19.3 CONCEPT DESIGN REQUIREMENTS

The following items shall be addressed in the design submittal:

- General discussion of how the building system will be connected to the UMCS / EMCS.
- Preliminary Input/Output (I/O) schedule sheets coordinated with the Stakeholder
- A separate line item on the estimate for connection from the building system to the central EMCS.

12.19.4 FINAL DESIGN REQUIREMENTS

The following items shall be included in the final design documents:

- The building system including all required HVAC control panels will be shown on the drawings, as has been coordinated with the Stakeholder or outlined by other furnished criteria.
- Sensors and EMCS connections shall be shown on the floor plans and on Temperature Control schematics.
- Provide a separate dedicated 20 amp/120-volt power circuit to each HVAC control panel.
- I/O summary sheets shall be on the drawings. Failure modes shall be shown on the I/O sheets
- FED Guide Specifications for Utility Monitoring and Control Systems, shall be edited.
- A cost estimate shall be provided for the building HVAC control system. A separate estimated cost shall be provided for HVAC control system connection and integration into UMCS / EMCS.

12.19.5 DESIGNER NOTES

When proprietary DDC System is required by the user, it is necessary to indicate in the contract specifications that exception is taken to the Federal Acquisition Regulation (far) 52.236-5, Material and Workmanship, which states:

"References in the specifications to equipment, material, articles, or patented

processes by trade name, make, or catalog number, shall be regarded as establishing a standard of quality and shall not be construed as limiting competition." Therefore, for proprietary items with Sole Source Justification approval by the COE Competition

Advocate, the following paragraph shall be edited and inserted in the Technical Specifications for the item required:

Notwithstanding Section 00 72 00 Contract Clauses FAR 52.236.5, Material and Workmanship, [PRODUCT] shall be manufactured by [MANUFACTURER] in order that [REASON]. No other product will be acceptable. The Competition Advocate authorizes sole source procurement. The [PRODUCT] listed shall be the equipment, material, article, or patented process. The [MANUFACTURER] listed shall be the full legal company name of the manufacturer. The [REASON] listed shall be the reason(s) why it is necessary to procure the item through sole source procurement.

12.19.6 GUIDE SPECIFICATIONS

The FED Guide Specifications shall be completely edited and fully coordinated with the drawings to accurately and clearly identify the product and installation requirements for the facility. The specifications shall not be edited to reduce the level of quality for equipment, services provided materials, and items of equipment. Installation requirements identified in the provided specifications but not required for the facility shall be deleted. Where materials, items of equipment, or installation requirements are not covered in the provided specifications; special sections within each guide specification shall be prepared to cover those subjects. Government approval is required for any addition of materials, items of equipment, or installation requirements not covered in the provided specifications. The use of proprietary brand names in the specifications shall not be used. See Chapter 3 - SPECIFICATIONS for further guidance.

12.20 ELEVATORS

Elevator design shall follow UFC 3-490-06 and ASME A17.1. Where there is a conflict between the two documents, use the more stringent requirement.

12.21 HVAC COMMISSIONING

Department of Defense requires the use of an ASHRAE Defined “Total Building Commissioning” process for the projects. Refer to Chapter 17 Commissioning.

12.22 DESIGN SUBMITTAL REQUIREMENTS

Design submittal documentation requirements shall be in full compliance with UFC 3-401-01 & 3-410-01 as well as this section.

12.22.1 PARAMETRIC DESIGN

This section contains instructions and requirements for the following Project Definition Design submittal requirements:

- Mechanical Equipment Room Sizing Requirements
- Design Drawings
- Guide Specifications
- Design Analysis Narrative
- Design Analysis Calculations

Compliance with the design requirements for the building mechanical systems will be determined by a review of the submitted drawings and Design Analysis. All conflicts, lack of specific criteria, and/or direction, inconsistencies, ambiguities, and lack of thorough understanding of the nature and scope of work shall be identified or resolved prior to submittal of the follow on stages of design.

12.22.1.1 DESIGN DRAWINGS

Design drawings shall be fully coordinated with the Design Analysis. Floor plans shall use the architectural floor plans as a basis, with the building outline half-toned. Unless otherwise indicated, all floor plans shall be drawn at a minimum 1/8" (100) scale and shall show room names and numbers. The following design drawings shall be included in the Project Definition Design submittal:

EXTERIOR UTILITY DRAWINGS

The following exterior utility drawings shall be provided:

- Removal Plan: All existing exterior mechanical utilities and utilities which are to be removed shall be indicated on the Site Removal Plan located in the civil section of the drawing package.
- Utility Plan: All existing and new mechanical utilities shall be indicated on the Site Composite Utilities Plan located in the civil section of the drawing package. The location of existing exterior utilities shall be thoroughly checked and indicated on plans and profiles, thus preventing interference with new services. The utility drawing shall indicate all new utilities, including tie-in points, and existing utilities, which are to be abandoned.

REMOVAL PLANS

General removal drawings required for the rehabilitation or modification of the existing facilities shall be provided. Removal drawings may be combined into a composite removal plan as long as legibility is not compromised.

MECHANICAL DRAWINGS

Show on mechanical drawings, all major items of mechanical equipment systems to determine proper space allocation within the intent of the architectural layout requirements. Plans, elevations, and sections shall be developed sufficiently to insure that major equipment items, piping, and ductwork cause no interference with structural members, electrical equipment, etc. The following HVAC drawings shall be provided:

- Composite Mechanical Plan: A composite mechanical plan shall be provided showing the tentative layout of the main supply/return air ductwork and piping distribution systems. All interior walls that extend from the floor to the roof

structure shall be identified on the plan. Outlines of all electrical panels and equipment shall be shown. A key plan and room schedule legend shall also be included on the composite plan.

- Enlarged Mechanical Room Plan: An enlarged mechanical room plan showing all mechanical and plumbing systems and drawn at a minimum 20 scale shall be provided. Plans shall show layout of all equipment, piping, and ducts located within the rooms. Mechanical equipment shall include (but not limited to) air handling units with outside air intakes, relief air, and associated supply/return ducts, CW pumps, exhaust/supply fans, mechanical and boiler room ventilation intake/relief openings, gas service entrance, combustion air opening, unit heaters, HW pumps, boilers, expansion tanks, and HVAC control panels. Plans shall show dedicated access space for items requiring maintenance.
- Plumbing equipment shall include the water service entrance, fire protection entrance and risers, and lawn sprinkler apparatus. In addition, all electrical panels and equipment located in the room shall be outlined in half-tone.
- Mechanical Room Sections: For each air handling unit within the mechanical room, a mechanical room section view shall be provided showing, but not limited to, all AHU components, ductwork connections/routing, and relationship to adjacent structural features.

HVAC CONTROL DRAWINGS

Simplified, one-line type control schematics with anticipated sequence of operation shall be provided for all mechanical systems.

12.22.1.2 GUIDE SPECIFICATIONS

No guide specifications are required to be edited and submitted at this design stage, but a listing of the guide specifications intended for editing shall be included as part of the Design Analysis.

12.22.1.3 DESIGN ANALYSIS NARRATIVE

The narrative portion of the Design Analysis shall contain a narrative description and analysis for each of the mechanical portions of the design. The basis and reasons for specific engineering decisions, special features, unusual requirements, etc., shall be explained or summarized as applicable. If it is necessary to deviate from criteria or standard practice, reasons shall also be included. Design statements shall be provided in sufficient detail to enable the reviewer to get a clear picture and understanding of all included work so that approval will be granted. Narrative shall be complete relative to scope and intended design approaches.

The total scope projected to final design shall be outlined in a form that will be conveniently adapted, expanded, and detailed at the final design stage. If alternatives were to be evaluated and selected by the designer, conclusions shall be included; if final decisions were to be deferred to future conferences or reviews, report the findings (pros and cons) of the evaluation.

The Design Analysis shall carry a complete narrative for every item and system covered in the design, and will include, but not be limited to, the following:

- Index: Provide a Design Analysis index identifying all main and sub-paragraph headings.
- Project Summary: Provide a brief description of the mechanical design objectives.
- Applicable Criteria: A list of all applicable criteria used for basis of design.
- Guide Specifications: A list of all Guide Specifications that will be used for the Final Design of the project.
- Design Conditions: A list of Mechanical HVAC design conditions including elevation, latitude, heating/cooling degree days, winter and summer inside/outside summer design temperatures, hours of building occupation/ operation, ventilation rates, etc. shall be provided.
- System Descriptions: Using the Technical Design Requirements Section as a basis, provide a complete description of all building systems; include the designer's reasons for selecting specific materials, systems, etc. in which the reason for selection is not obvious.
- Zone HVAC System Descriptions: A complete description of all building Zone HVAC systems shall be provided.

12.22.1.4 DESIGN ANALYSIS CALCULATIONS

The Design Analysis calculations shall provide an estimate of the heating and cooling loads and a preliminary selection of the type and size of all equipment located in the mechanical room. A minimum of two, preferably three manufacturers shall be selected to determine the maximum size and weight of each item of mechanical equipment. Mechanical equipment rooms shall be laid out to accommodate the largest of the manufacturer’s available equipment. A Design Analysis index identifying all calculation items shall be provided. In addition, a list of Mechanical HVAC design conditions including elevation, latitude, heating/cooling degree days, winter and summer inside/outside summer design temperatures, hours of building occupation/ operation, ventilation rates, etc. shall be provided.

12.22.2 CONCEPT DESIGN

This section contains instructions and requirements for the following Concept Design submittal requirements:

- Design Drawings
- Guide Specifications
- Design Analysis Narrative
- Design Analysis Calculations

Compliance with the design requirements for the building mechanical systems will be determined by a review of the submitted drawings and Design Analysis. All conflicts, lack of specific criteria, and/or direction, inconsistencies, ambiguities, and lack of thorough understanding of the nature and scope of work shall be identified or resolved prior to submittal of the next design phase.

12.22.2.1 DESIGN DRAWINGS

Design drawings shall be fully coordinated with the Design Analysis. Provide sufficient

plans, mechanical room sections, HVAC control diagrams, sequence of operational control description, etc., as necessary to define the required design intent.

Large-scale plans of congested areas shall be provided. Floor plans shall use the architectural floor plans as a basis, with the building outline half-toned. Unless otherwise indicated, all floor plans shall be drawn at a minimum 50 scale and shall show room names and numbers. Sheet reference number sequencing shall be in accordance with the CADD Standards identified.

The following design drawings shall be included in the Early Preliminary Design submittal:

EXTERIOR UTILITY DRAWINGS

The following exterior utility drawings shall be provided:

- Removal Plan: All existing exterior mechanical utilities and utilities which are to be removed shall be indicated on the Site Removal Plan located in the civil section of the drawing package.
- Utility Plan: All existing and new mechanical utilities including main fuel piping runs and fuel piping problem areas shall be indicated on the Site Composite Utilities Plan located in the civil section of the drawing package. The location of existing exterior utilities shall be thoroughly checked and indicated on plans and profiles, thus preventing interference with new services. The utility drawing shall indicate all new utilities, including tie-in points, and existing utilities, which are to be abandoned.

REMOVAL PLANS

Any removal drawings required for the rehabilitation or modification of the existing facilities shall be provided.

PLUMBING DRAWINGS

The following plumbing drawings shall be provided:

- Composite Plumbing Plan: For reference, a composite plumbing plan shall be provided showing the entire facility and all plumbing systems on one sheet. Building outline, electrical equipment, and pertinent HVAC equipment shall be half-toned with plumbing system at standard line weight. No construction notes shall be provided on the plan. A key plan and room schedule legend shall also be included on the composite plumbing plan sheet.
- Plumbing Plans: Plumbing plans showing the design and tentative layout of the domestic hot and cold water distribution systems; make-up water piping; soil, waste and vent piping; and storm water drainage system shall be provided. Plans shall show all anticipated routing of piping systems from the connections within the structure to a point 1.5 m outside the structure. The grade of all drain lines shall be calculated and invert elevations established. All electrical panels/equipment and pertinent HVAC equipment (expansion tanks, boilers, AHU's, pumps, lawn sprinkler system, etc.) shall be outlined in half-tone on the plumbing plans. Plans may combine building areas and be drawn at 100 scale as long as legibility is not compromised.

MECHANICAL HVAC DRAWINGS

Show on mechanical HVAC drawings, all items of mechanical equipment, including boiler room equipment, HVAC equipment layout, air handling units, air distribution and exhaust systems, etc., to determine proper space allocation within the intent of the architectural layout requirements. Plans, elevations, and sections shall be developed sufficiently to insure that major equipment items, piping, and ductwork cause no interference with structural members, electrical equipment, etc. The following HVAC drawings shall be provided:

- Composite Mechanical HVAC Plan: For reference, a composite mechanical HVAC plan shall be provided showing the entire facility and all associated mechanical systems on one sheet. Building outline and electrical equipment shall be half-toned with mechanical systems at standard line weight. No construction notes shall be provided on the plan. A key plan and room schedule legend shall also be included on the composite mechanical plan sheet.
- Mechanical HVAC Plans: Mechanical HVAC plans showing the design and tentative layout of the hot water piping distribution system and equipment, the air supply and distribution systems, and the ventilation and exhaust systems shall be provided. All main supply and return air ductwork shall be shown as double-lined, other ducts may be single-lined. Air supply and distribution systems shall include VAV box locations. The location of all ceiling diffusers, grilles, and registers shall be shown. All electrical panels/equipment and pertinent plumbing equipment shall be outlined in half-tone on the HVAC plans. Mechanical plans shall be drawn at 50 scale.
- Enlarged Mechanical Room Plan: An enlarged mechanical room plan showing all mechanical and plumbing systems and drawn at a minimum 50 scale shall be provided. Plans shall show layout of all equipment, piping, and ducts located within the rooms. Mechanical equipment shall include (but not limited to) air handling units with outside air intakes, relief air, and associated supply/return ducts, CW pumps, exhaust/supply fans, mechanical and boiler room ventilation intake/relief openings, gas service entrance, combustion air opening, unit heaters, HW pumps, boilers, expansion tanks, and HVAC control panels. Plans shall show dedicated access space for items requiring maintenance. Plumbing equipment shall include the water service entrance, fire protection entrance and risers, lawn sprinkler apparatus, and any electrical equipment or panels located in the room. In addition, all electrical panels and equipment located in the room shall be outlined in half-tone.
- Mechanical Room Sections: For each air handling unit within the mechanical room, a mechanical room section view shall be provided showing, but not limited to, all AHU components, ductwork connections/routing, and relationship to adjacent structural features.
- Chilled Water System Flow Diagram: Provide flow diagram showing connections to the existing chilled water system, the piping layout to the facility, and the facility piping system including the pumps and connected CW

equipment. Each pump and equipment item shall show associated GPM flowrate. All isolation and control valves, bypass piping, etc. shall be shown.

- Airflow Diagrams: Airflow diagrams shall be provided for each Air Handling Unit system showing airflow quantities for outside air, return air, and supply air. Supply-air side of each diagram shall be broken down into zones, with each zones supply, return, and relief/exhaust airflow quantities identified.
- Mechanical Detail Sheets: Mechanical details shall be provided for each item of mechanical equipment. Furnished generic details shall be used whenever possible and shall be completed and/or revised as necessary to suit the project requirements. Any new details shall be drawn at a minimum scale of 20.
- Mechanical Schedule Sheets: Schedules, with preliminary capacities, shall be provided for each item of mechanical equipment. Furnished typical equipment schedules shall be used wherever possible and shall be completed and/or revised as necessary to suit the project requirements.

HVAC CONTROL DRAWINGS

Simplified, one-line type control schematics with detailed sequence of operation shall be provided for all mechanical equipment and systems. Sequence of operation for each item of equipment and system shall be sub-sectioned into paragraphs describing discreet operational requirements. See Section 11.19 above for HVAC Control Drawing specific requirements.

12.22.2.2 GUIDE SPECIFICATIONS

No guide specifications are required to be edited and submitted at this design stage, but a listing of the guide specifications intended for editing shall be included as part of the Design Analysis.

12.22.2.3 DESIGN ANALYSIS

NARRATIVE

The narrative portion of the Design Analysis shall contain a narrative description and analysis for each of the mechanical portions of the design. The basis and reasons for specific engineering decisions, special features, unusual requirements, etc., shall be explained or summarized as applicable. If it is necessary to deviate from criteria or standard practice, reasons shall also be included. Design statements shall be provided in sufficient detail to enable the reviewer to get a clear picture and understanding of all included work so that approval will be granted.

Narrative shall be complete relative to scope and intended design approaches. The total scope projected to final design shall be outlined in a form that will be conveniently adapted, expanded, and detailed at the final design stage. If alternatives were to be evaluated and selected by the designer, conclusions shall be included; if final decisions were to be deferred to future conferences or reviews, report the findings (pros and cons) of the evaluation.

The Design Analysis shall carry a complete narrative for every item and system covered in the design, and will include, but not be limited to, the following:

- Index: Provide a Design Analysis index identifying all main and sub-paragraph

headings.

- Project Summary: Provide a brief description of the mechanical design objectives.
- Applicable Criteria: A list of all applicable criteria used for basis of design.
- Guide Specifications: A list of all Guide Specifications that will be used for the Final design of the project.
- Design Conditions: A list of Mechanical HVAC design conditions including elevation, latitude, heating/cooling degree days, winter and summer inside/outside summer design temperatures, hours of building occupation/ operation, ventilation rates, etc. shall be provided.
- System Descriptions: Using the Technical Design Requirements Section as a basis, provide a complete description of all building systems; include the designer's reasons for selecting specific materials, systems, etc. in which the reason for selection is not obvious.
- Zone HVAC System Descriptions: A complete description of all building Zone HVAC systems.

CALCULATIONS

The Design Analysis calculations shall provide an estimate of the heating and cooling loads and a preliminary selection of the type and size of mechanical equipment. A minimum of two, preferably three manufacturers shall be selected to determine the maximum size and weight of mechanical equipment. Mechanical equipment rooms shall be laid out to accommodate the largest of the manufacturer’s available equipment.

Design calculations shall be given in sufficient detail to enable the reviewer to get a clear picture and understanding of all included work to allow approval. Backup data shall be furnished to support basic design decisions related to sizing of major equipment and materials, performance of specific systems or equipment.
Manufacturer's catalog data sheets shall be provided for each item of equipment and shall be labeled to match the mechanical equipment schedules identification type.
Calculations may be performed by manual or computerized procedures. Use of standardized charts, curves, tables, graphs will generally be acceptable for portions of required calculations or in lieu of specific calculation procedures. Such data shall be from a recognized source, which is identified in the Design Analysis. If possible, a copy of applicable sheets or pages shall be included with the calculations.

Preliminary design calculations and computations shall be provided for all systems. The following shall be included:

- Index: Provide a Design Analysis index identifying all calculation items.
- Design Conditions: A list of Mechanical HVAC design conditions including elevation, latitude, heating/cooling degree days, winter and summer inside/outside summer design temperatures, hours of building occupation/ operation, ventilation rates, etc. shall be provided.
- Area Air-Conditioning Loads: Preliminary cooling calculations shall be prepared using the Cooling Load Temperature Differential/Cooling Load Factors

(CLTD/CLF) Method as described in the ASHRAE Handbook Fundamentals.

- Block Air-Conditioning Loads: Preliminary block cooling load calculations, each encompassing all areas served by an air handling unit, shall be prepared using the CLTD/CLF Method. Separate block load calculations shall be provided for each of the air handling units, including the outside-air handling unit. The calculated size of equipment and distribution system may be increased by up to 10 percent to compensate for morning recovery due to night set forward or by up to 10 percent to compensate for unanticipated loads or changes in space usage; however, size of equipment and distribution system will not be increased by more than 15 percent total.
- Psychometric Charts: A psychometric plot, corrected for site elevation, shall be provided for each of the air handling units. All points in the conditioning process (outside air, return air, mixed air, coil leaving condition, and fan temperature rise) shall be clearly identified on the psychometric chart and verification of both sensible, latent, and total capacity shall be shown using the appropriate data from the chart.
- Air Handling Unit Selections
- Chiller Plant Sizing Summary & Selections
- Chilled & Hot Water Pump Selections
- Heating and Cooling Load Calculations based on primary systems and zones
- Building Envelope U-Factors
- Heating Plant/Boiler Sizing Summary & Selections
- Supply & Exhaust Fan Selections
- Pressure loss calculations for all air fans and hydronic pumps
- Terminal Unit Selections
- Unitary Heating/Cooling Sizing & Selections
- Combustion-Air Intake
- ASHRAE 62.1 Ventilation & Exhaust Rate Calculations
- Domestic Water Demand: Plumbing fixture determination, listing quantity and types of fixtures identified by federal or military specifications. Fixture units for drainage, venting, cold and hot water piping. Determination of number of fixtures, cold water demand, hot water demand, pipe sizing, equipment selection, etc. shall be provided.
- Domestic Hot Water Demand: Unless otherwise stated in this guide, the design guidance provided for service water heating in ASHRAE Handbook HVAC Systems and Applications will be followed. Water service pipes will be sized in accordance with the IPC. Consideration will be given to increasing pipe sizes based on the anticipated future installation of fixtures when performing design calculations.
- Roof Drainage System: Roof areas used in determining storm drainage pipe sizes and sizing of pipes shall be provided.
- Electrical Load Summary: A tabular summary of all mechanical equipment and the associated electrical load requirements shall be provided.
- Hydrant Fueling Systems: 90% completed surge analysis, 90% completed

piping stress analysis

12.22.3 PRELIMINARY DESIGN

The purpose of the Preliminary Design phase is to validate that the design is being developed in accordance with the approved design criteria and is meeting the Stakeholder's expectations. The A-E shall be thoroughly familiar with the approved design development document information prior to the start of this stage. This stage of design development shall also verify the progress of the contract drawings, review general technical competency, and assure compliance with the Far East District's design standards. The Preliminary Design shall include the requirements listed for the previous stages of design. The Preliminary Design shall incorporate specific criteria furnished and all previously concurred DrChecks review comments.

12.22.4 FINAL DESIGN

This section contains instructions and requirements for the following final design submittal requirements:

- Design Drawings
- Guide Specifications
- Design Analysis Narrative
- Design Analysis Calculations

The final design submittal shall include all the information presented in the previous submittals, updated to 100% design status, and corrected to reflect changes made in response to review comments. Compliance with the design requirements for the building mechanical systems will be determined by a review of the submitted Design Analysis, drawings, and specifications. All conflicts, lack of specific criteria, and/or direction, inconsistencies, ambiguities, and lack of thorough understanding of the nature and scope of work shall be resolved prior to starting this final design stage.

12.22.4.1 DESIGN DRAWINGS

Final design drawings shall be fully coordinated with the Design Analysis and specifications. Provide sufficient plans, piping diagrams and isometrics, mechanical room sections, water and air flow diagrams, details, schedules, control diagrams, sequence of control operation description, etc., as necessary to define the required design intent. Large-scale plans of congested areas shall be provided. Coordinate with architectural design for provision of access panels for all concealed valves, traps and air vents, etc. Floor plans shall use the architectural floor plans as a basis, with the building outline half-toned. Unless otherwise indicated, all floor plans shall be drawn at a minimum 50 scale and shall show room names and numbers. Sheet reference number sequencing shall be in accordance with the CADD Standards identified.

The final design drawings shall include all the drawings submitted at the Concept and Intermediate design stage, updated to 100% design status. In addition, the following drawings shall be provided:

MECHANICAL ABBREVIATION, LEGEND, AND GENERAL NOTES SHEET

This sheet shall include all mechanical abbreviations and symbols that will be used on the drawings. Symbols shall be grouped into sections; as a minimum, Plumbing, Heating, Chilled Water, Miscellaneous Piping, Valves and Fittings, and Air Conditioning sections shall be provided. Include any mechanical general installation notes that may be required to clarify the construction intent that may not be readily apparent in the specifications or on the drawings. General notes may be provided on a separate sheet if space does not exist on the Abbreviation and Legend sheet.

PLUMBING DRAWINGS

The following plumbing drawings shall be provided:

- Composite Plumbing Plan: For reference, a composite plumbing plan shall be provided showing the entire facility and all plumbing systems on one sheet. Building outline, electrical equipment, and pertinent HVAC equipment shall be half-toned with plumbing system at standard line weight. No construction notes shall be provided on the plan. A key plan and room schedule legend shall also be included on the composite plumbing plan sheet.
- Enlarged Toilet Room Plans: Enlarged toilet room plans showing all fixtures, water, waste, and vent piping shall be provided for each toilet area. Enlarged plans shall be drawn at a minimum 50 scale.
- Plumbing Riser Diagrams: Plumbing water and Waste/Vent riser diagrams shall be provided for each toilet area. Riser diagrams are recommended to be located on the same sheet as the respective enlarged toilet room plans.
- Plumbing Detail and Schedule Sheet: The following details shall be provided; roof/overflow drains, electric water heater, and water service entrance. The provided plumbing fixture schedule and a contractor generated electric water heater schedule shall be provided.
- Enlarged Mechanical Room Plumbing Plan: An enlarged mechanical room plumbing plan drawn at a minimum 50 scale shall be provided. Plan shall show layout of all equipment and piping within the rooms. In addition to all the plumbing systems required, the plan shall show half- toned outlines of all HVAC equipment located in the room, gas service and chilled water entrances, lawn sprinkler apparatus, the fire protection entrance and risers, and the outline of any electrical panels or equipment located in the room.

MECHANICAL HVAC DRAWINGS

Show on mechanical HVAC drawings, all items of mechanical equipment, including boiler room equipment, HVAC equipment layout, air handling units, air distribution and exhaust systems, etc., to determine proper space allocation within the intent of the architectural layout requirements. Plans, elevations, and sections shall be developed sufficiently to insure that major equipment items, piping, and ductwork cause no interference with structural members, electrical equipment, etc. The following HVAC drawings shall be provided:

- Hot Water System Flow Diagram: Provide a hot water flow diagram showing the primary and secondary piping systems; including the boiler, pumps, and connected HW equipment. Each equipment item shall show associated

flowrate.

- Chilled Water System Flow Diagram: Provide flow diagram showing connections to the existing chilled water system, the piping layout to the facility, and the facility piping system including the pumps and connected CW equipment. Each pump and equipment item shall show associated flowrate. All isolation and control valves, bypass piping, etc. shall be shown.
- Airflow Diagrams: Airflow diagrams shall be provided for each Air Handling Unit system showing airflow quantities for outside air, return air, and supply air. Supply-air side of each diagram shall be broken down into zones, with each zones supply, return, and relief/exhaust airflow quantities identified.
- Mechanical Schedule Sheets: Schedules shall be provided for each item of mechanical equipment. Furnished generic equipment schedules shall be used wherever possible and shall be completed and/or revised as necessary to suit the project requirements.
- Mechanical Room 3D Sheets: Each Mechanical room shall be shown in 3D perspective. The current state of BIM technology allows for ease of creation of 3D views that can convey greater detail than 2D plan or section views. Provide 3D perspective view of each mechanical room that supplements the plan and section views in showing equipment layout, ductwork and piping layout and configuration.

HVAC CONTROL DRAWINGS

In accordance with the Technical Design Requirements, detailed HVAC system sequence of control, schematics, diagrams, and point lists are required for all mechanical systems.

12.22.4.2 GUIDE SPECIFICATIONS

The guide specifications shall be fully edited and coordinated with the drawings and Design Analysis to identify the product and installation requirements of the facility.

Materials, items of equipment, or installation requirements identified in the provided specifications but not required for the facility shall be marked for deletion. Where materials, items of equipment, or installation requirements are not covered in the provided specifications; special sections within each guide specification shall be prepared to cover those subjects. Specifications shall be prepared in accordance with Chapter 18: Specifications of this Design Guide.

12.22.4.3 DESIGN ANALYSIS NARRATIVE AND CALCULATIONS

The final Design Analysis Narrative and Calculations shall include the basic information presented in the previous submittals and shall be corrected to reflect changes in content made in response to review comments. The text and content of the previous narrative and calculations shall be expanded to reflect the completed design.

BASIS OF DESIGN MECHANICAL EQUIPMENT DATA SHEETS

For each specific mechanical equipment listed on the mechanical schedules provide computer generated original equipment manufacturer basis of design performance

selections which clearly indicates make, model, and operating performance parameters that are project specific and match the mechanical schedules. Performance data shall be in metric. Generic manufacturer's catalog cut sheets are not acceptable.

12.23 COMMON DEFICIENCIES

Some requirements of the Far East District Design Guide have been repeatedly overlooked in the past. Subsequently these errors have been identified and the Architect-Engineer directed to make corrections. The work involved in such corrections becomes lost effort and time for the designer. Carefully compare the mechanical design and contract documents with these requirements at several points in the design process to avoid unnecessary changes later. Some of these requirements which are most often overlooked include:

12.23.1 GENERAL

- Not using correct abbreviations, terminology, or symbols on the drawings. Abbreviations & symbols shall match what is used on the standard abbreviation sheet and terminology shall match what is used in the standard guide specifications.
- Not using the correct scales, north arrow designation, section cut system, or incomplete dimensioning on the drawings.
- Inapplicable text not edited out of the guide specifications and specifications not tailored to be project specific.

12.23.2 DESIGN ANALYSIS

- Inadequate cooling/heating load calculations.
- Inadequate supporting calculations for the design & equipment selection.
- Inadequate supporting basis of design equipment selection data sheets.

12.23.3 DRAWINGS

- Equipment schedules not completed and/or inconsistent data where equipment cannot be properly selected/sized.
- General lack of completeness.
- Lack of drawing clarity due to too small of scale and/or unnecessary reference drawings being shown such as reflected ceiling grids.
- Incomplete/Missing Control Sequences of Operation, Schematics, & Points Lists.

12.23.4 SPECIFICATIONS

- Specs not completely edited.
- The use of Specific Manufacturer/Model numbers without a generic specification so that in effect the AE has sole sourced equipment.
- Specs not applicable to the project and/or missing specs.

12.24 SEISMIC DESIGN REQUIREMENTS

AE shall develop performance requirements per UFC 3-301-01" Structural Engineering and ASCE 7-10, Chapter 13 on the construction documents within the General Notes.

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CHAPTER 13- PLUMBING

13.1 GENERAL

The design of all plumbing systems shall meet the instructions and requirements contained herein, the other government furnished criteria, and the requirements of the FED Guide Specifications. Where conflicts between the above documents exist, these instructions shall take precedence.

Plumbing designs shall be economical, maintainable, sustainable and energy conservative with full consideration given to the functional requirements and planned life of the facility. Plumbing design shall also consider life cycle operability, maintenance and repair of the facility and real property installed equipment components and systems.

13.2 DESIGN CRITERIA

The design publications listed below shall be used as sources of criteria for plumbing design. The criteria from these sources may be supplemented, but not supplanted, by applicable criteria contained in nationally recognized codes, standards, and specifications.

Many of the referenced government engineer publications can be found in the Whole Building Design Guide at http://www.wbdg.org.

- American National Standards Institute (ANSI) Air Force Manuals (AFM)
- Air Force Engineering Technical Letters (ETL)
- American Society of Sanitary Engineering Standards (ASSE)
- Army Regulation (AR)
- American Society of Heating, Refrigerating, & Air Conditioning Engineers (ASHRAE)
- ASTM International (ASTM)
- Army Architectural & Engineering Instructions Design Criteria (ARMY AEI)
- Director of Central Intelligence Directive (DCID)
- Energy Independence and Security Act of 2007 (EISA 2007)
- Energy Policy Act of 2005 (EPAct 2005)
- Engineering Manuals (EM)
- Executive Order 13423 Greening the Government through Efficient Energy Management

- Technical Manuals (TM)
- Code of Federal Regulations (CFR)
- Instrument Society of America Standard (ISA)
- Military Handbook (MIL-HDBK)
- National Fire Codes (NFPA)
- Unified Facilities Criteria (UFC)
- Underwriters Laboratories (UL)
- International Code Council International Building Code (IBC)
- International Code Council International Plumbing Code (IPC)

13.3 GENERAL PIPING REQUIREMENTS

As applicable, the following shall be provided for all piping systems:

- All piping and equipment located in finished areas of the building shall be concealed or furred-in; exposed piping and equipment is allowed in utility, equipment, storage, boiler, and other rooms of this nature.
- All pumps, regardless of service, shall be non-overloading allowing the pump to operate at any point on its characteristic curve.
- Provide vent and drain valves with hose-end connections on all piping systems. Air vents shall be installed on all high points in piping systems. Drain valves shall be installed at low points and at equipment, which shall be dismantled for servicing.
- Pipe taps, suitable for use with either a 6 mm (1/8 in) OD temperature or pressure probe, shall be located at each pressure gauge, thermometer, pressure sensor and temperature sensor.
- Provide isolation valves, balancing valve, flow measuring device, and pressure/temperature test ports at all heating and/or cooling terminal units.
- All coils shall be provided with valved drain and air vent connections.
- On air handling units with multiple coils, isolation valves shall be installed on the supply piping and a balancing valve on the return piping of each coil. A thermometer shall be installed on the supply piping of each coil. Pressure / temperature test ports shall be provided on the supply and return piping of each coil.
- Strainers shall be provided with a valved blowdown connection and, where indicated, piped to a floor drain.
- Water and natural gas service lines shall be metered where they enter the building.
- All underground metallic lines, fittings, and valves; except for cast- iron soil and storm drain piping systems, shall be cathodically protected in accordance with

Electrical Section paragraph entitled "Cathodic Protection".

- All exterior, underground non-metallic piping shall be buried with locator wire and pipe detection tape.
- All pipe, ductwork, and equipment supports and hangers shall be coordinated with the roof design to avoid overloading of any of the structural elements.

13.4 IDENTIFICATION OF PIPING

All exposed or concealed piping in accessible spaces shall be identified with color coded bands and titles in accordance with American National Standards Institute (ANSI) Standard A13.1, Scheme for Identification of Piping Systems.

13.4.1 SEISMIC DESIGN CONSIDERATIONS

AE shall develop performance requirements per UFC 3-31-04 “Seismic Design of Buildings, UFC 3-301-01” Structural Engineering and ASCE 7-10, Chapter 13 on the construction documents within General Notes.

13.4.2 FIRE PROTECTION IN BUILDINGS

All water pipes for fire protection systems will be designed under the provisions of the applicable NFPA Chapters.

13.5 PLUMBING SYSTEMS

The plumbing system consists of the water supply distribution system; fixtures, and fixture traps; soil, waste, and vent piping; storm water drainage; acid and industrial waste disposal systems. The plumbing system extends from connections within the facility to a point 1.5 m (5 ft) outside the facility. The design of the plumbing system will comply with the most current edition of the International Plumbing Code (IPC) and UFC 3-420-01 Plumbing Systems unless otherwise stated. All plumbing products shall be lead free meeting the safe drinking water requirements of ANSI/NSF 61 Section 9.

13.5.1 PIPE MATERIALS

Pipe materials for the domestic water system shall be specified as nonferrous.

13.5.2 WATER SERVICE

Underground water pipes will be installed below the recognized frost line. Service lines will enter the building in an accessible location and when entering through the floor, a displacement type water entrance shall be provided. When the incoming pressure of water supply exceeds the water pressure necessary for proper building operation by 0.7MPa (10 psig), a pressure reducing valve will be provided. Water meters are required for all domestic water service lines and shall be located in the facility Mechanical Room. Meters may be installed at alternate locations in the facility if locating the meter in the Mechanical Room is not practical.

13.5.3 PIPING RUNS

Piping runs will be arranged to minimize interference with ordinary movement of

personnel and equipment. The water supply piping will be distributed throughout the building, with mains generally running above the ceiling of the lowest floor. Neither water nor drainage piping will be located over electrical wiring or equipment unless adequate protection against water (including condensation) damage has been provided. Insulation alone is not adequate protection against condensation. Water and waste piping will not be located in exterior walls, attics, or other spaces where there is danger of freezing. Where piping is to be concealed in wall spaces or pipe chases, such spaces shall be checked to ensure that clearances are adequate to properly accommodate the piping. Water piping shall be designed for a maximum velocity of 2.5 m/s (8 ft/s) at full flow.

13.5.4 PROTECTION OF WATER SUPPLIES

Cross connections between water supply piping and waste, drain, vent, or sewer piping are prohibited. Piping will be designed so that a negative pressure in the water supply pipe and a stopped-up waste, drain, vent, or sewer pipe will not cause backflow of waste water into the water supply piping. Backflow prevention shall be provided in accordance with the latest version of the IPC. (Single check valves are not considered adequate protection against back flow.)

13.5.5 BACK-SIPHONAGE

The supply outlet connection to each fixture or appliance that is subject to back-siphonage of non-potable liquids, solids, or gases will be protected in accordance with the IPC. Air gaps will conform to the IPC. Double check valve assemblies, reduced pressure principle assemblies, atmospheric (non-pressure) type vacuum breakers, and pressure type vacuum breakers will be tested, approved, and listed by the Foundation for Cross-Connection Control & Hydraulic Research. Pipe-applied atmospheric type vacuum breakers, hose connection vacuum breakers, and backflow preventers with intermediate atmospheric vent will be in accordance with American Society of Sanitary Engineering (ASSE) Standards 1001, 1011, and 1012.

13.5.6 SERVICE STOP VALVES

Servicing stop valves shall be installed in all water connections to all installed equipment items, as necessary for normal maintenance or replacement, and shall be shown on the drawings, except when called for in the project specifications.

13.5.7 FIXTURES

All plumbing fixtures, including but not limited to water closet, lavatory, shower, kitchen sink, service sink shall be low flow water conserving fixture to meet UFC 1-200-02.

The maximum water flow values are 20% less than those in the International Plumbing Code (IPC) as required to comply with DoD mandates for water conservation identified in UFC 3-420-01.

13.5.8 WATER HAMMER ARRESTERS

Commercially available water hammer arresters shall be provided at all quick closing vales such as solenoid valves and will be installed according to manufacturer recommendations. Vertical capped pipe columns are not permitted. Water hammer

arrestors are not classified "A" thru "C" like on US products. Add drawing note "Size and install per manufacturer's instructions" as fixture units for calculation used per manufacturer can differ.

13.5.9 WATER COOLERS

Electric, refrigerated water coolers shall be used for all drinking water requirements, except in hazardous areas per N.E.C. Article 500. Refrigerant R-12 shall not be allowed.

13.5.10 WALL HYDRANTS

Freeze-proof wall hydrants with vacuum- breaker-backflow-preventer shall be located on outside walls so that, with no more than 30 m (100 ft) of garden hose, the entire perimeter of a facility can be watered without crossing main building entrances.

13.5.11 EMERGENCY SHOWER AND EYEWASH

Emergency showers and eyewash shall be provided where hazardous materials are stored or used or as required by the Stakeholder and shall be installed in accordance with ANSI Standard Z385.1 In accordance with ANSI Standard Z385.1, a heated water system shall provide tepid water (15.5 to 38°C (60 to 100°F)) for a 15 minute duration at the flow rate required by the installed shower/eyewash. Water temperature shall be maintained by a thermostatically controlled mixing valve designed for this application.

13.5.12 DOMESTIC HOT-WATER

Domestic water heating energy source shall be selected by the designer. Use of electricity will be avoided if possible. Electricity is allowable for point-of-use water heaters only. Domestic hot-water design temperatures shall be 49°C (120°F) for distribution. Domestic hot water shall be stored at 60°C (140°F).

13.5.13 CIRCULATING PUMPS

Criteria determining the need for circulating pumps in ASHRAE HANDBOOK-HVAC Applications will be followed. Pump sizing will also be in accordance with simplified method in ASHRAE unless specific conditions warrant the need for more detailed calculations. In facilities operated on a nominal 40-hour week or on a nominal two-shift basis (either a 5- or a 7-day week), a clock or automatic control by the facility HVAC control system will be installed on domestic hot-water circulating pumps to permit operation only during periods of occupancy plus 30 minutes before and after.

13.5.14 FLOOR DRAINS

Floor drains shall be provided in toilet rooms with three or more water closets. Provide floor drains in shower drying areas serving two or more showers. In utility and boiler rooms, provide enough floor drains to avoid running equipment drain pipes above the floor.

13.5.15 ACID WASTE SYSTEMS

The selection of pipe and fitting materials for acid waste and vent applications will be based upon the type, concentration, and temperature of acid waste to be handled. Acid neutralization tanks shall be provided for all acid waste drainage systems.

13.5.16 VENTS

Where feasible, provide circuit vents in a concealed space to a main vent through the roof in lieu of an excessive number of individual vents through the roof. Waste and vent piping shall be concealed unless otherwise specifically instructed.

13.5.17 STORM DRAINAGE

Storm drainage will include roof drains, leaders, and conductors within the building and to a point 1.5 m (5 ft.) outside the building. Roof drainage systems will be designed in accordance with rainfall intensity-frequency data in the IPC.

13.5.18 SEISMIC DESIGN CONSIDERATIONS

AE shall develop performance requirements per UFC 3-301-01 “Structural Engineering and ASCE 7-10, Chapter 13 on the construction documents within General Notes.

CHAPTER 14 - ELECTRICAL

14.1 GENERAL

This chapter covers instructions for the preparation of drawings, specifications and design analysis as related to power, lighting, cathodic protection, and electronic systems as well as energy conservation features. Fire alarm system connections are covered in the chapter on Fire Protection.

14.2 DESIGN CRITERIA

Government design and contracting activities are controlled by Federal Acquisition Regulations (FARS). The details of the electrical design shall conform to the electrical portions of applicable military design and construction manuals and supplementary criteria documents as listed in the following paragraphs. The Far East District Design Guide shall serve as the basic criteria document for electrical design of Corps of Engineers projects.

Whenever reference is made in this chapter to any publication, standard or code, or paragraph therein, the issue/version of publication indicated in the AE contract shall be used unless direction is provided to the contrary. If dates are not indicated in the AE contract or in the absence or other direction, the issue/version of publication in effect at the time the design was started shall be used. Many military publications are available electronically at http://www.wbdg.org/ccb/ccb.php. Consult this website to ensure the latest versions are used.

UNIFIED FACILITY CRITERIA (UFC)

UFC 1-200-01	DoD Building Code (General Building Requirements)
UFC 1-200-02	High Performance and Sustainable Building Requirements
UFC 3-260-01	Airfield and Heliport Planning and Design
UFC 3-501-01	Electrical Engineering
UFC 3-510-01	Foreign Voltages and Frequencies Guide
UFC 3-520-01	Interior Electrical Systems
UFC 3-520-05	Stationary Battery Areas
UFC 3-530-01	Interior and Exterior Lighting Systems and Controls
UFC 3-535-01	Visual Air Navigation Facilities
UFC 3-540-01	Engine-Driven Generator Systems for Backup Power Applications
UFC 3-550-01	Exterior Electrical Power Distribution
UFC 3-555-01N	400 Hertz Medium Voltage Conversion/Distribution Systems

UFC 3-560-01 Electrical Safety, O&M

UFC 3-570-02A Cathodic Protection

UFC 3-570-02N Electrical Engineering Cathodic Protection

UFC 3-570-06 Operation and Maintenance: Cathodic Protection Systems

UFC 3-575-01 Lightning and Static Electricity Protection Systems

UFC 3-580-01 Telecommunications Interior Infrastructure Planning and Design

UFC 3-600-01 Fire Protection Engineering for Facilities

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

UFC 4-010-06 Cybersecurity of Facility-Related Control Systems

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

UFC 4-021-02 Electronic Security Systems

UFC-4-510-01 Military Medical Facilities

ARMY PUBLICATIONS

TM 5-683 Facilities Engineering Electrical Interior Facilities

TM 5-684 Facilities Engineering Electrical Exterior Facilities

TM 5-811-3 Electrical Design: Lightning and Static Electricity Protection [AFM 88-9, Chap 3]

POWER SYSTEMS AND EQUIPMENT

TL 1110-3-412 Transformer Application Guidance - rescinded 04 Mar 09

TL 1110-3-432 Exit Signs - rescinded 04 Mar 09

TI 811-16 Lighting Design

COMMUNICATIONS SYSTEMS AND EQUIPMENT

I3A Technical Criteria for Installation Information Infrastructure Architecture

FIRE PROTECTION

See Chapter 11 - "FIRE PROTECTION" for criteria publications

MISCELLANEOUS

TL 1110-3-403 Electrical Power Systems for Nonlinear Loads - rescinded 04 Mar 09

TL 1110-3-465 Design and Construction of Water Meters and Appurtenances at New Army Facilities - rescinded 04 Mar 09

TL 1110-3-466 Selection and Design of Oil/Water Separators at Army Facilities - rescinded 04 Mar 09

TL 1110-3-474 Cathodic Protection - rescinded 04 Mar 09

TL 1110-9-10(FR) Cathodic Protection Systems Using Ceramic Anodes - rescinded 04 Mar 09

AIR FORCE PUBLICATIONS

POWER SYSTEMS AND EQUIPMENT

AFJMAN 32-1083 Facilities Engineering Electrical Interior Facilities [TM 5-683]

AFM 88-9, Chap. 3 Electrical Design: Lightning and Static Electricity Protection [TM 5-811-3]

MISCELLANEOUS

AFH 32-1290 Cathodic Protection Field Testing AFI 32-1065 Grounding Systems

DCID 6/9 Director of Central Intelligence Directives Air Force Base Area Network Functional Specification

AMERICAN SOCIETY OF HEATING, REFRIGERATION, AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings

ILLUMINATING SOCIETY OF NORTH AMERICA

IESNA Publications Illuminating Engineering Society of North America, www.ieusa.org

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS

IEEE/ANSI C2 National Electrical Safety Code

IEEE 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book)

IEEE 1110	Powering and Grounding Sensitive Electronic Equipment (Emerald Book)
IEEE 466	Emergency and Standby Power for Industrial and Commercial Applications (Orange Book)

The entire color book series.

INSTRUMENT SOCIETY OF AMERICA (ISA)

ISA 5.1	Instrumentation Symbols and Identification ISA 5.2 Binary Logic Diagrams for Process Operations

INTERNATIONAL ASSOCIATION OF ELECTRICAL INSPECTORS (IAEI)

IAEI	Soares Book on Grounding

INTERNATIONAL CODE COUNCLE

International Green Construction Code (IgCC)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	National Electrical Code
NFPA 70E	(OSHA) Standard for Electrical Safety in the Workplace NFPA 72National Fire Alarm Code
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 101	Life Safety Code
NFPA 780	Lightning Protection Code
NFPS 170	Standard for Fire Safety Symbols

NATIONAL ASSOCIATION OF CORROSION ENGINEERS (NACE)

NACE RP0169	Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE RP0177	Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems
NACE RP0188	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

NACE RP0193 External Cathodic Protection of On-Grade Carbon Steel Storage Tank Bottoms

NACE RP0285 Corrosion Control of Underground Storage Tank Systems by Cathodic Protection

NACE RP0286 Electrical Isolation of Cathodically Protected Pipelines

MILITARY HANDBOOKS

MIL HDBK 419A Military Handbook Grounding, Bonding and Shielding for Electronic Equipment and Facilities

MIL HDBK 1190 Military Handbook for Facility Planning and Design Guide

MISCELLANEOUS REFERENCES

AFI 32-1054 Corrosion Control

ANSI-TIA-EIA 568B Commercial Building Telecommunications Cabling Standard

ER 1110-345-700 Design Analysis, Drawings and Specifications

ER 1110-345-100 Design Policy for Military Construction AMCR 385-100 Army Material Command Safety Manual

CADD Electrical Lighting Details; Construction Criteria Base (CCB); NAVFAC

CADD Details at http://www.wbdg.org/ccb/browse_cat.php?o=78&c=232 https://cadlib.wes.army.mil/DetailsLibrary

CFR 28 Part 36 Nondiscrimination on the Basis of Disability of by Public Accommodation and in Commercial Facilities, Final Edition (ABA). (In case of a conflict with NFPA 72 and/or FED-STD 795, this document takes precedence.)

CFR 49 Part 192 Transportation of Natural and other Gas by Pipeline: Minimum Federal Safety Standards

CFR 49 Part 195 Transportation of Hazardous Liquids by Pipeline

CFR 40 Part 280 Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Fuel Storage Tanks

	(UST)
FED-STD-795	Uniform Federal Accessibility Standards IES Lighting Handbook
NESC	National Electrical Safety Code

OTHER PUBLICATIONS AND STANDARDS

In addition to the codes and standards listed above, all electrical work shall comply with the applicable requirements of the latest edition of the standards of the National Electrical Manufacturer's Association (NEMA); Insulated Power Cable Engineer's Association (IPCEA); and all applicable federal, state, city, and local codes, regulations, ordinances, publications and manuals. All new manufactured equipment shall be listed by the Underwriter's Laboratory (UL) or a similar testing laboratory acceptable to the Corps of Engineers. When codes conflict, the more stringent standard shall govern.

CODE ENFORCEMENT

In projects where the Corps of Engineers will be the code enforcing authority, project-specific or site-specific interpretations of given provisions can be made, however such variations shall be consistent with Code intent or objectives and shall be approved

by the Contracting Officer. Variations shall provide equivalent or superior safety and/or reliability. If nongovernment facilities are involved, verify proposed arrangement with the applicable Code enforcing authority.

14.3 USE OF GOVERNMENT FURNISHED EQUIPMENT

Certain projects will require that design documents include provisions for accommodation of Government-Furnished Equipment either Government Installed (GFGI) or Contractor Installed (GFCI). If equipment is GFGI, electrical support to the designated equipment location is sufficient. If equipment is GFCI, documents need to stipulate where equipment will be located on site, identify any special transporting and installation requirements, in addition to designing the electrical support subsystem. A list of the electrical GFCI items plus special instructions needs to be given to Specifications Section for insertion in Section 00 73 00 "Special Contract Requirements" (typically paragraph "Government- Furnished Property"). Approximate value of the equipment shall be noted.

If equipment is Government Furnished and will be on site for Contractor installation, feeders shall be extended directly to the assembly and connected in a terminal box, wiring compartment, or control cabinet.

If the equipment will be installed later by others, extend the feeder to a junction box located adjacent to the space reserved for the particular item (tape ends of conductors or install a terminal block). Provide or verify that a disconnecting means is available within sight of the equipment location.

14.4 HARD METRIC DESIGN CONSIDERATIONS

Drawings, specification and design analysis submittals shall be provided using metric units.

- Conduits: All conduits, tubing and fittings shall be indicated on project drawings in millimeters (mm). Typical conduit metric designators are shown in Table 4 of NFPA 70. KS equivalent conduit sizing shall be specified for all projects (see attached “Wires, Cables and Conduits” Table).
- Degree Celsius: Degree Celsius (°C) shall be used as the metric equivalent of Fahrenheit (°F).
- Conductor and Conduit Size: Conductor and conduit sizes shall be in metric system. KS equivalent conductor and conduit sizing shall be specified for all projects (see attached “Wires, Cables and Conduits” Table).
- HVAC Controls: All HVAC control equipment and devices including all thermostats, meters, gauges, etc. shall be shown on plans and specifications as IP units only.
- Light Fixtures: Use hard metric fixture sizes for lay-in type when using a hard metric ceiling grid. Common fixture sizes are 600 by 600 mm and 600 by 1200 mm. The hard metric sizes do not apply to fluorescent/LED tube lengths as they are not manufactured in hard metric. The hard metric fixtures are manufactured to accommodate the 609 mm (24-inch) and 1218 mm (48-inch) length tube. Because of the tube length, some metric fixtures cannot be laid out in continuous row configurations. Designer shall verify restriction on metric fixture layouts with manufacturers. Caution shall be used to not take an older design based on inch-pound system and merely convert to hard metric because new requirements may substantially change the lighting layout.

14.5 REHABILITATION(ADD/ALTER) WORK

14.5.1 VERIFICATION OF EXISTING CONDITIONS

A field survey shall be made to obtain accurate design information. An electrical power study shall be made if necessary to determine existing system loads (Estimated Maximum Demands (EMDs). As-Built plans used for design shall be verified in the field. If as-built plans are inserted in contract documents to show removal or new work, the existing legend symbols, details, etc., shall be revised or added to as required or directed.

Accuracy of existing drawings shall be determined before beginning the design effort. Existing drawings may be included into contract documents for reference purposes ("For Information Only" drawings) if reasonably complete and accurate.

14.5.2 REUSE OF EXISTING EQUIPMENT AND MATERIALS

In the absence of specific directions for a given project, the following guidelines apply: existing wiring shall be removed and not reinstalled; incandescent luminaires shall be removed; fluorescent, LED and HID fixtures, if in good condition and energy-efficient, can be removed and reinstalled after cleaning and relamping; conduit can be reused

if verified suitable for use; reuse of safety switches, toggle switches, and duplex receptacles under 30 amps could be allowed at the option of the contractor, however if items have received 5 years of use it is preferred that new components be required.

14.5.3 DISPOSITION OF SALVAGE

Equipment and material that is to be removed and not reinstalled will become Contractor's property to be disposed off-site typically. Contract documents need to address disposition requirements. If particular items are to remain Government property, arrangements need to be spelled out (removal, delivery to a designated location, etc). Details shall be verified with Specifications Section to ensure that drawings and specification are coordinated. Certain equipment and materials shall be disposed of in accordance with specific regulations (PCB transformers, ballasts, lamps employing mercury or radioactive elements, etc).

14.6 ENVIRONMENTAL CONSIDERATIONS

14.6.1 DAMP OR WET LOCATIONS

Designers need to examine project features and areas for environments that could be classified as a wet or damp location per NEC. Areas shall be identified on the plans or adjust specification verbiage as required to identify. Most wet location equipment are UL rated for "Wet Location with Cover Closed" (i.e. passive use, de-energized, load unplugged, self-closing cover); fully rated "Wet Location" use (active use, energized, plug inserted) requires special construction. Devices which have a weatherproof cover which is not self-closing can qualify only for a "Damp Location" rating.

14.6.2 HAZARDOUS LOCATIONS

The type (Class, Group, Division) of hazardous environment applicable to specific locations shall be identified on the plans and the boundaries of the area(s) delineated.

14.6.3 ALTITUDE DERATING

Capacities of certain equipment installed in locations above 1000 meters above sea level need to be adjusted to compensate for greater tendency to overheating.
Equipment includes motors, generators, UPS, and some electronics assemblies.

Generators shall be derated for altitude (1 percent for each 100 meters or fraction thereof above 1000 feet mean sea level). Diesel-Generator sets, stationary, shall be specified in accordance with Guide Specification UFGS 26 32 15.00 10 for 100 to 2500
kW sizes and Guide Specification UFGS 26 32 14.00 10 for 15-300 kW sizes. Use the

following guidance for generator sizing:

- Industrial Facilities use 10% maximum frequency deviation and 20% maximum voltage deviation.
- Offices and General Facilities use 8% maximum frequency deviation and 15% maximum voltage deviation. Computer Facilities use 5% maximum frequency

deviation and 10% maximum voltage deviation.

These numbers are general guidelines for generator sizing. The designer shall get approval before significantly deviating from these ranges.

Motor capacity can be derated similar to the procedure used for generators or a service factor of 1.15 can be stipulated.

Derate transformers at one-half the percentage applied to generators.

14.6.4 FROST DEPTH

Refer to UFC 3-301-01, Table E-1 for a comprehensive list of frost penetrations. These values shall normally be used for design, which involves frost depth considerations. If other frost depths have been approved by local authorities or standard commercial practices in given areas, those values may be substituted, however, if the variance exceeds 25 percent in decreased depth, approval of Far East District, Electrical Design Section is required. In accordance with Utility practice in the area, lesser depths will be permitted with some restrictions. Encased duct is to be placed at 600 mm (or 24 inches) below grade, Non-encased duct can be placed at 600 mm (or 24 inches) and direct burial cable at 750 mm (or 30 inches) minimum if 200 mm (or 8 inches) of sand backfill is provided above and below (vs. 6 inches (150 mm) above, 3 inches (75 mm) below in the TM). If plowing is permitted, cable shall be placed below frost depth.

14.7 SPACE CRITERIA

14.7.1 ELECTRICAL AND TELECOMMUNICATIONS SPACE ALLOWANCE

When a project is received, the electrical designer shall review the DD Form 1391 single
gross square footage for adequate space allowances, for both the electrical utility space and communications. The Electrical Room Sizing Survey Data and EIA/TIA-569 for communications space shall be used as an aid unless more pertinent information is available. For most facilities, electrical space would suffice with min. 2% of the gross building square footage. Shortages of space allowances shall immediately be reported to the Project Manager, so the Stakeholder can be consulted as how to proceed. The spaces initially identified are for planning purposes, actual space required for the design needs to be coordinated between the architect and the electrical designer at the min. 5% stage and as the design progresses. Notify project Architects as soon as possible when electrical room and/or telecommunications rooms do not meet the proper clearances and minimum room sizes prescribed in the NEC, TIA and UFC 3-580-01.

14.7.2 EQUIPMENT ROOM

Electrical equipment shall be located in rooms or space dedicated exclusively to such equipment. Electrical designers shall coordinate with architects and other disciplines as required to ensure that an electrical equipment room (or dedicated electrical space) will be provided and be in a suitable location and of adequate size. Drawings shall

clearly identify such a reserved space. The electrical designer shall verify that adequate ventilation is available particularly when electrical apparatus is added to existing equipment rooms, placed in closets or congested electrical or mechanical equipment rooms. Locations with extensive communications facilities shall also provide a dedicated communications room unless approved otherwise.

14.7.3 EQUIPMENT CLOSET

In larger facilities closets shall be provided for step down transformers, distribution panels, communications auxiliaries, communications terminal boards, etc. The preceding provisions for equipment will be generally applicable to closets also. Space in janitors' closets and other storage rooms will generally be unacceptable because it is difficult to ensure that the code required space will remain unrestricted.

14.7.4 CLEARANCES AND ACCESS

Ensure compliance with working space requirements of NEC Article 110, including entrance requirements for high ampacity equipment.

14.7.5 EQUIPMENT PADS

In applications where floors are washed down periodically or where accidental discharge could occur, concrete "housekeeping" pads are required to be placed under switchgear and other electrical equipment. Pads shall extend 75mm to 150mm above the floor with a 25mm minimum border around the equipment. Details shall be coordinated with the structural designer. Design shall be such that operating handles of overcurrent devices and switches will be positioned a maximum of 2m above the adjacent floor.

14.7.6 DISABILITY ACCOMMODATIONS

All projects and designs will incorporate provisions of the Architectural Barriers Act (ABA)) and the Uniform Federal Accessibility Standards (UFAS) unless excluded. Electrically the primary considerations are that switches shall be installed no higher than 1350mm above the floor and receptacles no less than 400mm. Provisions pertaining to clearances will generally be accommodated by other disciplines, however electrical designers need to observe some precautions such as avoiding equipment configurations which would project into restricted clear space in corridors.

14.8 DESIGN SUBMITTAL REQUIREMENTS

This chapter entails descriptions of minimally accepted electrical and telecommunications submittal requirements for each phase of the design.

14.8.1 PARAMETRIC DESIGN

The Project Definition Design Analysis shall include all data and any calculations (if required) to support design decisions and estimates at this stage of design. The analysis shall incorporate specific criteria furnished and conference minutes of all systems considered. The design analysis shall include the following:

14.8.1.1 DESIGN ANALYSIS

DESIGN ANALYSIS NARRATIVE

Electrical and Telecommunications work shall be described to the extent necessary to identify scope, proposed configurations, and tentative sizes of major equipment such that funding costs can be verified. The narrative shall address exterior power distribution, exterior lighting, exterior communications, interior power, interior lighting, emergency power, lightning protection risk analysis, grounding, communication systems, and any specialty equipment to be included in the project. General statements of intent are acceptable for conventional applications or standard practices (Examples: "Illumination in parking lots of 0.2 foot-candle horizontal average per UFC 3-530-01 will be achieved using fully shielded 100W LED cobra head luminaires. Receptacle configurations will consist of conventional 20A duplex outlets throughout dwelling units, to be spaced so that no point measured horizontally is more than 1.8m (6ft) from a receptacle per NEC.") Designers' intentions relative to special requirements or unique design features shall be defined in greater depth. Such areas might involve 400 Hz power, hazardous environments, security lighting, intrusion detection, UPS equipment, single point grounding, TEMPEST vaults, filtered power lines, EMCS, surge protection, seismic treatment, etc.

14.8.2 CONCEPT DESIGN

The Concept Design shall incorporate specific criteria furnished and conference minutes of all systems considered. It shall also include the requirements from the Parametric Design, as well as those requirements stated below:

14.8.2.1 DRAWINGS

GENERAL

- Provide a legend and abbreviations sheet indicating symbols used in the drawings and their corresponding designation.
- Typical details planned to be used in the project shall be provided for early evaluation.
- A preliminary riser and/or one-line diagram shall be included.

EXTERIOR ELECTRICAL

- Existing and new electrical primary and secondary lines both overhead and underground shall be properly identified.
- Show removals and relocations, if any. If extensive, provide separate demolition/relocation drawing(s).
- Indicate electrical characteristics of all items as much as possible; include voltage, phase, size, and kVA.
- Show new routing of feeders, special grounding requirements and locations of new transformers, manholes and handholes.
- Typical layout of exterior lighting system with the pole and fixture type indicated.
- For extensive exterior electrical work, provide a site one-line diagram.

INTERIOR ELECTRICAL

- Typical lighting layout of each different type of interior illumination. An office,

corridor, stairwell, utility room, bedroom and laundry room are considered typical examples of different types of illumination and one or more layouts shall be provided for each condition. The type of fixture shall be indicated on the drawing.
- Show the service and the main electrical service equipment and their ratings.
- Show the location of all major pieces of electrical equipment such as panelboards, switchgear, switchboard, substations, large motor driven items, shop machinery, kitchen equipment, etc.
- Show the proposed riser diagram. Sizes of all conduit, wires, cables, panels, etc., need not be included, except for the main service feeder. Where the electrical configuration cannot be adequately explained on a power riser diagram, a complete one-line diagram will be provided.
- Provide receptacle layout for several different areas to indicate project requirements.

EXTERIOR TELECOMMUNICATIONS

- Existing and new telecommunications service lines, both overhead and underground, and manholes/handholes shall be clearly identified on a separate telecommunications site plan or as part of the electrical site plan(s) if telecommunications work is not extensive.
- Any removals and relocations shall be shown. If removals/relocations are extensive, demolition plan(s) are required as separate drawings.

INTERIOR TELECOMMUNICATIONS

- Show on floor plans the location of all telecommunication equipment racks, panels, and possibly cable runway routing for early discipline conflict coordination.
- Show the proposed riser diagrams for all systems.
- It may be necessary for the designer to provide a recommended layout for telephone, data, CATV, ESS and other telecommunication systems on floor plan at this stage.

14.8.2.2 SPECIFICATIONS

SPECIFICATIONS LIST

Provide a list of specifications to be used in the project, indicating the specification number and specification name as shown in the FED Guide Specifications.

14.8.2.3 DESIGN ANALYSIS

DESIGN ANALYSIS NARRATIVE

Narrative shall be well established at this point, relative to scope and intended design approaches. The total scope projected to final design shall be briefly outlined in a form that could be conveniently adapted, expanded, and detailed at the final design stages. The basis of significant design selections shall be explained or summarized as applicable. If alternatives were to be evaluated/selected by the designer, conclusions shall be included; if final decisions were to be deferred to future conferences or reviews, report the findings (pros and cons) of the evaluation. Any additional criteria, deviations concerning criteria, questions or problems shall be identified and listed.

DESIGN ANALYSIS APPENDIX

Include datasheets of proposed luminaires, panelboards, transformers and any relevant electrical and telecommunications equipment for early evaluation. Calculations are generally unnecessary other than rough calculations to determine tentative sizes of major cost items such as a load study based off the building area for sizing main building transformer; as required to execute specifically tasked studies; and as required to determine particular design selections such as Life Cycle Cost Analysis (LCCA) for a specific system.

14.8.3 PRELIMINARY DESIGN

The Preliminary Design shall incorporate specific criteria furnished and conference minutes of all systems considered. It shall also include the requirements listed for the previous stages of design as well as those requirements stated below:

14.8.3.1 DRAWINGS

GENERAL

- Symbols and descriptions on the legend and abbreviations sheet shall be close to final and shall match what is shown on the plans including lighting fixture and equipment connection tags.
- Congested areas where there can be interference with various electrical systems, cable trays, piping, ducts, etc., shall be thoroughly detailed by expanded scale drawings.
- Chosen systems, equipment, and items used in the project shall be thoroughly detailed on the detail sheets, including dimensions, salient characteristics, and any related notes.
- Riser and/or one-line diagrams shall be essentially complete except for finalization of conduit and wire sizes.
- Circuiting and routing shall be shown. Provide front elevation for free-standing equipment.
- Include pertinent notes for clarification and/or addition of construction requirements.

EXTERIOR ELECTRICAL

- All exterior electrical work shall be completely and accurately shown on the plans with corresponding details included in the detail sheets.
- Show all exterior electrical connections required for exterior equipment.
- Site lighting layout shall correspond to the calculated layout meeting the minimum UFC lighting level requirements.
- Lightning protection and grounding plans and details shall be included.

INTERIOR ELECTRICAL

- Power riser or one-line diagram shall be essentially complete except for finalization of conduit and wire sizes.
- Panelboards, motor control centers, switchgear equipment and all utilization equipment to include VFD's, fused and unfused safety switches, motor starters for HVAC equipment shall be located with schedules and physical layout

arrangement shown on drawings.
- Provide front elevation for free-standing equipment.
- Lighting fixtures, lighting controls, receptacles, and mechanical connections shall be shown.
- A completed lighting fixture schedule shall be included on the drawings.
- Before submittal, drawings shall be thoroughly checked by the designer for discrepancies and conflicts, particularly as related between disciples and various systems.

EXTERIOR TELECOMMUNICATIONS

- Locations of telecommunication lines, handholes and manholes on the site plan(s) shall be close to final. Removals and relocations shall be complete at this stage.
- Thoroughly check for discrepancies and conflicts, particularly between disciplines.

INTERIOR TELECOMMUNICATIONS

- Provide riser diagrams for intrusion detection system, public address system, CATV, telephone system, etc. Risers shall show the location of the various components and interconnections with other systems.
- Show location of all devices and equipment for electronic systems on the floor plans. Show location of devices to be interconnected. Location of all devices shall conform to NFPA 72 and UFC-3-600-01 and Architectural Barriers Act/ ABA.
- Show cable runway and protective distribution system (PDS) routing.
- Provide details of telephone outlets, telephone backboard arrangement, and other items required by criteria or comment.

14.8.3.2 SPECIFICATIONS

Read Thoroughly And Comply With The Instructions In Front Of Each Set Of Guide Specifications, Including Notes To Specification Writer.

- Cross out not applicable index items, publications, paragraphs, phrases, words, and sentences. Fill in blanks as applicable.
- Add publication references, paragraphs, phrases, words, and sentences for items not adequately covered by specifications.
- Do not specify proprietary items unless approved.
- Ascertain that major or special types of equipment are available commercially in the local project area.
- For a design whose demand load is 500 kVA and above, or is for a processing system that would be undesirable for the system to cease functioning, the specifications shall require the construction contractor to provide a system short circuit study, coordination curves and arc flash study including arc flash stickers for the equipment.
- If the design is predominately exterior overhead or underground with a small amount of information required that is contained in the interior electrical

specification, the design specifications may include excerpts from the interior specifications in either the overhead or underground specifications. This procedure shall have prior approval.

14.8.3.3 DESIGN ANALYSIS

DESIGN ANALYSIS NARRATIVE

This stage of Design Analysis shall be an entirely updated analysis (not amendments to concept submittal) to permit verification that the design complies with the criteria furnished and the approved Concept Design. Any additional criteria, deviations concerning criteria, questions or problems shall be listed here.

DESIGN ANALYSIS APPENDIX

At this stage, electrical and telecom design calculations shall be thoroughly documented. Include all datasheets of electrical and telecommunications equipment used for the calculations.

Seismic protection calculations may be performed by a registered US engineer, or by a American 1st Class Qualified Architect.

14.8.4 FINAL DESIGN

The Final Design shall incorporate specific criteria furnished and conference minutes of all systems considered and shall essentially be complete. It shall also include the requirements listed for the previous stages of design as well as the requirements stated below:

14.8.4.1 DRAWINGS

GENERAL

- All details for final package shall be on the drawings (pole details, fixture details, etc.).
- Complete all circuiting.
- Complete all schedules including panel schedules.
- Thoroughly check the drawings for discrepancies, for compatibility between drawings and specifications, and for compatibility between disciplines.
- All HVAC equipment motor starters, VFD 's, safety switches, fusible disconnects, disconnecting means physical locations shall be shown on drawings.
- All HVAC equipment motor starters, VFD's, safety switches, fusible disconnects, etc., shall have all pertinent information shown on drawings at each device location or on a separate table, or special index on the drawings. Minimum information required for motor starters is NEMA Enclosure Type, Type motor starter, Contactor NEMA Rating, #of Poles, Voltage, Enclosure Amp Rating if applicable, Fuse sizes, etc., as they apply to the design and drawings.

14.8.4.2 SPECIFICATIONS

Final specifications shall incorporate all previous comments and provide all information previously required by early percentages.

14.8.4.3 DESIGN ANALYSIS

DESIGN ANALYSIS NARRATIVE AND APPENDIX

This analysis is an extension of the previous approved design analysis and shall contain all the information required by previous design analysis descriptions. This design analysis shall support and verify that the design complies with the requirements of the project. All final calculations are to be included.

14.8.5 READY-TO-ADVERTISE – RTA

The comments generated during the Final Review shall be incorporated into the completed specifications and drawings before they are submitted as Ready-to-Advertise. The analysis typically is not republished at this time, but changes shall be made and place in the project folder e.g. calculations which were required to be updated. The drawings and specifications shall be complete and thoroughly checked.

14.9 DESIGN CALCULATIONS AND POWER SYSTEMS ANALYSIS

An analysis of the distribution system shall be performed in every design. In some applications a cursory analysis will be adequate, while others will require an extensive exercise. Power system analysis shall be performed on new portions of the distribution system and generally include the first upstream device on the existing portion of the system, at a minimum. If the results of the evaluation show that the existing configuration would need to be adjusted or individual components replaced, coordinate with the local installation and Far East District for approval.

14.9.1 LIFE CYCLE COST ANALYISIS (LCCA)

At the beginning of the project, the electrical designer shall conduct market research for electrical features that can enhance the performance of the electrical system, while saving project cost, maintenance cost, and energy cost considering local markets and standard practices in Korea. Any electrical feature that deviates from the prescribed systems in the UFC shall be evaluated and have LCCA included in the Design Analysis. See Chapter 12 for Life Cycle Cost Analysis methodology and documentation.

14.9.2 LIGHTNING PROTECTION RISK ANALYSIS

A lightning protection risk analysis shall be conducted to assess if the project building/structure will require lightning protection. Lightning protection analysis shall consider the average flash density at the project location, building dimensions, and surrounding structures that could affect the analysis. Comply with NFPA 780 guidelines as a minimum.

14.9.3 GROUNDING

Determination of the grounding system shall be calculated based off the Military Handbook MIL-HDBK-419A for Grounding, Bonding, and Shielding for Electronic Equipment and Facilities, and the NEC as a minimum. Soil resistivity of the project site shall be acquired either through the site survey report or historical data from a

credible source. Spacing between ground rods shall be at least double the length of the ground rod. Use copper for all grounding items, utilizing exothermically bonding by cadweld or acceptable alternative for bonding. Provide grounding test wells at the four farthest corners of the building as a minimum. Refer to ANSI_TIA-607 for Telecommunications Bonding and Grounding.

14.9.4 LIGHTING

In the design analysis, provide a table listing of all rooms, spaces, and areas in the project; as well as their corresponding room classification per ASHRAE 90.1, ceiling heights, fixture mounting heights, targeted illumination heights, fixture types used, power consumption per fixture, quantity of fixtures and target uniformity and illumination levels per UFC and IES. Computations may be done manually or by computer assisted techniques. The method used shall be identified by including computation forms or by including printouts plus an explanation of the method used. Complete calculations for each room/area shall be included in the Design Analysis. Input data and results shall be summarized in a recap form for all cases when the project has more than five rooms/areas. Calculations shall be adjusted to compensate for special applications -- irregularly shaped rooms, open sides, ceiling obstructions (beams, ductwork), corridors, etc.

14.9.4.1 EXTERIOR LIGHTING

Exterior calculations will typically require the use of a computer program in order to obtain the point-to-point values. Small exterior lighting projects with just a parking lot and/or short section of street can use templates for deriving the spacing of light poles. If submitting for light pollution LEED credit, provide exterior lighting calculations demonstrating compliance with light trespass and pollution requirements within the project LEED boundary.

14.9.4.2 INTERIOR LIGHTING

It is recommended that computations be based on the simple lumen method using coefficients of utilization corresponding to 70 percent ceiling, 50 percent wall and 20 percent floor reflectance factors in office type applications (white suspended ceilings and light colored unobstructed walls). Consider 50 percent/30 percent factors for applications with CMU (concrete masonry unit) walls, dark colors, irregular surfaces and/or structural obstructions. A maintenance factor of 0.7 shall be used for the typical application (this value shall be adjusted for non-typical applications - 0.75 or 0.8 for a well maintained office or lab with a filtered air supply, 0.65 for a mechanical room with minimal maintenance). If the lumen method is used for corridor calculations, the calculations shall be performed using a module in which the length does not exceed 3 times the width (2:1 ratio referred).

14.9.4.3 14.9.4.3 EMERGENCY LIGHTING

Provide emergency lighting calculations simulating the lighting levels on the path of egress during an emergency situation. Emergency lighting illumination shall meet NFPA 101.

14.9.4.4 DAYLIGHTING

Coordinate with the project architects for locations and dimensions of windows, skylights, and regularly occupied spaces as defined in the project. Daylighting simulations shall be calculated in compliance with UFC 1-200-02 for ASHRAE requirements and calculated in accordance with the selected third party certification rating tool. Method of calculation can either be the (1) Spatial Daylight Autonomy method or the (2) Illuminance Calculations as described in UFC 1-200-02 and elected third party certification green rating tool.

14.9.4.5 LIGHTING ENERGY CONSUMPTION

Include a lighting energy consumption calculation, which entails all designed exterior and interior lighting fixtures' total power consumption and how it compares to the ASHRAE 90.1 and IgCC baselines calculated for the project. State any assumptions made and the room/space classification used to determine the watts/sf selection from the ASHAE 90.1 baseline tables. For determining the exterior lighting baseline consumption, use a per fixture count method using HID lamps (i.e. if project is being designed for 10 exterior LED pole lights, use 10 exterior HID pole lights as the baseline for the exterior lighting energy consumption). Total designed lighting energy consumption shall be 30% less than the calculated baseline energy consumption from the AHRAE tables for the whole project.

14.9.5 TRANSFORMER SIZING

Document how transformer sizes were determined for the project, showing connected load, demand load, and diversity factor according to UFC 3-501-01.

14.9.6 VOLTAGE DROP

Calculations shall be in accordance with the NEC and applicable IEEE guidelines. Interpolation and projection techniques may be used (i.e., a calculation for a 35 meter feeder to a 225A panel would not be necessary if a calculation for a 40 meter feeder to a 225A panel had already been performed). Calculations shall be sufficient to encompass the application range of the project.

14.9.6.1 PRIMARY – OVER 600 VOLTS

Distribution system design for voltages over 600 volts shall be based on a maximum of 2% voltage drop.

14.9.6.2 SECONDARY – OVER 600 VOLTS OR LESS

Distribution and branch circuit system design shall be based on a maximum of 5% voltage drop from the transformer to the utilization equipment. This shall be split such that there will be 2% or less voltage drop from the transformer (service drop, service entrance, etc.) to the branch circuit panelboard (proportioned most economically between the service and feeder conductors) and 3% voltage drop or more on branch circuits.

14.9.7 SHORT CIRCUIT ANALYSIS

It is the designer's responsibility to ensure that the distribution system is adequately protected against the effects of short circuits by specifying components with adequate

short circuit ratings and/or specifying protective devices or components that will reduce fault current levels or durations. The minimum acceptable short circuit ratings shall be shown on the plans. Higher rated equipment shall be specified if any of the following conditions apply: if data on available fault current is questionable, if utility substation or line capacity is projected to increase, or if calculated fault values fall near a standard equipment rating.

The designer shall be aware when calculating let-through current on transformers that the transformer impedances used shall be in compliance with DOE 10 CFR Part 431, Subpart K. Low-voltage, dry type transformers manufactured on or after January 1, 2007 and liquid-immersed distribution transformer manufactured on or after January 1, 2010 shall be manufactured to conform with the efficiencies specified in DOE 10 CFR Part 431, Subpart K. These increased efficiency levels will result in lower transformer impedances which will result in higher let through currents on the transformer secondaries. Reference UFGS Specification 26 12 19.10 (Designer Notes on last page of specification) for typical impedances.

14.9.7.1 BASIC REQUIREMENT

Maximum theoretical fault current levels based on infinite bus conditions shall be determined for all projects if enough information on the installed equipment is available. Otherwise, a simple Point to Point Approach shall suffice during design. Additionally, more specific analysis shall be performed in most projects to determine whether equipment ratings can be reduced from infinite bus ratings to reduce cost while maintaining conservative protective margins. This approach will require obtaining actual available short circuit information. This approach shall only be used if approved by the Far East District, Electrical Design Section. The analysis by the designer shall be in the form of a reference or baseline model with design values (ratings, settings, sizes, as

applicable) to be confirmed and refined by a more extensive Construction Contractor analysis based on specific characteristics of the equipment actually selected.

14.9.7.2 EXTENT OF ANALYSIS

- Low Fault-Levels. If the fault level (at the service transformer secondary) is 14,000 A.I.C. (Amps Interrupting Capacity) or less for 480 V systems and 10,000 A.I.C. or less for 208 V systems, a simple analysis can be provided.
- High Fault-Levels. If the theoretical fault levels would exceed 50,000 A.I.C., an extensive analysis shall be performed based on actual fault current levels available upstream of the service transformer.
- Computerized analysis using software such as EasyPower is preferred. The evaluation shall continue downstream and system/equipment modifications shall be implemented until calculated fault levels are attenuated to 14,000
- A.I.C. or less for 480 V systems, 10,000 A.I.C. or less for 208 V systems.
- Intermediate Fault-Levels. Unless other direction has been given, the type and extent of analysis and documentation in the 14,000 to 65,000 A.I.C. range shall be required. Factors which would recommend an extensive analysis include: available fault levels considerably lower than infinite bus values (and no future

utility substation expansion planned), large facilities with a considerable amount of expensive switchgear, considerable economic savings by specifying equipment with S.C. ratings lower than the infinite bus level.

14.9.7.3 CALCULATION PROCEDURES

Use guidelines of IEEE publications (ANSI/IEEE 242, etc.) to the extent applicable. Comprehensive systems type calculations shall show maximum three phase, phase-to phase, and phase-to-ground fault currents throughout the system. Phase-to-phase-to-ground data is recommended, but not mandatory. Available fault current levels shall be obtained from or verified with the installation or local utility company as applicable.

14.9.8 INTERRUPTING RATINGS

Equipment ratings shall be determined based on results of the above analysis. Minimum standard interrupting ratings shall be identified on the plans, preferably on a one-line diagram or alternatively in panel schedules. Ratings may be called out in the specifications when single items are involved. The designer shall identify variables (such as equipment impedances) which could affect available short circuit current and verify that equipment acceptable under contract plans and specifications would not permit fault current levels higher than the specified interrupting ratings. If not adequate as is, increase specified ratings, increase the minimum acceptable impedance values where stated, and/or insert minimum values where none have been stated.

14.9.9 PROTECTIVE COORDINATION ANALYSIS

The proposed electrical distribution design shall be analyzed to determine the most advantageous locations, sizes, settings for overcurrent devices, relays, ground fault equipment, etc. as applicable. The designer shall strive to determine an optimum arrangement that would minimize the amount of nuisance or multiple tripping, limit

outages to the shortest duration, and impact the smallest areas practicable. Selection of device types and sizes shall be evaluated to best achieve a well-coordinated arrangement. Generic or sample requirements shall be defined by the designer.
Designer shall have the construction contractor recreate, complete, or verify, the theoretical or baseline configuration by performing a short circuit and coordination study based on the specific electrical and mechanical equipment proposed. If connection is made to, or will affect, existing installations, the scope of the evaluation shall include the existing system or equipment. (An extensive analysis and formatted presentation will not be necessary for smaller applications having simple basic configurations and standard features (example: single 600A, radial service using non-adjustable molded case circuit breakers); however, sufficient investigation and calculations shall be performed to determine available fault current and/or verify adequacy of equipment ratings relative to infinite bus values.) System coordination and design analysis may be performed by a Korean engineer with qualifications equivalent or equal to the requirements of US engineers.

14.9.10 ARC FLASH ANALYSIS

The electrical distribution system shall be designed to minimize exposure of electrical workers to Arc Flash hazards. Arc Flash Analysis shall be conducted to determine the

best electrical distribution layout that will result in low Arc Flash levels for electrical equipment, while still providing for a well-coordinated electrical system. Designer shall have the construction contractor verify, calculate and create the arc flash analysis based off actual attributes of the installed equipment. Provide Arc Flash labels per UFC 3-560-01.

14.10 EXTERIOR ELECTRICAL DESIGN

14.10.1 EXTERIOR SYSTEM VOLTAGE SELECTION – MEDIUM VOLTAGE

14.10.1.1 MEDIUM VOLTAGE DISTRIBUTION

Typical medium voltage distribution in Korea is 22.9 kV and 13.8 kV for new projects. 6.6 kV rated cables and related accessories (except surge arresters which shall be sized to the lower system voltage) to allow for future conversion to the higher rated voltage level with minimum inconvenience and cost. Typical medium voltage distribution in old army and air force camp is 13.8 kV. Specify 15kV rated system for 13.8kV distribution systems. Typical 22.9kV Medium voltage cables shall be tested using the High Direct Current Voltage (HDCV) method per IEEE400.1, using an engineer from the Korea Electrical Safety Inspection Association. Very Low Frequency (VLF) testing of medium voltage cable shall not be required. Medium voltage cable splices and terminations shall be performed by qualified personnel certified by the National Cable Splicing Certification Board (NCSCB) or by personnel certified as Qualification for High Voltage Electric Work Handling Engineer in Korea. Contract drawing designation for transformers typically omit the delta symbol, but the “Y” shall be retained in all cases.

LOW VOLTAGE DISTRIBUTION

- **Phase Configuration (Three-Phase vs. Single-Phase)**: Three-phase power shall be standard practice. Single-phase service shall be limited to housing and similar low demand applications unless specifically directed otherwise.
- **Voltage Configuration**: The designer shall choose the electrical system voltages to be utilized in the project based off locally available equipment voltages, base engineers preference and Stakeholder needs at the earliest stage of design as possible. By the Concept Design stage, the electrical system voltages to be used in the project shall be finalized. Ensure that products selected are readily available in the market by providing manufacturer cutsheets reflecting the selected voltages. Typical Korea three phase mechanical equipment run at 380 V and/or 220 V. Consider using typical Korea three phase 380 V and/or single phase 220 V exterior oil-filled transformers for these applications if possible. The 208Y/120 V and/or 480Y/ 277 V system could be considered to serve US materials when required.

14.10.2 OVERHEAD DISTRIBUTION

Overhead Distribution Lines – Medium Voltage: Design per UFC 3-550-01, Section 3-10 “Overhead Power Distribution”.

14.10.3 UNDERGROUND CONSTRUCTION

14.10.3.1 UNDERGROUND DISTRIBUTION LINES-MEDIUM VOLTAGE

Design shall be based on ANSI C2 (the National Electrical Safety Code), UFC 3-550-01, and UFGS 33 71 02. Primary cable shall normally be installed in concrete-encased duct banks or rigid steel (heavy wall) conduits. Direct burial is not acceptable for primary cable installation unless so directed in writing. Splices shall be made per UFC 3-550-01, Section 3-11.5. Underground lines shall be routed to avoid crossing under paved surfaces, buildings, or other structures whenever possible.

14.10.3.2 CABLE CONFIGURATION

Use of ethylene propylene insulation is preferred where long life is a consideration or where electrical characteristics are more significant than physical durability. Cross-linked polyethylene insulation with option of polyvinyl or polyethylene jacket is preferred for other applications. Shielded construction shall be standard.

14.10.3.3 CABLE ACCESSORIES

Components shall be as indicated in UFGS 33 71 02. Potheads shall not be specified to the exclusion of other type of terminations. Termination kits will be specified instead of potheads. Cable taps shall be made using primary junction boxes, preformed junction assemblies, or modular splice assemblies similar to G & W's Universal Splice.

14.10.3.4 CONDUCTOR SIZING

For Air Force, size new primary conductor to carry existing and projected future loads with the circuit capacity. Specify 15 KV rated system for 13.8 kV distribution.
Design documents shall permit the use of single conductor cable rather than being restricted to the multi-conductor construction. KS equivalent conductor sizing shall be specified for all projects.

14.10.4 DUCT BANKS

14.10.4.1 REINFORCED CONCRETE APPLICATIONS

Reinforced concrete encased duct banks are required under aircraft pavement, railroads, or paving subject to frequent heavy equipment use. Where reinforced concrete is required, it shall be so designated on the drawings.

14.10.4.2 MANHOLES, HANDHOLES, AND PULL BOXES

Korean precast concrete manholes and handholes shall be specified wherever possible. They shall not be held to the AC1318M/ACI SP-66 standard, since it is only applicable to US made products.

14.10.4.3 DUCT INTERFACING

Duct shall enter manholes perpendicular to the wall or within 30 degrees.

14.10.4.4 SPACING

Manholes shall be spaced at intervals not exceeding 150 meters for straight runs. Recommended spacing shall not exceed 90 meters with 45 degrees maximum bend, 60 meters for 90 degrees maximum, 45 meters for 135 degrees, 30 meters for 180 degrees. Vertical bends into equipment pads shall be counted in determining the total

bend. Provide an analysis with calculations and pulling criteria if these limits are exceeded.

14.10.5 DIRECT BURIAL – LOW VOLTAGE

Direct burial can be considered for feeders to isolated equipment such as pumps, for service to lighting in remote uncongested areas, and similar applications. For direct buried installations, verify the frost depth applicable to the particular project area. Note that ANSI C2 (Section 353D2b) recommends cable installation below frost depth in areas where frost could damage cable. Preferred practice for Far East District applications is to install direct burial cable in trenches at 750 mm minimum below grade, duct at 600 mm, with 200 mm sand backfill above and below; if plowing is used, cable shall be placed below frost depth.

14.10.6 INSTALLATION – LOW VOLTAGE

Conduit shall be employed for low voltage wiring extended under hard surfaced parking lots, sidewalks, driveways, ramps, and other paving. The secondary from service transformers is to be in duct unless direct burial has been specifically requested. Conduit shall also be used for secondary lines in congested areas with other utilities.

14.10.7 EXTERIOR TRANSFORMERS AND EQUIPMENT

14.10.7.1 MEDIUM VOLTAGE DISTRIBUTION EQUIPMENT

Refer to UFC 3-550-01, UFGS 26 11 14.00 10, 33 71 01, and 33 71 02 as applicable.

- Pole Mounted Switches, Sectionalizers, and Miscellaneous Equipment: Feeder and distribution system sectionalizing shall be provided by using gang-operated, load-break/interrupting switches in lieu of fused cutouts. Power factor correction capacitors, fixed and/or switched, shall be provided.
- Pad Mounted Switchgear: Above grade locations are preferred for switching functions. Switches shall be live front air-break type.
- Below Grade Assemblies: Below grade equipment shall be suitable for wet location use. Switches shall be dead front vacuum type.
- Interior Applications – Indoor Medium Voltage Transformers: Medium voltage transformers installed indoors shall be dry type, epoxy-encapsulated type, or be installed in fire resistive vaults with curbed liquid containment structures. Installation shall conform to provisions of NEC and UFC-3-600-01.

Equipment testing shall be performed in accordance with NETA ATS standard, or by personnel certified by the Electrical Safety Inspection Association of Korean.

14.10.7.2 MEDIUM VOLTAGE TRANSFORMERS AND SUBSTATIONS

In selecting transformers, the designer shall utilize standard voltage and connections as much as possible. The primary and secondary arrangements considered standard by manufacturers will depend on the application (i.e., overhead vs underground, single phase vs three phase, dry type vs oil filled, power vs distribution class, etc.). Refer to ANSI Std. C84.1, "Voltage Ratings for Electric Power Systems and Equipment," and C57.12.00, C57.12.21, C57.12.25, or C57.12.26 as applicable. Transformer shall be Korean cubicle type.

Ensure that the step down transformer KVA rating is consistent with the US transformer standard KVA rating as the following:

Table 28: Transformer Phase Voltage Requirements

PHASE	KVA
SINGLE PHASE	10, 20, 30, 50, 75, 100, 150, 200, 300, 500
THREE PHASE	10, 20, 30, 50, 75, 100, 150, 200, 300, 500, 750, 1000, 1500, 2000

- Secondary Unit Substation (Load-Center Transformer): See UFGS 33 71 02 and UFC 3-550-01.
- Pole Mounted: Aerial type transformers shall be provided in areas where a ground-mounted installation would not be suitable. They may also be used in remote applications where existing practice is overhead construction. Transformers shall be Distribution Transformer Type I mineral-oil insulated. Transformer banks of 300 kVA or less shall be radial or cluster-mounted on a single pole. Transformer banks of more than 300 kVA shall be platform-mounted. Pole mounted transformers shall be cluster mounted.
- Pad Mounted: The pad-mounted compartmental-type shall comply with (ANSI C57.12.21 single phase live front), (ANSI C57.12.21 three-phase live front), (ANSI C57.12.25 single phase dead front), and (ANSI C57.12.26 three phase dead front).
- Transformer Sizing – Oil Insulated: For oil immersed, self-cooled, "exposed to the weather" applications, the kVA (kilovolt-ampere) rating of transformers may be computed conservatively using 100 percent of the calculated, diversified Estimated Maximum Demand (EMD) or more economically by allowing temporary overloading per the method of the following subparagraphs. The conservative approach shall be followed for applications involving 40 degree C or over ambient, peak loads lasting more than 8 hours, existing facilities where accurate load data can't be obtained or is of questionable accuracy, or new facilities where future loading can't be predicted with confidence. The economical approach incorporating short-term overload is preferred where design life of the facility is under 15 years. The more economical sizing approach could also be used if temperature monitoring and relaying is specified to either shut down the transformer, activate alarms, or energize forced air cooling whenever loading exceeds tolerable levels.

Transformer Location

Transformers of the mineral oil insulated or low flammability ("non-flammable", "less flammable liquid-filled") type shall be located per UFC 3-600-1, Sec 4-40.5.4.5. In addition to fire safety reasons, transformer locations on DoD installations are also restricted by antiterrorism/force protection considerations, as described in UFC 4-010-01.

14.10.7.3 AUXILIARY POWER SUPPLIES

14.10.7.4 POWER SOURCES – NORMAL AND EMERGENCY

Recommended references are IEEE 446 "Emergency and Standby Power for Industrial and Commercial Applications" (Orange Book) and IEEE 141 "Electric Power Distribution for Industrial Plants" (Red Book).

14.10.7.5 UTILITY POWER

Available capacity and power quality of the normal source shall be verified, if information has not been furnished in the project criteria package. In most projects on military complexes, the existing distribution system has capacity and is sufficiently reliable for administrative type functions. Designers can select and detail a proposed interface and address specific aspects in the Design Analysis for Stakeholder review and comment. In other projects investigation and coordination will be necessary.

14.10.7.6 GENERATORS – PRIME POWER AND STANDBY

Refer to application notes in UFGS 26 32 14.00 10 and 26 32 15.00 10. Note that various manufacturers will offer the same basic engine-generator package in both standby and prime power versions. The prime power set will carry a lower kW output rating because of the continuous physical demands, heating effects, reduction in life, etc. The standby unit is rated for a higher output since use is occasional allowing heat dissipation, less overall stress to insulation, and longer life. If a standby unit is intended to support frequent, drastic load shifts (no load to 100 percent), the transient performance and testing standards required shall be more stringent.

- Direct Current Systems: A battery inverter arrangement shall be used instead of a battery system using a centrally located battery bank and a DC distribution system.
- Battery Supplies: Provide for Uninterruptible Power Supply (UPS) installations per UFGS 26 32 33.00 20 or 26 32 33.00 10, as applicable. An UPS installation may also be required for powering control circuits, and other sources such as UPS, EPS, or generators will not be provided or would not be available when needed.
- Local AC/DC Inverters: In military projects, use of standard units is recommended. (Examples: The B-8 and B-9 rectifier will operate with 480V or 240V 3-phase input and deliver 200A or 400A respectively at 28V.)

14.10.7.7 MEDICAL FACILITY APPLICATION

Refer to IEEE 602 "Electric Power Systems in Health Care Facilities" (White Book) and UFC 4-510-01 hospitals.

14.10.7.8 UNINTERRUPTIBLE AND GROUNDING DESIGN

14.10.7.8.1 SYSTEM PROTECTION – MEDIUM VOLTAGE

14.10.7.8.2 MEDIUM VOLTAGE – OVERVOLTAGE PROTECTION

The preferred arrestor arrangement is distribution class "MOV" surge arresters at pad-mounted transformers and intermediate class surge arresters on all overhead to underground transition poles. Arrestor sizes are to be shown on plans.

14.10.7.8.3 MEDIUM VOLTAGE – OVERCURRENT PROTECTION

Fuse cutouts are sufficient at overhead transformers. Drywell type current limiting fuses are preferred for most pad mount transformer installations. Use power fuses in switchgear - size and type per protective coordination analysis.

14.10.7.8.4 MEDIUM VOLTAGE – FERRORESONANCE CONSIDERATIONS

Ferroresonance conditions result in sustained overvoltages being imposed on distribution components which will suffer shortened life or complete failure. The more severe damage will occur to transformers and metal oxide arresters (silicon carbide arresters can sustain longer durations.) The probability of the phenomenon occurring increases proportionate to the extent the following factors are present: single phase switching or overcurrent device operation, delta primary transformer, long length of underground primary cable (or as short as 90 meters (or 300 feet) if other factors are present), a comparatively high voltage primary line serving a relatively small transformer, an unloaded or lightly loaded secondary. Mitigating measures include use of grounded wye primary lines and transformers, ganged switching and overcurrent equipment, switching at the transformer instead of upstream poles, and switching with transformer loaded.

14.10.8 SERVICE ENTRACE FEEDER AND ENTRANCE EQUIPMENT

14.10.8.1 SERVICE ENTRANCE FEEDER CONFIGURATION

- Overhead Secondary: Overhead services may be considered for use in industrial-type areas where appearance is not a significant factor, existing service is overhead, and where cost considerations are critical. Conductor size shall be based on the building estimated maximum demand (EMD) and the NEC Table, column entitled "Bare and Covered Conductors." The conductor coverings shall be left to the options shown in UFGS 33 71 01 for Service Drops, except that messenger (neutral) supported conductors shall be used in lieu of open wire on secondary racks.
- Underground Secondary: Underground services from a pad mounted transformer shall be used for the typical project. Conductor size shall be based on the building estimated maximum demand (EMD). Type USE or equivalent EPR or XLPE cable with outer covering shall be specified.

14.10.8.2 SERVICE DISCONNECTING PROVISIONS

Location: Service equipment shall be located in rooms or space dedicated exclusively to electrical equipment (see paragraph "Equipment Rooms"). Service entrance equipment shall be readily accessible and be located as near as practical to the point of entrance of the main service feeder per NEC.

14.10.8.3 LIFE SAFETY AUXILIARIES

Unless other direction is provided for a specific project, the normal power supply for emergency systems shall be via a dedicated feeder that would not be subject to power interruption from switching actions or faults occurring within the facility external to the emergency system components. When a tap is made upstream of the facility main disconnecting means, the 10 and 25 foot tap rule requirements of NEC shall be met.

Provide current limiting fuses in the disconnect.

14.10.8.4 POWER METERING

- Primary Metering: Primary metering may be advantageous at project boundaries if an entire complex is to be served. Provide support structures, current and voltage transformers, and meter housing. Many utilities will provide the meter head or require approval of a Stakeholder-supplied unit. Verify details with the specific utility.
- Secondary Metering: Preferred location is the service switchboard located in the electrical equipment room. Coordinate meter location with Stakeholder. Comply with IgCC submetering requirements as required by the Stakeholder.
- EMCS Provisions: Unless other direction is provided, furnish contacts for EMCS/UMCS interfaces. See UFGS 26 20 00.

14.10.9 CYBERSECURITY

Cybersecurity shall be implemented to all project designs with features related to industrial control systems such as Energy Management and Control Systems (EMCS), Utility Monitoring and Control Systems (UMCS), Electronic Security Systems (ESS), Building Automation Systems (BAS), Supervisory Control and Data Acquisition (SCADA) systems, and similar control systems that utilize industry standards such as BACnet, LonWorks or Internet Protocol (IP). Control system designer shall follow UFC 4-010-06 Cybersecurity of Facility Related Control Systems criteria.

14.10.10 CONDUCTOR AND CONDUIT TYPES

Coordinate with base electrical engineers on required conductor and conduit types specific to their installation. Korean conduit shall be specified wherever possible. Set screw type fittings for EMT shall be acceptable Ensure that conductors and conduit sizes are specified in hard metric and with Korean standard sizes. If installation-specific requirements are not specified, apply the following or refer to UFC requirements as a minimum:

14.10.10.1 CONDUCTORS

For low voltage, 600 volts and below: EM-IE type with the appropriate rating For high voltage, 6.6 kV or higher: EM-CET type with the appropriate rating

14.10.10.2 CONDUITS

Table 29: Conduits

APPLICATION	TYPE
Interior – Above Ceiling or concealed locations	Type E (EMTS) and RSC conduits
Interior and exposed	Type E (EMTS) conduits or Type RGS (thick wall/steel) conduits for wet/damp/hazardous areas

Exterior direct burial	Type PVC (40) conduits for non-paved areas or Type RSC (rigid steel) conduits for under paved areas or Type HIVE (extra heavy wall rigid PVC) conduits under heavy traffic areas
Exterior/Concrete embedded	Type VE (PVC) conduits or Type PE (PVC coated rigid steel) conduits

14.11 INTERIOR ELECTRICAL DESIGN

14.11.1 LOW-VOLTAGE DISTRIBUTION EQUIPMENT

Power distribution equipment shall be provided in accordance with UFGS 26 20 00 and UFGS 26 23 00. For details of design, see NEMA Standards Publications PB-2 and SG5, current editions, and appropriate manufacturer's catalog and specifications. In general, switchboards would be of limited benefit for loads of less than 600 amperes.
Spare circuits in equipment assemblies shall be apportioned at one spare for every 4-6 active circuits however at least one spare circuit shall be provided in each equipment assembly unless other direction is given.

14.11.2 SUBMETERING

Provide submetering if required by the UFC. As much as possible, dedicate each branch panel to one load type (i.e. lighting panel, receptacle panel, mechanical panel, etc.).

14.11.3 SYSTEM PROTECTION – LOW VOLTAGE

14.11.3.1 LOW VOLTAGE – OVERVOLTAGE PROTECTION

Molded-case circuit breakers shall normally be used in branch circuit panelboards and are recommended for distribution panels if served by a fuse type switchboard. Refer to designer notes in UFGS 26 20 00 for recommended application of insulated-case breakers and low-voltage power circuit breakers. Specify solid state multifunction type devices in switchgear or larger distribution panels if the objectives of the protective coordination analysis could be best achieved. Bolt-on circuit breakers shall be provided for panelboards. Plug-in circuit breakers shall only be used for family housing, if approved by the User.

14.11.3.2 LOW VOLTAGE –FUSES

In fusible switchboards and safety switches, use dual element, current-limiting type (RK1 or RK5) for most projects. See designer notes in UFGS 26 20 00.

14.11.3.3 LOW VOLTAGE – CIRCUIT BREAKERS

Molded-case circuit breakers shall normally be used in branch circuit panelboards and are recommended for distribution panels if served by a fuse type switchboard. Refer to designer notes in UFGS 26 20 00 for recommended application of insulated-case breakers and low-voltage power circuit breakers. Specify solid state multifunction type devices in switchgear or larger distribution panels if the objectives of the protective

coordination analysis could be best achieved. Bolt-on circuit breakers shall be provided for panelboards. Plug-in circuit breakers shall only be used for family housing, if approved by the User.

14.11.3.4 LOW VOLTAGE – RELAYS

Fuses and molded-case circuit breakers perform reliably in the short circuit range (abnormal currents exceeding 6 times the nominal rating) and well into the overload range (approximately 1-1/2 to 6 times nominal rating). Performance is not certain or consistent for slight overloads (i.e., in the 110 to 125 percent range). If precise operation and tight protective margins are essential, adjustable current sensing relays are recommended.

14.11.3.5 LOW VOLTAGE – GROUND FAULT PROTECTION FOR EQUIPMENT

Provide ground fault protection on grounded wye services with service disconnecting means of 1000A and larger (480Y/277V typically) per NEC. Annunciation only can be substituted for automatic system shutdown on emergency systems and where critical processes shall be maintained.

14.11.3.6 LOW VOLTAGE – GROUND FAULT PROTECTION FOR PERSONNEL

Provide ground fault protection on receptacles in lavatories and on the exterior of buildings and in other locations addressed in the NEC. GFCI circuit breakers (or feed-through receptacles) need dedicated neutrals to function properly. If a 3-phase feeder or 2-leg single-phase feeder is used, multiple neutrals shall be provided downstream in lieu of a shared neutral.

14.11.3.7 ARC FAULT PROTECTION FOR PERSONNEL

Provide ark fault protection on receptacles in dwelling unit in the NEC. The one pole arc-fault circuit-interrupter is not designed for use on circuits in which the neutral conductor is shared with other circuits (defined as a multiwire branch circuit in NFPA 70) and will nuisance trip on shared neutral circuits. Provide and indicate on the drawings one pole arc-fault circuit-interrupter breakers for each circuit, and do not use shared neutral for these circuits in new construction projects.

14.11.4 HEAVY-DUTY (INSULATED-CASE CIRCUIT BREAKER) SWITCHBOARD

Assemblies may require rear access.

14.11.5 NORMAL-DUTY (INSULATED-CASE CIRCUIT BREAKER)

SWITCHBOARD Rear access is not required.

14.11.6 PANELBOARDS

For all except smaller projects, it is preferred that lighting and power loads be supplied from separate panels. In some projects, it will be desirable to further separate sensitive loads (precision instrumentation, etc.) from harmonics generating equipment or to group motor loads. Odd and even circuits shall be balanced to the extent practical; i.e., three pole breakers opposite three pole breakers and one pole breaker opposite one pole breaker, etc.

14.11.6.1 PANEL CONFIGURATION AND LOAD IDENTIFICATION

Loads are to be shown in watts unless vector addition is used. The type and size of each load shall be shown in the "Load" column of the panel schedules. The load to be shown shall be the actual connected load (nameplate rating) of the equipment (such as electric heating equipment). If there are many loads of the same type, distinguish by number (EF#4, pump P2, etc.) or location (Rm 315, kitchen, etc.).

14.11.6.2 BUS RATINGS

Required capacity shall be computed from the estimated maximum demand of the panel board and specified as the next larger manufactured standard bus or main lug size. Bus sizes for circuit breaker panel boards are 100, 225, 400, 600, 800, and 1200 amp and for fusible panel board main lug sizes are 200, 400, and 600A. Loading on panels shall not exceed 80 percent of bus rating (see paragraph "Feeders and Branch Circuits"). Panel boards serving predominantly nonlinear loads shall be supplied with a 200 percent neutral bar.

14.11.6.3 OVERCURRENT CALCULATIONS

For panel boards with heavy motor loads, computations shall also consider starting current of the largest motor or motors in addition to the continuous demand amperes correlating to the EMD watts or volt amps.

14.11.6.4 SPARE CIRCUITS

Spares shall be provided as follows: facilities with low or average electrical use (schools, office, dormitory, mess hall) - at least one spare for every six (6) active circuits; facilities subject to relatively intense electrical use (shops, manufacturing, hangars, etc.) - one spare for four (4) active. Coordinate positions of active and spare circuits to provide a balanced phase panel. Indicate in the panelboard schedules whether a pole is a spare or a space. With spares, indicate the circuit breaker rating. Flush mounted panels that are inaccessible for future addition of wiring may have a minimum of spare circuits; empty conduits shall be routed to the nearest J-Box above the panelboard, if possible.

14.11.6.5 PHASE BALANCE

Since the usual circuiting patterns tend to load up Phase A, designers shall review their layouts after initial allocations are made and compensate by shifting spares or heavier loads to B and C phases.

14.11.7 INTERIOR TRANSFORMERS

14.11.7.1 CONVENTIONAL DRY TYPE

Low-voltage general-purpose dry-type transformers shall be sized so that the maximum continuous load would not exceed 80 to 100 percent of the nameplate. Standard units with a Class 220 (formerly Class H) insulation system can support rated load in a 40□C ambient without exceeding a 150□ ambient without exceeding a 150tinuous load would not exceed 80 to 100 percent of the nameplate.

14.11.7.2 EPOXY-ENCAPSULATED TYPE

Consider isolation transformers for health care facilities or other applications where

sensitive loads could be grouped and served by a dedicated transformer. The isolation shield shall be grounded in the same manner as the secondary neutral of general-purpose transformers.

14.11.7.3 BUCK-BOOST

Provide where necessary to accommodate individual loads designed to operate at different voltages than the facility system (example 230V motor-driven appliance to be supplied from a 208V system).

14.11.7.4 PREMIUM GRADE, LOW ENERGY

If phase balance or future loading patterns are uncertain, recommend use of a heavy duty, low energy type transformer in lieu of the standard unit. A Class H unit with Class 220□C insulation and an 80□C maximum rise will be capable of operating at 126-130 percent of rated load. Since the internal design of these units is similar to the K-4 and K-13 nonlinear rated units, they will perform well in nonlinear applications.

14.11.7.5 K-FACTOR RATED UNITS / HARMONIC MITIGATION

Provide K-factor transformers for nonlinear (harmonics generating) loads (K-4 for 50 percent, K-13 if 100 percent nonlinear). Some caution shall be exercised when using formulas to calculate theoretical K-factors, the need for units with ratings higher than K- 13 is unlikely and shall be justified in the Design Analysis. Consideration shall be given to application of harmonic mitigation transformers in lieu of k-rated transformers where nonlinear (harmonics generating) loads are present in a facility. The advantage of harmonic mitigation transformers is that a significant portion of the harmonics can be cancelled out instead of just installing a k-rated transformer which is designed to accommodate the extra heat generated by the presence of harmonic currents. When treating these higher level harmonic currents, it is important to balance the load between the transformers, as only the balanced portion of the load is treated. Voltage distortion is normally greatest at the point where the equipment is connected to the distribution system. Therefore, to attain maximum benefit, harmonic mitigating transformers shall be installed as close as possible to the panels they feed.

14.11.7.6 CONTROL TRANSFORMERS

Use of 120V control transformers with one fused leg and one grounded leg is recommended for all control circuits.

14.11.8 FEEDERS AND BRANCH CIRCUITS

14.11.8.1 SIZING

Sizes shall be based on the load supplied (Panel board EMD) and voltage drop. The ampacity of feeder conductors shall not be less than 30 amps, see NEC. Where more than one panel board is supplied, a diversity factor can be applied. Assume EMDs will be continuous (sustained for over 2 hours) and size conductors at 125 percent of EMD (or load the conductors to 80 percent maximum of their rated ampacity). KS equivalent cable sizing shall be specified for all projects.

14.11.8.2 TRANSFORMER FEEDER SIZING

Sizes for primary and secondary feeders for transformers are recommended to be

based on transformer kVA. Use of kVA instead of EMD allows future load growth to utilize full use of the transformer capacity.

14.11.8.3 NEUTRAL SIZING

Use of full size neutrals shall be standard practice (i.e. having the same ampacity as the phase conductors). Include back-up data in the Design Analysis for all cases where reduced neutrals have been permitted. For all applications involving discharge type lighting (fluorescent, HID) or other harmonics generating equipment (inverter, variable frequency drives, other solid state apparatus), the neutral shall be treated as a current carrying conductor (see NEC Table). In data processing applications including personal computers, the neutral shall be sized larger than the phase conductors. Size the neutral at 173 percent minimum (of the phase conductors) unless a harmonic analysis or field data demonstrates that a smaller size would be adequate. Single-phase branch circuits with oversized neutrals shall not share neutrals with other circuits.

14.11.8.4 DERATING

Ampacity of conductors is affected by two NEC derating factors. One is an adjustment factor that is applied when there are more three current carrying conductors installed in a raceway. When nonlinear loads are served, the neutral shall be treated as a phase conductor. If a double size neutral is employed, count it as two line conductors. The other derating factor is for temperature correction. Temperature correction is required when the ambient temperature in a given area is different than 26oC - 30oC (78oF - 86oF). Typically installations where this would be a factor would include rooms with outside air ventilation such as mechanical and electrical rooms. The NEC also recommends considering temperature correction for circuits run in conduits on roof tops.

14.11.8.5 PARALLELED RUNS

Use of bus duct shall be considered in lieu of parallel runs of cable when required ampacity is at or above 800A. Parallel runs of cable shall be limited to 3 legs generally or 4 maximum. If these approaches are not practical, use of a higher distribution voltage shall be given strong consideration (especially if a 208Y/120V system is involved).

Use of cable sizes above 500 kcmil tends to yield minimal ampacity gains relative to cost. Substitution of parallel cable arrangements will generally be more cost effective and installation less cumbersome. Each leg shall contain all circuit conductors (phase, neutral, and ground) in a common raceway to function properly and shall be equal in length, size, configuration, materials, brand, etc. to ensure proportionate division of current. Equipment grounding conductors in each leg shall be sized to carry the total fault current based on the rating of the upstream overcurrent device (i.e., per NEC Table which means that the grounding conductor is not down-sized to the size of the parallel conductor, but is sized to the breaker rating). Apportioning fault currents in the same manner as load currents is not acceptable.

14.11.8.6 CABLE AND CONDUCTORS

Sizing of wiring, conduit, and related items is to be based on use of copper conductors.

When special cable (such as oil resistant) is required, the type shall be identified, preferably on the drawings at specific locations or equipment. The requirement could be inserted in the specifications if it is applied generically. KS equivalent cable sizing shall be specified for all projects.

14.11.8.7 CONDUCTOR AND TERMINAL RATINGS

Most available terminating components and materials are UL approved based on use with 60□C conductor insulation in circuits of 100A or less and 75□C insulation in circuits over 100A. Designers shall therefore size conductors using the 60□C ampacity column of NEC Table for sizes through #1 AWG and the 75□C column for #1/0 and larger. Size of conduit, however, shall be based on THW insulation (or type USE for underground feeders).

14.11.8.8 CONDUCTOR IDENTIFICATION

See UFGS 26 20 00 specification and designer notes.

14.11.9 RACEWAY AND CABLE TRAY

Sizing shall be based on use of single conductor cable with THW or RHW insulation for conductor sizes #1 and smaller and THHN for #1/0 and larger. Designer can base conduit size on TW for all conductor sizes, if desired. KS equivalent conduit sizing shall be specified for all projects (see attached “Wires, Cables and Conduits” Table). Korean metal raceways shall be specified wherever possible. In such cases, standard UL5 shall not be applicable.

14.11.9.1 CONDUIT

The NEC Tables, which prescribes minimum sizes of conduit, shall be used with some discretion (limit to short runs with one bend maximum). To reduce the possibility of insulation damage, it is recommended that for longer runs or runs with two bends or more, raceways be sized one or two sizes larger than the minimums in the tables.
Underground conduit shall be sized on the basis of type USE cable. Korean conduit shall be specified wherever possible. Set screw type fittings for EMT shall be acceptable.

14.11.9.2 CABLE TRAY

Verify that cable fill does not exceed NEC Table. Covered tray is usually required - verify for specific projects.

14.11.9.3 SERVICE POSTS

Consider the use of service post for rehabilitation of existing facilities. Use of under floor systems is preferred in new construction (possible exception: large bay area with multiple desk locations that change periodically).

14.11.9.4 SURFACE MOUNTED RACEWAY AND WIREWAYS

Consider surface metal raceway, sized for multi-outlet application (e.g. Wiremold 3000 or 4000), in maintenance facilities with multiple work benches or test sets. Typically, mount on longer walls with receptacles spotted at 0.6-1.2 meter intervals and provide a parallel equipment/static ground bar. Smaller cross-section versions (e.g. Wiremold 1900 and 2000) may be considered for existing facilities where concealed installation

would not be practicable and where the appearance would be less objectionable than conduit.

14.11.9.5 UNDERFLOOR SYSTEMS

In new construction, the preferred method of providing electrical support to scattered loads in the central portions of open expanses is installation of underfloor raceway or duct in the concrete floor. If extensive raceway volume is required to support concentrated demands or multiple services, the cellular floor configuration is recommended. Arrangements and details need to be coordinated with the structural and architectural designers. Service outlet fittings shall be located at tentative locations of Stakeholder loads. Provide 10-20 percent spare fittings if other direction is not furnished. If only a few devices would be required, use individual floor boxes supplied by conduit.

14.11.9.6 BUS DUCT AND CABLEBUS

When load demand reaches the 800-1000A range, feeder type bus duct shall be considered in lieu of parallel cable runs. Plug-in type busway, overhead or wall mounted, would be recommended for industrial applications with multiple loads of 30A or more, particularly if the arrangement, size, and location would be subject to periodic changes in mission scope or function. Note that tap boxes (cable feeder/duct interface) are bulky; in finished areas an above ceiling placement is recommended. Cable bus can also be considered. If parallel runs are involved each leg shall be of equal length.

14.11.10 MOTORS

14.11.10.1 ELECTRICAL CONSIDERATIONS

Sizes and Capacities shall be based on the performance requirements specified for the specific equipment the motor is to power. It is preferred that single-phase motors be limited to 3/4 HP maximum. Since motor size typically cannot be exactly specified without being proprietary, one of the following (or something similar) shall be placed on the plans:

- A note on appropriate sheets reading "Motor-use indicated. The H.P. rating shown is not mandatory if required equipment performance can be achieved with other sizes. See Specification."
- A note similar to the following on sheets containing motor, or panel schedules or electric power plans:
- "Horsepower and wattage sizes of motor loads and other equipment are indicated in panel schedules and one-line diagrams. These are tentative design values used to size electrical supporting accessories and materials. Since motor size can vary by manufacturer, actual sizes will be governed by performance criteria in the specifications or data on non-electrical plans. Electrical support items such as conduit, conductors, overcurrent devices (also panels, transformers, etc. if affected) shall be increased in size if necessary to accommodate the equipment actually selected by the Contractor at no additional cost to the Government."
- "The horsepower indicated are approximate. Motors are to be provided and

sized in accordance with performance information given in other portions of the plans and specifications. If motors, or other components or equipment are furnished in sizes other than the design size indicated, it is the responsibility of the Contractor to adjust the indicated sizes of wiring, circuit breakers, etc. and to re-circuit if necessary at no additional cost to the Government. (See Specifications.)"

14.11.10.2 VOLTAGE RATINGS

When ratings are specified, ensure the value pertains to the motor (per NEMA MG-1) not the line (see paragraph "System Selections"). Note that 200V motors for use on 208Y/120V systems are available only in 3-phase versions, the proper single-phase motor rating would be 115V (120V nominal line to neutral). A 230V single-phase motor could be connected to a 240/120V system or to 2 poles of a 240V delta system.

14.11.10.3 ADJUSTABLE SPEED DRIVES (ASDS)

Coordinate selection of ASD type and layout specifics with the mechanical designer. Note that the variable frequency type will generate harmonics that can affect other input side loads and also reduce the output side efficiency; VFDs also have a tendency to oscillate on cold start. Consider use of filtering, isolation transformers, grouping of loads to maintain power quality. In some applications, alternate techniques such as multispeed motors, VAVs, eddy current drives, magnetic clutches, hydraulic couplings, DC motor, etc. may be more cost effective or reliable than ASDs.

14.11.10.4 HIGH EFFICIENCY AND PREMIUM EFFICIENCY MOTORS

High efficiency and premium efficiency motors shall be applied as indicated by UFGS 26 20 00.

14.11.10.5 DISCONNECTING PROVISIONS

Disconnects shall be shown on floor plans and one line diagrams. Since the disconnect and starter represent different functions, it is preferred that different symbols be used. The contractor shall be allowed to provide combination starters at his option.

14.11.10.6 MOTORS AND APPLICATIONS

A disconnecting means shall be provided for all motor operated equipment and fixed appliances. The disconnect shall be in view from the motor or appliance location unless it is lockable. It is preferred that a local disconnect be supplied within the view of a motor or appliance, even if locking type disconnects would be available at the controller location. The safety switch configuration is preferred unless the motor is in sight of a panel, switchboard, motor control center, etc.

14.11.10.7 MOTOR SCHEDULES

For projects that will have a number of motors, a motor schedule that shows each motor name, horsepower rating, number of phases, FLA, and voltage used shall be included in the electrical sheets.

14.11.10.8 MOTOR CONTROLLERS

- Control Circuits: Control voltage shall be 120 volts. Circuits shall be supplied via

a control transformer with one fused leg and one grounded leg in the typical application (both legs fused if not grounded).

- Individual Starters: Electrically operated, electrically held magnetic starters are to be the norm for polyphase motors. Frequent on/off manual operation shall utilize pushbuttons in lieu of the on and off positions of the 3-position selector switch.
- Motor Control Centers: MCCs shall be provided for applications involving large motors, numerous smaller motors, clusters of motors (mechanical equipment rooms, heavy equipment repair facilities, etc), or controls that extend to a variety of devices and/or interface with more than one controller. The preferred assembly configuration would be a Class I control center with Type B wiring (per NEMA ICS 2).
- Special Purpose Controllers: Reduced voltage starters shall be provided whenever motor locked rotor current exceeds the rating of supply transformers or conductors. Coordination of motor and controller selection with mechanical designers shall include requirements for special controllers such as multi- speed or reversing types.
- Switches: Switches with pilot lights used as indicators require 4 wires - 2 hot plus neutral and ground. Switches with lighted toggles ("night light") are interchangeable with conventional toggle switches.

14.11.10.9 MISCELLANEOUS LOW VOLTAGE APPARATUS AND EQUIPMENT

Circuit loading of fixed equipment shall not exceed 80% of the circuit capacity.

14.11.10.10 HEATING APPLIANCES

Electric heating will be limited to supplemental uses unless specifically authorized.

14.11.10.11 PHASE CONVERTERS

Use of phase converters shall be considered for remote applications with minimal loads (10 Hp pump, etc) located some distance from nearest three-phase line. The rotary type shall be specified rather than solid state versions.

14.11.10.12 FREQUENCY CONVERTERS

Converters are typically used to supply 400 Hz power to aircraft and associated maintenance and test equipment. Government furnished motor-generator sets or solid state frequency converters are typically used. Electrical service to and from the designated converter locations is required. The more common sizes are the 15 kW MD- 2, 30 kW MD-3, 50 kW MD-4, 60 kW ECU-105E and 100 kW EPU-5/E (input 23.3 kVA,
30.0 kVA, 83.2 kVA, 112.7 kVA, and 200 kVA at 480V).

14.11.10.13 DISCONNECTING PROVISIONS

See UFGS 26 20 00. A disconnecting means shall be provided for all fixed appliances. The disconnect shall be in view from the appliance location unless it is lockable. (Also see paragraph "Motors and Drives".)

14.11.10.14 ELEVATORS

Coordinate with architectural and structural designers to determine what components will be furnished by the manufacturer in the elevator package and what shall be shown on electrical drawings (or described in electrical specifications). ~~ANSI~~ A17.1 (Safety Code for Elevators and Escalators) requires a switched luminaire and a receptacle in the pit area; the typical elevator package does not include these items. Designers shall also check for special requirements in local codes (it is the policy to conform to state codes on Government property whenever feasible).

In recent projects, local Korean elevators have been deemed acceptable if the following information is provided:

- Get an official letter/memo from the elevator manufacturer stating the elevators can meet the requirements of ASME A17.1.
- The official letter/memo shall also confirm the elevators meet the requirements from UFC 3-600-01, 4-12.4.

If the elevator manufacturer can provide this information, Far East District will review it for compliance.

14.11.10.15 CRANES AND HOISTS

(See UFGS 41 22 13.13 or similar sections.) The electrical designer needs to coordinate motor sizes and voltages, type and location of controls, routing and height of tracks and rails with structural, architectural, or mechanical designers as applicable.

14.11.11 SPECIAL APPLICATION – LOW VOLTAGE

14.11.11.1 INFORMATION TECHNOLOGY EQUIPMENT

Provide capability to shut off service to information technology equipment and HVAC by means of a shunt trip main circuit breaker controlled by pushbuttons (or similar arrangement) located at the exits of the information technology equipment area (See NEC). Emergency Power OFF (EPO) pushbuttons shall be of the extended guard style and/or shall have a safety cover to prevent accidental activation.

14.11.11.2 400 HZ DISTRIBUTION

Design needs to consider a variety of special techniques to compensate for high inductive losses - equipment needs to be designed specifically for 400 Hz operation or be capacity derated (cable, transformers, breakers, panelboards, etc). Conduit and equipment enclosures shall be nonferrous to the extent practicable (PVC coated aluminum conduit, non-magnetic stainless steel enclosures and aluminum-housing bus duct preferred). Conductor sizing needs to take into account decreased amperage rating, increased inductive reactance (6.6 times the 60 Hz), and increased AC resistance. Single conductors will have the worst voltage drop and shall be used for smaller loads and/or lengths. The next level up would be a jacketed three-phase power cable assembly. This type of assembly provides a lower voltage drop and is not much more expensive than single conductors. Another option is the use of contrahelically wound cable. Standard manufacture of these cables uses six phase conductors spiraled in an ABCABC rotation around a neutral (neutral and phase conductors all

the same size) and a single ground conductor on the outside. This cable is more expensive and does require the conduit to be increased in size. The use of conductors over 1/0 AWG is typically not cost effective and parallel conductors shall be considered. Use of Line

Drop Compensators (LDC), adjustable to line conditions, is recommended for applications with larger ampacity feeders, runs exceeding 45 meters, or where load type and configurations could change. LDCs shall be 400 Hz type designed for aircraft application - the 60 Hz power line-regulating type is not suitable. Acceptable units are available from Teledyne Inet (Series ILD, 90 kVA), Rapid Power Technologies (90 kVA) and Hobart Bros (90 and 140 kVA). Recommended design references are "A Guide to 400 Hz Power Distribution" from Actual Specifying Engineer, February 1972 and IEEE 241 "Recommended Practice for Electric Power in Commercial Buildings".

Contact manufacturer application engineers for capability of specific products.

14.11.12 RECEPTACLES

14.11.12.1 GENERAL USE RECEPTACLES

Single and Duplex Receptacles for general purpose applications shall be 15 amp, 125 volt, 2-pole, 3-wire grounding type. In general, a maximum of nine (9) duplex receptacles may be connected to a receptacle circuit, however, 5-8 receptacles is the preferred range for most circuits. Where the circuit is intended for low powered equipment, a higher maximum number of receptacles might be acceptable; and where a circuit is designed for shop type equipment (such as electric drills, soldering irons, woodworking tools, etc.) maintenance equipment, appliances, test instrumentation, medical apparatus, etc., as few as one or two receptacles might be acceptable. The number of receptacles per circuit shall be the designer's judgment, based on economics and the above guidelines. Receptacle circuits shall not supply lighting loads. In offices and dwelling rooms, general use receptacles on walls shall be 3.5 meters (or 12 feet) on center. In other areas, receptacles may be up to 6 meters (or 20 feet) on center. The preferred design approach is to have a green grounding conductor installed with the power conductors. This is mandatory for Air Force Projects.

14.11.12.2 DEDICATED RECEPTACLES

Special use receptacles shall be located where required by specific design criteria and shall be designed to suit the equipment served. Receptacles and circuits shall not be loaded to more than 80% of circuit or receptacle capacity. Floor cleaning receptacle circuits (simplex configuration, 20A, 120V, 1600W load) shall be furnished in larger facilities (1,000 sq. m.) and considered for smaller buildings. Place at 15 meter maximum intervals in corridors.

Suggest using 400VA per computer receptacle with a maximum of 4 computer receptacles per 20A, 120V circuit.

14.11.12.3 AUTOMATIC RECEPTACLE CONTROLS

Provide automatic receptacle controls in accordance with ASHRAE 90.1 – 2013 per UFC 3-520-01, Section 3-17.

14.11.13 ELECTRICAL SUPPORT FOR FIRE PROTECTION

14.11.13.1 SUPPRESSION SYSTEM

Coordinate with mechanical or fire protection designer relative to types of systems and devices that will be specified. Provide connections to alarm contacts (water flow indicators) and supervisory contacts (OSY valves, PIVs, low pressure, etc).

14.11.13.2 FIRE PUMPS

Coordinate size and locations. Ensure that electrical design gives precedence to maintaining pump operation vs. motor protection. Fire pump installations, electrical service, and sizing of transformers, shall conform to NFPA-20.

14.11.13.3 ELECTRONIC MONITORING SYSTEM

Coordinate requirements for monitoring fire alarm, smoke control, and other special systems with other designers as required.

14.11.13.4 FIRE PROTECTION CONFIGURATION

Coordinate requirements with fire protection, mechanical, or architectural designers as required. Ensure that fire alarm system is consistent with overall protection philosophies.

14.11.13.5 ELECTRICAL INSTALLATION IN FIRE BARRIERS OR SPACES

Recommended references are IEEE 446 "Emergency and Standby Power for Industrial and Commercial Applications" (Orange Book) and IEEE 141 "Electric Power Distribution for Industrial Plants" (Red Book).

14.11.14 LIGHTING DESIGN

The lighting system shall be designed to meet the lighting levels prescribed in the UFC and IES, considering Stakeholder needs, energy efficiency and initial cost.
Luminaires shall be scheduled in the plans using a lighting fixture schedule. Loading of branch circuits supplying luminaires shall not exceed 80 percent of the circuit capacity.

14.11.15 CRITERIA

Lighting design shall generally be in accordance with the UFC and the "Lighting Handbook", published by the Illumination Engineering Society. The designer shall take into consideration meeting proper uniformity levels per UFC, in addition to meeting the recommended illumination levels.

14.11.16 LUMINAIRE SELECTION

Lighting fixtures shall be required to be Energy Star qualified. The lighting fixture details are to be placed on the project drawings. A visual representation with a generic description of performance and construction requirements shall be placed on drawings. Examples of lighting fixture details are shown in the Standard Criteria Base (CCB) contained in standard drawing series CADD Electrical Lighting

Details; Construction Criteria Base (CCB); NAVFAC CADD Details at http://www.wbdg.org/ccb/browse_cat.php?o=78&c=232.

Exterior applications shall utilize enclosed luminaires in lieu of open type.

14.11.17 LAMPS, DRIVERS AND BALLASTS

Lamps shall generally be LED type where Life Cycle Cost Effective. Self-Ballasted Mercury Vapor Lamps shall not be used in new design. If fluorescent lamps were to be used, they shall be specified as the rapid start type. Use of high frequency electronic (solid state) ballasts and T8 lamps shall be permissible where LEDs are not deemed life cycle cost effective. The use of electronic ballasts in specific applications shall consider harmonics generation, interference problems, and reliability problems with some brands. Electronic ballast performance shall conform to the requirements specified in UFGS 26 51 00. The use of incandescent lamps shall be limited to special applications only.

14.11.18 SELECTION OF GENERAL ILLUMINATION VS. TASK LIGHTING

Lighting directed to specific tasks shall be given strong consideration when illumination levels exceeding 30 foot-candles are required (exceptions: drafting rooms, precision maintenance shops).

14.11.19 ENERGY EFFICIENT LIGHTING

14.11.19.1 APPLICATION REQUIREMENTS

Light Emitting Diode (LED) lamps shall be specified in most cases. Where LEDs are deemed not Life-cycle cost effective or are restricted for other reasons, fluorescent lamps shall be considered. Use low energy ballasts, and multiple switching of lamps, ballasts, or fixtures when possible. Avoid the use of incandescent lamps, low efficiency mercury vapor lamps and low efficiency ballasts. To avoid light level degradation due to short lamp lifespans of fluorescents, utilize LED or Induction lamps for high bay applications where cost effective.

14.11.19.2 LAMP BALLAST COORDINATION

Energy saving lamps typically shall be operated with compatible ballasts and within specified environmental conditions in order to assure proper performance. In some cases, the lamp and ballast shall be of the same manufacturer for optimum performance. If energy efficient lamps are to be used, the existing ballast shall be replaced with an energy saving type or a conventional 40-watt ballast that is rated for use with either standard 40-watt lamps or the 34-watt energy saving type.

14.11.19.3 DESIGN CALCULATIONS

Energy related lighting calculations shall be based on actual wattage of lamps and ballasts. Illumination calculations shall use actual lumens of the particular lamp type or from manufacturers' catalogs and IES files.

14.11.20 EMERGENCY AND EGRESS LIGHTING

Emergency lighting systems, egress lighting, and exit signs shall be provided in accordance with the requirements of NFPA 101. Illumination at points of egress shall be a minimum of one foot-candle. Use of LED units is preferred followed by fluorescent. Fixtures containing radioactive materials are not acceptable. LED versions is encouraged (energy consumption approximately 15 percent of

conventional type, with "lamp" life exceeding 10 years). For Air Force projects, comply with ETL 99-4 on Emergency Lighting and Marking of Exits.

14.11.20.1 BACKUP POWER PROVISIONS

Backup power for the emergency lighting system shall be obtained from an Emergency Power System (battery inverter assembly), from an automatic standby AC generator, or from integral batteries. Individual self-contained battery unit type luminaires (Emergency Light Sets) is the preferred method when a generator or a battery inverter assembly is not available.

Where automatic standby AC generated power is available, a battery system will not normally be required. (The generator shall be capable of supporting the load within 10 seconds of a loss of normal power. Central battery inverter systems (see Paragraph "Emergency Power System") shall be used in facilities where more than seven battery powered exit and egress lights would otherwise be required and with express permission of the User. These systems have a history of high maintenance and with them being a single point of failure are typically not desired. Terminals or a receptacle shall be provided to allow substitution of a temporary alternate source during a maintenance shutdown. Power shall be supplied from a point which will be energized continuously under normal conditions and which will be automatically transferred to generated power under emergency conditions.

14.11.20.2 CONNECTIONS

The emergency or egress lighting system shall be supplied from a dedicated distribution system. If the emergency or egress lighting system is off of a single unit such as a central battery inverter, it needs to be connected to a dedicated disconnecting means. Otherwise, individual battery units are connected to the light fixture circuit. Egress lighting (exit lights and egress luminaires in corridors) shall be connected in a "nightlight" mode (i.e., unswitched and connected to a source with backup power). Emergency lighting, which is supplementary and not mandatory to comply with life safety provisions, may be connected in a "standby" mode. Such luminaires may be locally switched, if a third unswitched lead is extended upstream of the local switch to monitor building power (i.e., one switched wire, one unswitched, and one neutral to the luminaire). Provide notes or symbols on drawings to ensure proper connections. Wall mounted emergency light sets shall be direct wired; cord-connected assemblies are not authorized. If a flexible connection is desired, extend liquid-tight conduit from an adjacent junction box. In areas with high intensity discharge (HID) lighting, emergency lighting shall stay on for at least 10 minutes after power returns to ensure the HID lights are on.

14.11.20.3 LOAD ALLOWANCE FOR EGRESS LIGHTS

Virtually all LED exit light drivers operate at low power factors (0.4 - 0.5 for 120V units, 0.25 - 0.4 for 277V). Inverter sizing and energy calculations shall use the values from the manufacturer as much as possible.

14.11.20.4 ELECTRONIC BALLASTS

Use of electronic ballasts is encouraged for applications where high frequency

interference would not be a concern. Design shall also consider possible effects of input side harmonics generation. Use of electronic ballasts shall be avoided in health care areas and electronics maintenance shops.

14.11.21 RECOMMENDED CIRCUIT CONFIGURATIONS FOR LIGHTING

14.11.21.1 INTERIOR APPLICATIONS

Only line to neutral circuiting shall be employed for interior lighting installations. Utilize higher line to neutral voltages in larger facilities to mitigate voltage drop.

14.11.21.2 EXTERIOR APPLICATIONS

The supply circuit shall be multiple type for new facilities; series type circuits shall be limited to rehab type projects or expansions of existing facilities. Street lighting circuits may be designed for 10% maximum voltage drop if constant wattage ballasts are used, 5% maximum is preferred for other lighting.

14.11.22 LIGHTING CONTROLS

14.11.22.1 PHOTOCELL

Use photocells for control of individual luminaires on buildings, along roadways, and other exterior locations if suitable. Place photocell on a south-facing wall and where it cannot be obstructed from sunlight when using one photocell to control multiple light fixtures.

14.11.22.2 CONTACTOR

Provide contactors to switch multiple or higher amperage circuits, for combined manual and automatic control, and for multi-function operating arrangements.

14.11.22.3 VACANCY/OCCUPANCY/DAYLIGHT SENSORS

Vacancy sensors shall be used in small and confined spaces such as individual office spaces and storage rooms. Occupancy sensors may be considered for locations such as corridors and restrooms where use would be intermittent and where control would generally be accessible to several individuals or functions. Dual-technology sensors (Passive Infrared and Ultrasonic combined) are preferred. Use of traditional manual on/off light switches shall be utilized where automatic off of lights can be a life safety concern such as in mechanical/electrical rooms. Daylight sensors shall be used to the maximum extent possible. Coordinate regularly occupied spaces that have daylight access with Architecture.

For computer based automatic lighting control systems, UFC-3-410-02, addresses this issue and should be used in the design of other electrical systems, and lighting control systems as stated in the UFC. Recommend that for complex systems utilizing a computer-based control scheme, that the required system protocol be the same as required for the HVAC control system. Recommend that lighting controls and HVAC controls be combined into a single front-end workstation for this type of control.

14.11.23 SPECIFIC LIGHTING APPLICATIONS

14.11.23.1 GENERAL OFFICE LIGHTING

Target illumination level shall be 30 foot-candles with task lighting to supplement the general illumination. Recessed light fixtures are preferred in the typical applications. Consider multilevel switching in perimeter rooms and in larger areas subject to variable use, but do not use multilevel switching as a means of manual energy conservation.

14.11.23.2 AREA LIGHTING

Area lighting type luminaires shall be provided in areas where general illumination is desired and walkway, parking lot, and/or street lighting is not considered sufficient. Luminaires mounted on the exterior of a building may be used as part of, or to supplement, area lighting. All exterior luminaires shall be full cut off luminaires to mitigate any uplight.

14.11.23.3 STREET LIGHTING

If power lines run parallel to a roadway, luminaires may be installed on the distribution poles.

14.11.23.4 PARKING AREAS

Illumination shall be provided for all parking areas unless directed otherwise. Target level shall be 0.2 foot-candles average (horizontal) except at handicapped spaces where 1-2 foot-candles is desirable.

14.11.23.5 SECURITY LIGHTING

Refer to project criteria package and to UFC 3-550-01. If contactors are used, specify the electrically operated, mechanically held type.

14.12 LIGHTNING PROTECTION AND GROUNDING DESIGN

14.12.1 LIGHTNING PROTECTION

Lightning protection shall be designed as a stand-alone system and not share components with other systems. Ground electrodes of other systems shall be interconnected below grade and other portions may be interconnected as appropriate, but a single ground rod and a single conductor to ground would not normally be acceptable. (See NEC)

14.12.1.1 LIGHTNING PROTECTION FOR FACILITIES

A risk assessment analysis per NFPA 780 is recommended to determine probability of loss due to lightning striking an unprotected structure. Note that some structures can have a comparatively high potential for being hit by lightning, but a much lower probability of loss (steel compared to wood structures). The analysis puts primary emphasis on the risk to the structure vs. damage to contents or injury to occupants. Air Force projects also need to comply with AFI 32-1065. AFI 32-1065 has special requirements regarding connections, which are not standard for lightning protection systems.

14.12.1.2 AMMUNITION PLANTS

Design typically comply with AMCR 385-100 Safety Manual, as directed by the Stakeholder.

14.12.1.3 STORAGE TANKS

Tanks shall be grounded and reflected in the drawings. They will not require air terminals if the wall thickness is more than 3/16-inch thick.

14.12.1.4 OTHER APPLICATIONS

In general, other facilities will require protection as determined by the criteria in Army TM 5-811-3 or when so directed by the Stakeholder.

14.12.1.5 LIGHTNING PROTECTION FOR ELECTRICAL SYSTEMS

Surge Arresters: Protection will usually be accomplished via surge arresters or suppressor and proper grounding techniques. The path to ground shall be as short and straight as possible to minimize voltage buildup and secondary flashes and alternate paths to ground. To best ensure this objective, the lightning protection configuration shall be laid out first and then the protected components positioned in parallel.

14.12.2 GROUNDING

Information on grounding of power systems is available in the IEEE Green Book (IEEE 142 "Grounding of Industrial and Commercial Power Systems"). If the application involves sensitive electronics testing, maintenance, communications, or data processing functions, Mil HDBK 419A "Grounding, Bonding, and Shielding for Electronic Equipment and Facilities", ANSI_TIA-607 “Telecommunications Bonding and Grounding”, and IEEE 1100 (Emerald Book) shall be utilized for reference and design criteria.
Grounding design shall comply with NEC 250.

14.12.2.1 OBJECTIVES

Equipment and systems are grounded for several reasons; to increase the operating stability of power systems, to minimize damage to equipment, prevent malfunctioning of equipment, and to provide for safety of personnel.

Designers shall strive to reduce voltage differentials between equipment and systems, provide low impedance paths for fault currents, and select configurations with the least probability of developing circulating currents.

14.12.2.2 TRANSFORMER GROUNDING

The preferred power system configuration for both primary and secondary distribution is the grounded wye connection with the system neutral connected to ground at transformer locations and at building services. If a delta tap is made off the wye system, the neutral shall be extended to the building service to ensure a low impedance path for fault currents and proper operation of overcurrent devices.

Pad-Mounted Transformer:

- If the transformer is delta on the primary, but the primary system voltage is a

grounded-wye, be sure to bring the neutral (grounded conductor) and connect to the ground lug on the transformer.

- If the transformer is grounded-wye grounded-wye, then the primary neutral and secondary neutral are to be tied together at the X0 terminal.
- Frame of the transformer is to be grounded from the high voltage equipment pad and the low voltage equipment pad.
- On a grounded-wye secondary, a ground strap is required from X0 to the frame, since UFGS 33 70 02.00 10 requires X0 to be isolated from the frame.
- If a building has a lightning protection system with a ground ring and the transformer has a ground ring and the ground rings are within 7.5 meters of each other, then it is suggested that the rings be interconnected below grade.
- Service from transformer to building shall not have a grounding conductor. NEC does not require this conductor. If the service is a bus duct, there may be a benefit to installing a grounding conductor of the same size as the neutral. This is a designer's choice.
- Install a counterpoise around concrete pads connected to 2 rods minimum (4 preferred, one at each corner).
- Extend separate conductors from arresters and transformer neutral/housing.

Neutral Grounding Methods: Solidly grounded neutrals shall be the normal practice. If resistance or other techniques are employed, provide backup data and reasoning in the Design Analysis.

14.12.2.3 LIGHTNING AND SURGE PROTECTION

Facilities and equipment subject to lightning and other voltage surges require low impedance conductors connected directly to ground to dissipate overvoltages away from protected components. The path shall be as short and straight as possible to minimize voltage magnitude and flashover to adjacent items. Ground electrodes shall be interconnected below grade with any electrodes of other systems located within 7.5 meters (interconnection is recommended within 30 meters).

14.12.2.4 EQUIPMENT GROUNDING

All electrical equipment shall be connected to an equipment grounding conductor sized per NEC Table. A separate cable shall be provided if nonmetallic raceway is used and for receptacle circuits in EMT. Separate grounding conductors are also required for all raceways metallic / non-metallic, feeders and motor circuits. Large metal items within buildings shall be interconnected to the equipment ground system. Equipment ground conductors shall not be extended between the building service and the service transformer when the neutral is bonded at both locations. If a ground conductor is extended and both ends are interconnected (bonded) to neutral and ground in the usual manner, neutral current can flow on the equipment conductor in violation of NEC.

14.12.2.5 SIGNAL REFERENCE SUBSYSTEM

A signal reference ground configuration shall be provided in electronics facilities with strict performance requirements. The objective is to interconnect equipment in a given

location to ensure that each item operates at the same reference voltage and all enclosures are maintained at the same voltage. Techniques vary depending on operating or processing frequencies of the equipment involved. Design shall be as prescribed in Mil HDBK 419A and IEEE 1100.

14.12.2.6 STATIC

Provisions for dissipating static buildup shall be provided for fuel handling locations, at aircraft parking locations, and other similar applications. The grounding receptacle detailed in TM 5-811-3 (Fig 3-1) may be used in the absence of other direction; a shepherds hook configuration is often required for aircraft facilities. See AFM 85-16.

14.12.2.7 BONDING CONSIDERATIONS

Bonding involves connection of equipment to grounding conductors, conductors to electrodes, interconnections between systems and equipment. Buried connections below grade shall be made by the exothermic weld (thermo weld) process or equivalent. Below grade connections in wells and exposed above grade connections may use pressure connectors or set-screw clamps. The main bonding jumper (neutral to equipment ground and equipment ground to enclosure) shall be sized per NEC Table and equipment bonding jumpers shall be sized according to table.

- **Multi-Point**: Multi-point grounding is the recommended procedure for long lengths of distribution line to limit voltage gradients to approximately 25 volts. Neutrals of overhead lines shall be grounded at each pole, in addition to each transformer, and arrestor. Shields of underground cable shall be grounded at each manhole and splice.
- **Single Point**: See IEEE 1100 and Mil HDBK 419A:
- **Isolated Arrangement**: The NEC requires all electrical equipment and other items to be connected to the equipment grounding conductor. This normally results in multiple connections between the end use load and the service entrance location. Separate conductors dedicated to specific loads can be connected from the load directly to the service point without intermediate connections. This arrangement is recommended for personal computer applications (with corresponding isolated ground type receptacles).
- **Supplemental Provisions**: Equipment ground conductors need to be installed in the same raceway as corresponding supply conductors to conform to the NEC. Additional ground conductors, bonding jumpers, and ground electrodes can be included as supplemental measures once the basic NEC equipment grounding path has been provided.

14.12.2.8 ELECTRONIC SUBSYSTEM

PERFORMANCE REQUIREMENTS

Effectiveness of the electrode subsystem will be evaluated by resistance measurements. The preferred procedure is the fall-of-potential method using a reference electrode (see "Standard Handbook for Electrical Engineers" by Fink and Carroll or Biddle Instruments (AVO International) Ground-Resistance Testing Manual "Getting Down To Earth". For conventional power system grounding, the target level shall be 15 ohms with a maximum permissible upper limit of 25 ohms. If an electronics

facility is involved, target levels under 5 ohms are generally desired. Special electrode arrangements and testing techniques (bridge type instrumentation) are typically necessary.

MADE ELECTRODES

Each building shall be supplied with at least one made electrode. The preferred type is a copper or copperclad 10-foot rod. 8-foot rods are acceptable at individual overhead line-poles. Multiple installation of rod-type electrodes is most effective when rods are horizontally spaced at approximately twice the vertical length of the rod.

WATER PIPE

Interior metallic water piping shall be bonded to the equipment grounding system. Exterior water piping may be interconnected with the made electrodes, but it cannot be substituted for the made electrode. Jumpers shall not be connected across cathodic protection isolation fittings.

GROUND RING

A ground ring shall be provided around facilities where lightning protection is to be installed, and at munitions igloos, transformer pads, and other facilities such as electronics test labs. Provide a minimum of 4 ground rods.

GROUND GRID

Design of a grid configuration with all components bonded is recommended for transmission substations or switchyards.

Concrete-Encased Grounding Electrode SYSTEM

In areas with dry soils of high resistivity values, traditional grounding methods are frequently inadequate. In the concrete-encased grounding electrode system, the electrode consists of 6- 15 meters (or 20-50 feet) of bare copper conductor (#4 min) placed horizontally in concrete - typically the building foundation or sidewalls. Connection to rebar or additional conductor length improves performance. This arrangement has demonstrated consistent superior performance over extended periods. Note that every building design with rebar installed in concrete such as the footings shall have the rebar tied to the grounding system, except when concrete installed has insulation, vapor barriers, films or similar items separating concrete from the earth. See NEC, Section 250.52.

DEEP WELL SYSTEM

In areas with sandy soil and low water table, the deep well system shall be considered. Wells are drilled into the water table, casings and deep electrodes installed. A ground ring arrangement shall be installed to interconnect the deep wells and all facilities. Note: An environmental permit is usually required any time the water table is penetrated.

GROUND WELL

Provide ground wells where periodic access to ground electrodes is desired for testing the grounding system or for temporary grounding of special equipment. Common applications are munitions facilities (in ground ring) and avionics maintenance shops

(in floor adjacent to test sets). Use a 10-foot rod within a sewer-pipe end cap for conductor connections and provide a corrosion resistant cover.

SPECIAL ARRANGEMENTS

Supplemental electrode installations arranged in triangle or star patterns may be provided for specific electronics applications or shielded vaults. The subsystem shall have the traditional connection to building service unless the installation is electrically isolated from the rest of the structure (insulating barriers, isolation transformers, etc). Below grade interconnection of the electrode subsystems is recommended.

14.12.2.9 SPECIAL APPLICATIONS

OVERHEAD LINES

Connect neutral to ground at each line pole and transformer pole, plus separate arrester connections.

GUY WIRES

Guy wires connected to structures supporting conductors with a potential of more than 300 volts shall be effectively grounded as follows:

HIGH RESISTIVITY SOILS

In soils with resistivity of 30,000 ohm-cm or greater, guy wires may be connected to the system neutral if the system neutral is solidly grounded. Guys may also be grounded through the pole ground wire if the pole ground wire is connected to a grounded neutral (preferred method). In either case, the connection to the guy wire itself shall be coated with silicone grease or other water inhibitor.

LOW RESISTIVITY SOILS

In soils with a resistivity of less than 30,000 ohm-cm and where corrosion of underground structures is a problem, galvanized anchors and guys shall not be connected to copper grounding systems since severe corrosion may result. Strain insulators shall be installed in the guy wire in lieu of grounding. Insulators may be either the cross- connected porcelain type ("Johnny ball") or the fiberglass rod type, however the flash over rating (wet) shall be equal to the phase-to-phase voltage of the electrical circuit.

UNGROUNDED APPLICATIONS

On systems where a grounded neutral is not present, the above mentioned guy insulators shall be installed. If this is not possible, then the guy shall be grounded and galvanized ground rods shall be used.

UNDERGROUND CABLE AND MANHOLES

Ground the cable and hardware. See UFGS 33 71 02.

14.13 SEISMIC DESIGN REQUIREMENTS FOR ELECTRICAL

Designer shall develop performance requirements per UFC 3-301-01 Structural Engineering, and ASCE 7-10 Chapter 13.

Performance requirements shall be on the construction documents within the General Notes.

14.13.1 GENERATORS

Generators and Automatic Transfer Switches shall meet the seismic bracing requirements.

14.13.2 UFGS SECTION 26 24 13 SWITCHBOARD

UFGS Section 26 24 13 paragraph 2.4 shall be edited to include the following:

Provide a nameplate for each Designated Seismic Systems (DSS) component. Refer to Section 01 45 35 Statement of Special Inspections for the list of DSS. The nameplate shall:

- Be mechanically attached to or adjacent to the DSS component.
- Be not less than 125 mm X175 mm with red letters 25 mm in height on a white background stating "Certified Equipment".
- Include the statement "This equipment/component is certified. No modifications are allowed unless authorized in advance and documented in the Equipment Certification Documentation file."
- Contain the component identification number in accordance with the drawings/specifications and the O&M manuals.

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CHAPTER 15 - TELECOMMUNICATIONS

15.1 GENERAL

This chapter covers instructions for the preparation of drawings, specifications and design analysis as related to power, lighting, cathodic protection, and electronic systems as well as energy conservation features. Fire alarm system connections are covered in the chapter on Fire Protection.

15.2 DESIGN CRITERIA

Government design and contracting activities are controlled by Federal Acquisition Regulations (FARS). The details of the electrical design shall conform to the electrical portions of applicable military design and construction manuals and supplementary criteria documents as listed in the following paragraphs. The Far East District Design Guide shall serve as the basic criteria document for electrical design of Corps of Engineers projects. Whenever reference is made in this chapter to any publication, standard or code, or paragraph therein, the issue/version of publication indicated in the AE contract shall be used unless direction is provided to the contrary. If dates are not indicated in the AE contract or in the absence or other direction, the issue/version of publication in effect at the time the design was started shall be used. Many Army publications are available electronically at http://www.wbdg.org/ccb/ccb.php. Many of the Air Force publications are available electronically at http://www.epublishing.af.mil. These sites are to be consulted to ensure the latest versions are used. New documents found at the sites, which are not in the list shall be brought to the attention of the Far East District Electrical Section to see if it shall be followed.

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA) /

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

TIA/EIA-568-B Building Telecommunications Wiring Standards

TIA/EIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces

TIA/EIA-570-A Residential and Light Commercial Telecommunications Wiring Standard

TIA/EIA-606-A The Administration Standard for The Telecommunications Infrastructure of Commercial Buildings

ANSI/J-STD-607-A Commercial Building Grounding and Bonding Requirements for Telecommunications

ANSI/TIA-607-C Telecommunications Bonding and Grounding (Earthing) for Customer Premises

In applications limited to installation of outlets, cable, and raceway, provision of grounding shall be sufficient. Additional measures such as spark gap arresters or surge suppressor shall be considered where an entire system is to be installed.

15.3 DESIGN SUBMITTAL REQUIREMENTS

See Chapter 13.2 “Design Submittal Requirements” under Electrical.

15.4 COMMUNICATIONS – VOICE AND DATA

15.4.1 BASIC REQUIREMENTS AND SCOPE

The telecommunications system design shall comply with NEC, Corps of Engineers specifications, TIA/EIA 568A, 569, 607, I3A, and any base-specific requirements.
Outside plant shall conform to REA publications in the absence of other criteria. The design shall form a complete communications system, including, but not limited to: wires, terminations, raceway, cabinets, and outlets, as determined by the criteria for each project. In addition, it will also be necessary to provide instruments and switching equipment. Since head-end equipment and portable items involve a different funding category, the design documents need to separately address this portion of the system. Isolate physically on drawings or flag by symbols, annotations, descriptive notes, etc. to allow quick identification and takeoffs for cost estimates. The designer shall consult with the Stakeholder to verify communication requirements.

When involved with a large complex or building (i.e., multi-building complex, etc.), make a determination as early as possible if a private automatic branch exchange (PABX) is or will be planned. PABX installations require special considerations (e.g., space, additional HVAC, vented exhaust systems for batteries, rated walls, hazardous area, etc.). Often, the plans for a PABX may not be stated in the specific project document.
State any requirement or anticipated plans for a PABX in the concept design analysis along with all data justifying this need.

15.4.2 RACEWAY AMD CABLE TRAY

For Army projects, provide a conduit system in accordance with Technical Criteria for Installation Information Infrastructure Architecture (I3A). For Air Force projects, provide conduit system in accordance with Air Force Base Area Network Functional Specification 2013. For larger facilities, use of cable tray in corridors is recommended in lieu of individual conduit home runs.

15.4.3 CABLE

Inside cable will be presumed to be in the project scope unless specifically directed otherwise; outside cable will be normally be provided by others under separate

contract. Scope shall be confirmed at initial design stage. All raceways, cabinets, backboards and boxes will be installed with necessary wiring.

15.4.4 OUTLETS

Provide 8-pin USOC type RJ-45 jacks (verify with Stakeholder).

15.4.5 TERMINATING EQUIPMENT

Outlet and Cabinet (or Backboard) locations (prior to final design) shall be provided in accordance with designer's best estimate of the communications requirement. This is necessary for cost estimation. Final locations shall be coordinated with the local Communications Installation Engineers prior to final plan submittal.

15.4.6 UNDERGROUND DUCT

Installation in concrete encased duct shall be the standard method. If primary power follows the same routing, install in a common duct bank. An extension directly into a building from an adjacent communication pole may be in non-encased PVC if the Stakeholder has no objection.

15.4.7 DRAWINGS

Provide complete riser diagram for each system. Identify location of components by room number, building name or number, etc.

15.5 SPECIAL COMMUNICATIONS AND DATA SYSTEMS

15.5.1 PUBLIC ADDRESS SYSTEMS

Public Address Systems shall be provided in accordance with UFGS 27 51 16. Public address systems encompass many applications of amplified voice and music used for entertainment and distribution of voice messages. They run the gamut from a speech reinforcement system in a conference room to a frequency equalized voice and music system for an auditorium, and on to a complex multi-zone system used for both background music and selective paging by zone with multi-media selectable inputs and area level control with paging capability. Most systems involve amplifiers, loudspeakers, and a program input. Inputs include microphones, AM/FM tuners, tape decks, phonographs, and compact disk players. Many configurations can be developed using standard equipment to fit any desired operational requirement. Each system is to be designed to meet the user's criteria requirements.

In many cases, space limitations dictate the use of wall-mounted amplifiers. Dual voice coil speakers shall be used for background music systems that require voice paging to override the music levels. The use of miniature relays at zone volume controls to override volume control settings for paging shall be avoided. In small systems employing relatively short runs of audio bus cable and low power requirements, a 24-volt distribution system shall be used. Where long runs with high power requirements are levied on the distribution network, a 70-volt system shall be used. The choice of all system components shall be based on design calculations. These calculations shall begin with the desired sound pressure level to be achieved in each area and be

developed through the system to establish component power capacity and wire sizes.

Specifications shall include sufficient technical data to establish minimum equipment quality levels. This data shall include frequency response, distortion, RMS power capacity, and minimum number and types of controls. Public address systems shall be designed in accordance with the specifications and EIA standards for sound systems.

All-channel paging, consisting of paging microphone, push-to-talk switch paging amplifier, and one or more paging relays, shall be provided. All accessories, material and other equipment for a complete public address system shall be furnished. The system shall be accessed via the telephone system and may be located in the main telephone equipment room for convenience of interfacing. The design of Public Address System shall be coordinated with the telephone system and the user. The system shall be sized to be audible at all points throughout the facility. The system can be accessed through individual telephone handsets as well as through PBX switch. The system shall provide hands free talk back capabilities in lab areas.

At a minimum, separate paging zones shall be provided for the following areas: Administrative offices, Chemical labs, Biological labs, General office areas, Hazardous storage areas, Parking lots, and Exterior secured areas. In multi-floor facilities, further zoning will be required. Controls for individual speaker units shall be wall mounted and include volume control and on/off switching.

15.6 FIBER OPTICS

Use of fiber optic cable is encouraged by USACE. FO cable is preferred for LAN backbones and for the voice and data links between buildings. Category 6 type copper wire shall be used for horizontal wiring within buildings. Fiber Optic cable shall not be used for telephone systems that include PBX type equipment.

15.7 ELECTRONIC SECURITY SYSTEMS

Determine the scope and extent of the electronic security systems (ESS) to be included in the project during the initial planning charrette. ESS includes intrusion detection systems (IDS), access control systems, closed circuit television (CCTV), and duress alarms. Coordinate ESS responsibilities with FED, the project owner, and the base security department. Include in the planning charrette report a list showing the responsibilities of each member of the project delivery team. The list shall show how much of the ESS the AE will design (raceways and boxes only, system components, etc.), shall discuss the level of involvement and the responsibilities of outside organizations such as SPAWAR, and shall show which equipment items are project funded and which are funded by other sources.

15.7.1 INTRUSION DETECTION SYSTEMS

See AR 190-13 and other regulations pertaining to specific types of projects. Design direction and supervision is available from the ESS-MCX (Center of Expertise) at Huntsville Division.

A lockable circuit breaker shall be reserved for the Intrusion Detection System primary

power connection in the 120V power panel located nearest the service entrance.

All signal conductors outside component enclosures shall be enclosed in rigid, heavy wall conduit or intermediate metal conduit (IMC). Power cable from the Control Unit and the Monitor Cabinet to their respective junction boxes may be in electrical metal tubing (EMT).

15.7.2 IDS SUPPORT

In a majority of projects, raceway rough in is sufficient plus circuits for 120V power supply.

15.7.3 ACCESS CONTROL

Coordinate with architectural and civil designers as applicable. Generally, providing supply circuits and raceway rough in is sufficient for electrical support.

15.7.4 CCTV

The video security system, where required, shall be integrated into the overall function of the facility. Placement of cameras shall be carefully considered in order to avoid dead zones. Conduit and wiring shall be installed for the system and a camera shall be installed at all entrance and exit areas. The location of the camera shall be suitable for monitoring people movement when entering or leaving the building and an emergency circuit shall provide power for each camera location. Conduit, wiring, cameras, etc., shall also be installed in all parking lots, loading docks, and computer areas to provide monitoring.

Cameras shall be of the fixed or pan-tilt-zoom type as required for each specific location. Camera components shall include cameras, lenses, fixed and remote-control camera accessories, camera housing, and environmental options. Cameras shall be housed in proper enclosures for the environment in which they are to operate (e.g., defrosters, heaters, weatherproof enclosures, corrosion resistant or vandal proof enclosures, etc.).

All cameras shall be monitored/controlled at the facilities central control station. Monitors shall be event driven. Monitor components shall include monitors and monitor mounts. Digital video recording equipment shall be provided where required, to record unauthorized access (control by guard).

15.7.5 DURESS ALARMS

Determine during the planning charrette the feasibility of any duress alarms that may be requested or required by the owner. Determination shall be based, in part, on the availability an alarm monitoring point, the capacity of the monitoring point, the location of the monitoring point and its distance from the project site, and the type of connection required (hard wired or wireless).

15.7.6 CYBERSECURITY

Designs shall comply with the requirements of Engineering and Construction Bulletin (ECB) 2022-02, issued 07 Jan 2022, Subject: Cybersecurity Requirement for Design

and Construction of Control Systems and Integrated Low Voltage Systems for Permanent and Non-permanent Construction, Unified facilities Criteria (UFC) 4-010-06 Cybersecurity of Facility-Related Control Systems and the FED Guide Specifications Section 25 05 11, Cybersecurity for Facility-Related Control Systems.

Design documents shall include system descriptions that provide adequate information for local contractors to prepare a bid. The documents shall include, at a minimum, Cybersecurity device and inventory schedules, inter-connection diagrams for each network, one-line diagrams, wiring diagrams, sequence of operations, hardware / software descriptions, equipment layout plan views, equipment layout elevations, and keyed explanatory notes.

CHAPTER 16 - SUSTAINABILITY

16.1 GENERAL

This section covers requirements for successful implementation of Sustainable Design and Development (SDD).

Sustainable Design and Development is an integrated approach to planning, designing, constructing, operating and maintaining facilities in an environmentally-sensitive manner. Building construction and operation have an enormous direct and indirect impact on the environment. This "sustainable" approach supports an increased commitment to environmental stewardship and conservation, and results in an optimal balance of cost, environmental, societal, and human benefits while meeting the mission and function of the intended facility or infrastructure. The main objectives of sustainable design are to avoid resource depletion of energy, water, and raw materials; prevent environmental degradation caused by facilities and infrastructure throughout their life cycle; and create built environments that are livable, comfortable, safe, and productive.

16.2 DESIGN CRITERIA

The design publications listed below are the key criteria for sustainable design. The criteria from these sources may be supplemented, but not supplanted, by applicable criteria contained in nationally recognized codes, standards, and specifications.

Many of the referenced government engineer publications can be found in the Whole Building Design Guide at https://www.wbdg.org/ffc/dod.

Design effort associated with the development of the design documents shall be based on all applicable requirements/criteria, including, but not limited to, the latest versions of the following. In the event any conflict is noted between any requirements/criteria, the more stringent shall apply unless specifically noted otherwise:

- HQ AFCESA/CEO ETL 08-13, Incorporating Sustainable Design and Development (SDD) and Facility Energy Attributes in the Air Force Construction Program
- HQ USAF/A7C memo, Air Force Sustainable Design and Development (SDD) Implementing Guidance
- Department of the Army ASA IEE memo, Sustainable Design and Development Policy Update
- NAVFAC ECB 2014-02, NAVFAC Sustainability and Energy Building Requirements
- UFC 1-200-02, High Performance and Sustainable Building Requirements,
- ANSI/ASHRAE/IESNA Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings

- International Green Construction Code (IgCC)
- LEED BD+C v4 Rating System: https://www.usgbc.org/resources/leed-v4-building-design-and-construction-current-version
- US Green Building Council (USGBC)/Green Building Certification Inc. (GBCI) DoD Guiding Principles Certification Program: https://www.usgbc.org/articles/understanding-federal-compliance-and- guiding-principles
- Green Building Initiative (GBI) DoD Guiding Principles Compliance Program: https://thegbi.org/guiding-principles-compliance-certification

16.3 SUSTAINABILITY IMPLEMENTATION

16.3.1 THIRD PARTY CERTIFICATION

Projects meeting the thresholds for Third Party Certification (TPC) in Table 1-1 of UFC 1-200-02 shall obtain third party certification validated by the TPC provider. Projects located on Army Installations shall use the applicable LEED rating system for the project type and achieve at least LEED Silver certification. All other projects in the FED AOR shall use the USGBC/GBI DoD Guiding Principles Certification (GPC) Program.

16.3.1.1 THIRD PARTY CERTIFICATION (TPC) PROJECT REGISTRATION

The designer shall register the project with the applicable Third Party Certification (TPC) rating system and provide the Government with full access. The project registration shall be completed prior to the submission of the Concept design. The split review approach (separate design and construction submittal) shall be used. The designer shall utilize the TPC's online system to prepare all project documentation necessary for the design phase review. The designer shall provide the results of the final design phase review to USACE no later than one-month following the acceptance of the final backcheck design. After project registration, the designer shall grant Project Administrator rights to the FED SDD POC.

16.3.1.2 ACCREDITED PROFESSIONAL

The designer shall have a LEED BD+C Accredited Professional (AP) on the project team from contract award through closeout. The LEED AP shall facilitate an integrated design process, assist each discipline in their responsibilities, ensure correct interpretation of the TPC rating system credits, and ensure TPC rating system design phase supporting documentation is correct and complete.

16.3.1.3 TPC DESIGN DOCUMENTATION SUBMITTAL REQUIREMENTS

At a minimum, at each design submittal the designer shall provide a current TPC checklist along with a narrative describing how each credit will be met on this project. A checklist containing an additional column with the narrative is sufficient. For projects pursuing GPC certification, the GPA DoD Project Information Form shall be used. The GPA DoD Project Information Form will be provided by GBCI after project registration.

16.3.2 UFC 1-200-02 COMPLIANCE

The designer shall fulfill the requirements of the applicable sections of UFC 1-200-02. Table 1-1 of the UFC shall be used to determine the applicable sections. In the event that one or more of the requirements from UFC 1-200-02 cannot be met, the designer shall provide a written description of the issue along with supporting documentation and calculations. At each design submittal, the designer shall provide a current UFC 1-200- 02 compliance checklist along with a narrative describing how each requirement is fulfilled on this project. A checklist containing an additional column with the narrative is sufficient. Projects pursuing GPC certification may use the GPA DoD Project Information Form in lieu of a separate UFC 1-200-02 checklist.

16.3.3 HIGH PERFORMANCE AND SUSTAINABLE BUILDING GUIDANCE (HPSB)

Each DoD agency has an agency specific HPSB Compliance Checklist. This checklist is used by the agency for upward reporting. The designer shall provide a completed agency specific HPSB checklist in the final design submittal. UFC 1-200-02 Section 4-3 contains links to each agency's current HPSB Compliance Checklist.

16.4 ENERGY MODELING

Perform an energy modeling analysis to validate SDD features during design development, document estimated energy reduction levels, and demonstrate compliance with federal mandates and service component policy. Specifically, produce an energy model analysis to show compliance with the UFC 1-200-02 requirements for 30% energy reduction below an ASHRAE 90.1-2013/IECC 2009 baseline, if life-cycle cost effective, and any other specific service component energy reduction target. If the LEED rating system is being used, also modify the energy model for use in accordance with LEED EA Credit 1 – Optimize Energy Performance. The designer shall provide an updated energy model along with each design submittal.

16.4.1 NATIVE FILES

At each phase of design, native simulation files for life cycle cost analysis and energy modeling shall be provided to the Government with each design submittal.

Weather files for modelers are available in one of the following formats EPW (Energy Plus Weather) located at the following website: https://energyplus.net/weather or DOE2 files located at the following website http://doe2.com/index_Wth.html.

16.4.2 ENERGY PERFORMANCE

The goal for most projects is to achieve the highest energy or water efficiency that is life-cycle cost effective within project funds. Projects with energy and water optimization requirements shall comply with the below requirements which apply to the pre- solicitation stages of both design-bid-build and design-build projects.

The building envelope, interior and exterior lighting, HVAC, plumbing, and renewable

energy systems for the project shall be based on the results of life-cycle cost analyses prepared in accordance with applicable criteria. The systems and features for the building shall be selected during the concept phase of design for design-bid-build projects and during pre-solicitation/RFP development for design-build projects.

The minimum number of systems/features to analyze shall be as follows:

- Baseline and three alternatives (where applicable) for each of the wall systems, roof systems, lighting systems, and domestic hot water systems.
- Baseline and two alternatives for windows.
- Baseline and three viable alternatives for HVAC systems.

Where separate systems would be used for different areas of the building or different buildings in the project, each area or building shall be evaluated separately. Example: Area A and Area B will have separate HVAC systems; each area will have four alternatives analyzed. In any case where geo-exchange or ground source heat pump systems will be analyzed, both full and hybrid systems shall be analyzed. The number of alternatives to analyze may be reduced at the sole discretion of USACE. The systems/features to be analyzed shall be sufficiently varied to ensure that a wide-range of installed costs, maintenance costs, energy savings, etc. are considered; however, the systems/features selected for analysis shall also be available within the project funding.

Propose systems/features for analysis based on project stakeholder input (maintenance capability, available utilities, functional requirements, aesthetics, anti-terrorism/force- protection, etc.), preferences, design guides, etc. The AE shall provide brief narratives describing the reasoning used to determine the systems/features proposed for analysis.

The AE shall evaluate the HVAC system feasibility for energy and heat recovery and associated renewable components where applicable.

As an alternative to performing some of these energy and life-cycle cost analyses, data from previous energy and life-cycle cost analyses may be used for similar building types, sizes, occupancy/usage patterns, internal heat gains, utility rates, and climate at the sole discretion of USACE.

The information resulting from the analyses including installed costs, utility costs, operation and maintenance costs, and salvage value along with any other advantages and disadvantages to the systems/features analyzed shall be presented to the project stakeholders for discussion and final selection for incorporation into design at the end of the charrette. The AE shall retain documentation of approval of the systems/features selected.

Full year, 8,760 hourly calculations energy simulations shall be performed using Trane Trace, Carrier HAP, EQuest or IES VE Pro. Other energy simulation software shall be approved in advance by the Contracting Officer.

16.4.3 ENERGY COMPLIANCE ANALYSIS

Comply with UFC 1-200-02 High Performance and Sustainable Building

Requirements energy modeling requirements. Provide an Energy Compliance Analysis complying with UFC 1-200-02 with the final design submittal. In addition to the requirements of UFC 1- 200-02, include the following in the narratives:

- A listing of all energy conservation criteria that applies to the project and how the project has met compliance.
- Identification of the software used to prepare the calculations including the vendor and version.
- Summary table showing the baseline and proposed building annual energy consumption, energy costs, and calculated maintenance costs. The table shall show the energy consumption reduction percentage calculated and the energy cost reduction percentage calculated in accordance with TPC requirements.
- Description of each energy conservation feature and strategy designed for the project. Include rationale for selected systems to model. Provide a description of how the design limited or contributed to any maintenance cost increases caused by the energy conservation features and strategies.
- Provide a chart demonstrating the annual energy consumption and energy cost attributed to each end energy use including, but not limited to, lighting, space cooling, space heating, ventilation, receptacle/process loads, and hot water heating.
- Provide a report showing the monthly electricity and natural gas consumption for 12 consecutive months.
- Explanation of modeling assumptions, including but not limited to; material U-values, lighting loads, interior equipment loads, service water heating equipment, space heating equipment, space cooling and heat rejection equipment, fans and other HVAC equipment.

Input and output reports in excess of 100 pages may be provided electronically via CD or DVD. In addition to required reports, provide native files for computer generated calculations and simulations. Required reports include:

- Checksums output. Energy Simulation outputs and inputs for all spaces, systems, plants, schedules.
- Energy Cost Budget and Performance Summary.
- ASHRAE 62.1 output summary and/or calculations.
- LEED and/or Sustainability Summary Output Report.

Load analysis and energy model input and output shall be organized such that each space, zone, system, item of equipment, building component, etc. is correlated with identifiers on design plans and easily identifiable. Examples:

Conference Room #244 is identified as Conf Rm #244 on input/output documents; AHU-2-4 is identified as AHU-2-4 on input/output documents; Zone 3-4 on the input/output files is associated w/ VAV 3-4.

All calculations provided in worksheet format shall be clear with respect to method of calculation or include description of how the calculations were performed.

16.5 LIFE CYCLE COST ANALYSIS (LCCA)

Perform life-cycle cost analyses (LCCA) to evaluate SDD features during design development, and to demonstrate compliance with UFC 1-200-02 and ECB No. 2020-8. The LCCA shall be done in accordance with UFC 1-200-02 and ECB No. 2020-8. The LCCA report shall be prepared using the National Institute of Standards and Technology Handbook 135 (http://www.nist.gov/el/buildeconomic.cfm) and the Building Life Cycle Costing (BLCC) software program http://www1.eere.energy.gov/femp/information/download_blcc.html.

For all projects (regardless of if an energy modeling analysis is done), produce LCCAs for major building envelope features, large building HVAC systems, all renewable energy systems, vegetative roof gardens, specialized wastewater or stormwater treatment systems, and other SDD features that are energy-related.

CHAPTER 17 - CLIMATE DATA

17.1 GENERAL

This chapter will include the related climate data, climate zone information, along with related electrical, mechanical, civil and architectural associated climate information.

17.2 CLIMATE ZONES

The climatic patterns of Korea have a wide range, from tropical to cold regions. Refer to the climate zones as classified by ASHRAE Standard 169-2013.

17.3 DRY BULB, WET BULB

Follow the UFC 3-410-01 for the temperature requirements.

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CHAPTER 18 - COMMISSIONING

18.1 GENERAL

This chapter provides general guidance regarding commissioning of building systems. The specific commissioning team members, activities, and level of rigor shall be tailored to individual projects based on size, complexity, and the planned quality management.

18.2 DESIGN CRITERIA

All work shall conform to, but not limited to, the following criteria:

- UFC 1-200-02 High Performance and Sustainable Building Requirements
- ASHRAE Guideline 0-2013, The Commissioning Process
- ASHRAE Guideline 1.1-2007, HVAC&R Technical Requirements for the Commissioning Process
- International Green Construction Code (IgCC)
- ER 1110-345-723 Total Building Commissioning Procedures for USACE Projects

If a project has a Leadership in Energy and Environmental Design (LEED) requirement, commissioning requirements are imposed by the LEED Rating Systems. The design publications listed below shall be used as sources of criteria for commissioning. The criteria from these sources may be supplemented, but not supplanted, by applicable criteria contained in nationally recognized codes, standards, and specifications.

Many of the referenced government engineer publications can be found in the Whole Building Design Guide at https://www.wbdg.org/ffc/dod.

Design effort associated with the development of the design documents is typically based on all applicable requirements/criteria, including, but not limited to, the latest versions of the following. In the event any conflict is noted between any requirements/criteria, the more stringent typically applies unless specifically noted otherwise.

18.3 COMMISSIONING REQUIREMENTS

Total building commissioning activities shall be implemented for all Military Construction Army (MCA) projects executed by USACE that are subject to any of the referenced documents regardless of location (CONUS/ OCONUS) that include over 5,000 gross square feet (GSF) of interior space and the construction cost is greater than $3 million.

18.3.1 COMMISSIONING SPECIALISTS

18.3.1.1 Commissioning Specialist for the Government (CxG)

The CxG is the lead individual, employed by the Design and Construction Agent, but not affiliated with the construction contractor, and is responsible for government oversight of the commissioning process. The CxG shall have expertise in the commissioning of facilitates of type of similar scope and complexity comparable to the individual project. The CxG is required for all project procurement methods. The CxG is supported by other commissioning specialists/team members as necessary.

For the purpose of meeting USGBC's LEED Rating system EA Credit 3, "enhanced" Cx requirements, the CxG is considered the CxA for Design-Bid-Build (DBB) and for Design-Build (DB) projects. When LEED certification EA Credit 3 is being pursued from USGBC or any other 3rd party certification process, the CxG must possess the required applicable qualifications.

18.3.1.2 Commissioning Specialist for the Design Phase (CxD).

The CxD is the lead individual on the Design A/E staff, an employee of a commissioning firm directly contracted by the A/E, or for in-house projects, can be on the in-house USACE design staff, having expertise in the commissioning process for facilities of a scope and complexity comparable to the individual project, and is responsible for the commissioning activities during the design phase. The CxD is required for Design-Bid-Build (DBB) projects, and during Design-Build (DB) RFP preparation for DB projects. The CxD is supported by other commissioning specialists/team members as necessary.

18.3.1.3 Commissioning Specialist for the Construction Phase (CxC).

The CxC is the lead individual, employed by a commissioning firm, responsible for managing, scheduling, executing, and documenting commissioning activities for the duration of the construction contract. Both the commissioning firm and the CxC must be certified commissioning providers with the experience and expertise in the commissioning of facilities of comparable scope and complexity. Acceptable commissioning certification programs shall be as defined in the latest FED Guide Specifications. The CxC must also be employed regularly in building commissioning. Generally, the CxC shall be employed by a commissioning firm that is a first tier subcontractor hired by the construction contractor, and is supported by other commissioning specialists employed by that firm; however, as determined by the Authority Having Jurisdiction (AHJ), in consideration of the size, scope, and complexity of the project, with requisite experience and qualifications, the CxC may be an employee of the prime construction contractor. The CxC in a Design-Build Acquisition will also assume the responsibility for the design related commissioning tasks and duties associated with the design phase of the project. The CxC is required for all projects.

18.3.2 SPECIFICATIONS

Construction or Design-Build projects in the Far East District shall use the FED Guide Specifications Section 01 91 00.15 10 Total Building Commissioning .

The specification shall be edited in accordance with the specifier notes therein and shall be included in the solicitation of the construction or design-build contract.

18.3.3 COMMISSIONING DESIGN REVIEW

Projects shall have the commissioning specialist review the design documents, the Owner's Project Requirements, and the Basis of Design document with the interim submission. The commissioning specialist shall also review the final submission and backcheck comments. Commissioning comments shall be entered and addressed through DrChecks similar to other required design reviews.

18.4 COMMISSIONING DOCUMENTS

18.4.1 OWNER'S PROJECT REQUIREMENTS DOCUMENT

The Owner's Project Requirements (OPR) document shall be developed by the AE preparing the design or design-build RFP. A design-build RFP shall not serve as the OPR document. The OPR shall include the information required by LEED and IgCC and shall be attached to the project commissioning specification as an appendix.

The AE shall have the OPR complete prior to the interim submission of the design documents for review by the commissioning specialist.

Develop the Owner's Project Requirements by using the Far East District OPR template and customizing it according to this project's requirements prior to the project Charrette Conference. During the charrette, coordinate with the user and installation and complete the questionnaire. After the Concept submittal, the third party commissioning agent will inherit the OPR document. Develop the Basis of Design based upon the OPR as an integrated part of the design analysis.

18.4.2 BASIS OF DESIGN

The Basis of Design (BOD) document shall be developed by the designer of record. The AE shall prepare the BOD for design-bid-build projects and include it as an appendix to the project commissioning specification. A draft BOD shall be completed prior to the interim submission of the design documents for review by the commissioning specialist. For design-build projects, the design-build contractor's design team develops the BOD.

18.4.3 COMMISSIONING PLAN

The Commissioning Plan will be developed by the commissioning specialist. The AE shall attach the Commissioning Plan to the project commissioning specification for both design-bid-build and design- build projects. For other projects, the contractor's commissioning specialist develops the Commissioning Plan.

18.4.4 CHECKLISTS

Example commissioning checklists are included in the commissioning specification templates. For projects with a contractor hired commissioning specialist, the AE shall retain the example checklists as appendices in the commissioning specification. The commissioning specialist will be required to provide project specific checklists.

For design-bid-build projects, the commissioning specialist shall develop and provide project specific checklist which the AE shall attach as appendices to the commissioning specification. For design- build projects with independent commissioning, the AE shall retain the example checklists or provide examples prepared by the commissioning specialist as appendices in the commissioning specification.

CHAPTER 19 - ENVIRONMENTAL

19.1 GENERAL

This chapter covers special guidelines for the preparation of environmental specifications and various environmental surveys, as applicable, to the design process.

19.2 DESIGN CRITERIA

Construction and Service projects for Installations in Korea are subject to the latest Korea Environmental Governing Standards (KEGS), FED Guide Specifications, service component and Installation requirements. Specific Installation or unique project considerations shall be included in the specifications to address any additional requirements.