JAPAN DISTRICT DESIGN GUIDE

FEBRUARY 2017

Version 1.0 Approved for Public Release, Distribution Unlimited.
# TABLE OF CONTENTS

PREFACE ................................................................................................................................................................ V

CHAPTER 1 – GENERAL INSTRUCTIONS .................................................................................................................. 1
  1.1. PURPOSE .............................................................................................................................................. 1
  1.2. DESIGN POLICY ..................................................................................................................................... 1
  1.3. DESIGN CRITERIA, REGULATIONS, MANUALS AND STANDARDS ............................................................. 2
  1.4. COST ESTIMATES .................................................................................................................................. 2
  1.5. JAPANESE MATERIALS AND PRODUCTS ................................................................................................. 2
  1.6. JAPANESE PREFECTURAL DIFFERENCES ................................................................................................. 2

CHAPTER 2 – SUBMITTAL REQUIREMENTS ............................................................................................................. 3
  2.1. GENERAL .............................................................................................................................................. 3
  2.2. DESIGN DEVELOPMENT ........................................................................................................................ 3
  2.3. DESIGNER RESPONSIBILITY ................................................................................................................... 3
  2.4. GENERAL DRAWING REQUIREMENTS .................................................................................................... 4
  2.5. PARAMETRIC DESIGN REQUIREMENTS .................................................................................................. 4
  2.6. CONCEPT DESIGN REQUIREMENTS ........................................................................................................ 4
  2.7. INTERMEDIATE DESIGN REQUIREMENTS ............................................................................................. 10
  2.8. FINAL DESIGN REQUIREMENTS ........................................................................................................... 19
  2.9. BACKCHECK DESIGN REQUIREMENTS .................................................................................................. 21

CHAPTER 3 – SPECIFICATIONS .............................................................................................................................. 23
  3.1. GENERAL ............................................................................................................................................ 23
  3.2. DESIGN CRITERIA ................................................................................................................................ 23
  3.3. GUIDE SPECIFICATIONS ....................................................................................................................... 23
  3.4. PREPARATION OF PROJECT SPECIFICATIONS ....................................................................................... 23
  3.5. AMENDMENTS ................................................................................................................................... 26
  3.6. SPECIAL REQUIREMENTS .................................................................................................................... 26

CHAPTER 4 – QUALITY CONTROL REQUIREMENTS ............................................................................................... 29
  4.1. CRITERIA ............................................................................................................................................ 29
  4.2. DEFINITIONS ...................................................................................................................................... 29
  4.3. QUALITY CONTROL PLAN .................................................................................................................... 30

CHAPTER 5 – ANTITERRORISM ............................................................................................................................. 35
  5.1. GENERAL ........................................................................................................................................... 35
  5.2. DESIGN CRITERIA ................................................................................................................................ 35
  5.3. DEFINITIONS ...................................................................................................................................... 36
  5.4. BLAST ANALYSIS ................................................................................................................................. 36
  5.5. STRUCTURAL COMPONENTS .................................................................................................................. 36
  5.6. STANDARD 1: STANDOFF DISTANCES .................................................................................................. 36
  5.7. STANDARD 2: UNOBSERVED SPACE ..................................................................................................... 37
<table>
<thead>
<tr>
<th>CHAPTER 6 – CIVIL</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1. DESIGN CRITERIA</td>
<td>45</td>
</tr>
<tr>
<td>6.2. DESIGN SUBMITTAL REQUIREMENTS</td>
<td>46</td>
</tr>
<tr>
<td>6.3. DRAWING COMPOSITION</td>
<td>55</td>
</tr>
<tr>
<td>6.4. GEOTECHNICAL INVESTIGATION AND REPORT</td>
<td>56</td>
</tr>
<tr>
<td>6.5. TOPOGRAPHIC SURVEYS</td>
<td>56</td>
</tr>
<tr>
<td>6.6. SITE LAYOUT</td>
<td>59</td>
</tr>
<tr>
<td>6.7. PARKING</td>
<td>60</td>
</tr>
<tr>
<td>6.8. ROADS</td>
<td>62</td>
</tr>
<tr>
<td>6.9. GRADING</td>
<td>64</td>
</tr>
<tr>
<td>6.10. STORM DRAINAGE</td>
<td>65</td>
</tr>
<tr>
<td>6.11. FENCING</td>
<td>66</td>
</tr>
<tr>
<td>6.12. SPECIAL SITE SECURITY REQUIREMENTS</td>
<td>66</td>
</tr>
<tr>
<td>6.13. LANDSCAPE</td>
<td>66</td>
</tr>
<tr>
<td>6.14. UTILITIES</td>
<td>66</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHAPTER 7 – STRUCTURAL</th>
<th>69</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1. GENERAL</td>
<td>69</td>
</tr>
<tr>
<td>7.2. DESIGN CRITERIA</td>
<td>69</td>
</tr>
<tr>
<td>7.3. STRUCTURAL LOADINGS</td>
<td>72</td>
</tr>
<tr>
<td>7.4. DEAD LOADS</td>
<td>72</td>
</tr>
<tr>
<td>7.5. FLOOR LIVE LOADS</td>
<td>73</td>
</tr>
<tr>
<td>7.6. SNOW LOADS</td>
<td>73</td>
</tr>
<tr>
<td>7.7. WIND LOADS</td>
<td>73</td>
</tr>
<tr>
<td>7.8. SEISMIC LOADS</td>
<td>73</td>
</tr>
<tr>
<td>7.9. ANTITERRORISM (AT) STANDARDS</td>
<td>74</td>
</tr>
<tr>
<td>7.10. BUILDING CONSTRUCTION</td>
<td>74</td>
</tr>
<tr>
<td>7.11. FOUNDATION DESIGN</td>
<td>74</td>
</tr>
<tr>
<td>7.12. CONCRETE DESIGN</td>
<td>75</td>
</tr>
<tr>
<td>7.13. REINFORCING BARS</td>
<td>76</td>
</tr>
<tr>
<td>7.14. BUILDING SLABS-ON-GRADE</td>
<td>77</td>
</tr>
<tr>
<td>7.15. CONCRETE WALL THICKNESSES</td>
<td>78</td>
</tr>
<tr>
<td>7.16. MASONRY</td>
<td>79</td>
</tr>
<tr>
<td>7.17. STRUCTURAL STEEL</td>
<td>79</td>
</tr>
<tr>
<td>7.18. STEEL JOISTS AND JOIST GIRDERS</td>
<td>81</td>
</tr>
<tr>
<td>7.19. STEEL DECKING</td>
<td>81</td>
</tr>
<tr>
<td>7.20. COLD-FRAMED LOAD BEARING STEEL STUD WALLS</td>
<td>81</td>
</tr>
<tr>
<td>7.21. SPECIAL CONSTRUCTION</td>
<td>81</td>
</tr>
<tr>
<td>7.22. BLAST RESISTANT CONSTRUCTION</td>
<td>82</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHAPTER 8 – ARCHITECTURE</th>
<th>85</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1. GENERAL</td>
<td>85</td>
</tr>
<tr>
<td>8.2. DESIGN CRITERIA</td>
<td>85</td>
</tr>
<tr>
<td>8.3. DESIGN FOR SAFETY</td>
<td>85</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>11.22. FOOD SERVICE FACILITY REQUIREMENTS</td>
<td>141</td>
</tr>
<tr>
<td>11.23. MEDICAL FACILITY REQUIREMENTS</td>
<td>141</td>
</tr>
<tr>
<td>11.24. HVAC TEMPERATURE CONTROL SYSTEM</td>
<td>141</td>
</tr>
<tr>
<td>11.25. UTILITY CONTROL SYSTEM (UCS) / ENERGY MONITORING AND CONTROL SYSTEMS (EMCS)</td>
<td>143</td>
</tr>
<tr>
<td>11.26. GUIDE SPECIFICATIONS</td>
<td>144</td>
</tr>
<tr>
<td>11.27. ELEVATORS</td>
<td>145</td>
</tr>
<tr>
<td>12.1. GENERAL</td>
<td>147</td>
</tr>
<tr>
<td>12.2. DESIGN CRITERIA</td>
<td>147</td>
</tr>
<tr>
<td>12.3. GENERAL PIPING REQUIREMENTS</td>
<td>147</td>
</tr>
<tr>
<td>12.4. IDENTIFICATION OF PIPING</td>
<td>148</td>
</tr>
<tr>
<td>12.5. SEISMIC DESIGN CONSIDERATIONS</td>
<td>148</td>
</tr>
<tr>
<td>12.6. PLUMBING SYSTEMS</td>
<td>149</td>
</tr>
<tr>
<td>13.1. GENERAL</td>
<td>153</td>
</tr>
<tr>
<td>13.2. DESIGN SUBMITTAL REQUIREMENTS</td>
<td>161</td>
</tr>
<tr>
<td>13.3. DESIGN CALCULATIONS AND POWER SYSTEMS ANALYSIS</td>
<td>167</td>
</tr>
<tr>
<td>13.4. EXTERIOR ELECTRICAL DESIGN</td>
<td>171</td>
</tr>
<tr>
<td>13.5. INTERIOR ELECTRICAL DESIGN</td>
<td>184</td>
</tr>
<tr>
<td>13.6. LIGHTING DESIGN</td>
<td>195</td>
</tr>
<tr>
<td>13.7. LIGHTNING PROTECTION AND GROUNDING DESIGN</td>
<td>199</td>
</tr>
<tr>
<td>14.1. GENERAL</td>
<td>207</td>
</tr>
<tr>
<td>14.2. DESIGN SUBMITTAL REQUIREMENTS</td>
<td>208</td>
</tr>
<tr>
<td>14.3. COMMUNICATIONS – VOICE AND DATA</td>
<td>208</td>
</tr>
<tr>
<td>14.4. SPECIAL COMMUNICATIONS AND DATA SYSTEMS</td>
<td>209</td>
</tr>
<tr>
<td>14.5. FIBER OPTICS</td>
<td>210</td>
</tr>
<tr>
<td>14.6. SECURITY SYSTEMS</td>
<td>210</td>
</tr>
<tr>
<td>15.1. GENERAL</td>
<td>213</td>
</tr>
<tr>
<td>15.2. DESIGN CRITERIA</td>
<td>213</td>
</tr>
<tr>
<td>15.3. SUSTAINABILITY IMPLEMENTATION</td>
<td>214</td>
</tr>
<tr>
<td>15.4. DESIGN DOCUMENTATION SUBMITTAL REQUIREMENTS</td>
<td>215</td>
</tr>
<tr>
<td>15.5. SUSTAINABILITY ADAPTATION FOR JAPAN</td>
<td>217</td>
</tr>
<tr>
<td>16.1. GENERAL</td>
<td>219</td>
</tr>
<tr>
<td>16.2. CLIMATE ZONES</td>
<td>219</td>
</tr>
<tr>
<td>16.3. DRY BULB, WET BULB</td>
<td>220</td>
</tr>
<tr>
<td>16.4. RAINFALL DATA</td>
<td>221</td>
</tr>
</tbody>
</table>
In recent years, the United States saw a significant shift in American foreign policy from a Middle Eastern/European focus to an East/South Asian focus. In 2012, additional focus was placed on the Japan region’s strategy. This strategy resulted in a surge of infrastructure requirements that have placed a considerable amount of strain on the Japan District due to limited resources and extremely high volumes of work requirements. The District reacted as best they could and relied heavily on the expertise of our Architectural-Engineer (A-E) partnerships. Without this expansion of the District team, the work may not have been completed.

However, the extreme volume and unprecedented pace to be executed brought to light the need for uniformity among projects. As a service to our in-house design team, A-E partners and reach back districts, the Japan District has developed the Japan District Design Guide (JDDG) to assist all of our design partners.

It has been envisioned that the JDDG will be a valued and often used desk reference for practicing professionals, and others who may have a desire to use it, on the proven engineering techniques and expectations of the District. It has been made available to all and should be thoroughly examined, marked-up, noted and high-lighted. Practitioners should be very familiar with the guide holistically and be thoroughly familiar with it concerning their respective disciplines. Proper application of the JDDG into project specifics and details will have a much desired intended consequence—quality. It is this very essence of quality and the extreme importance of it that has led the District to develop this guide.

As practitioners and everyday users employ and utilize the JDDG, it will undoubtedly bring about questions and need for assistance. In the event that clarity is required, the project’s Technical Lead should be consulted at the earliest possible time. The Technical Lead is there to assist the Project Delivery Team (in-house design team, A-E partners and reach back districts) with any questions or concerns with current active projects. However, these chapters which comprise the JDDG have been written by many authors, all experts in their respective fields, and compiled into this one guide, may still contain errors and omissions. Every effort has been made to clarify any ambiguous guidance, reduce and eliminate errors and omissions, and provide a precise, relevant and accurate guide. Comments from users of this guide on suggested changes or modifications resulting from further engineering developmental work or hands-on experience are appreciated. All such comments should be directed to the Japan District, Engineering Division and sent via email at JDDG@usace.army.mil.
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), Japan District (henceforth referred to as the Japan District). Designers include the Architect-Engineer firms under contract with the Japan District, the Japan District project delivery teams producing in-house designs, and other USACE districts providing reach back support to the Japan 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. funded design and construction projects to include Military Construction (MILCON); Sustainment, Restoration and Modernization (SRM); Non-Appropriated Funds (NAF); and Operations & Maintenance (O&M).

The architectural and engineering discipline specific chapters are also applicable to the Host Nation funded construction program. The preparation of Criteria Packages (CPs) and Basic Criteria Packages (BCPs) are covered in their respective CP and BCP Guides.

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, Japan District.

1.2. DESIGN POLICY

The Unified Facilities Criteria (UFC) and the Unified Facilities Guide Specifications (UFGS) shall be used to the greatest extent possible 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.

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.


Engineering criteria related to Host Nation agreements in Japan are referenced in the discipline specific chapters. The *Japan Environmental Governing Standards (JEGS)* issued by U.S. Forces Japan applies to all U.S. Installations located within Japan.

1.4. **COST ESTIMATES**

The *Japan District Cost Estimating Guide* is a separate but vital document required to accomplish design projects at the Japan District. The guide is available from the Japan District Cost Engineering Section.

1.5. **JAPANESE MATERIALS AND PRODUCTS**

The design shall incorporate Japanese materials, products and construction methods. The use of Japanese 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.

There are several important exceptions when Japanese materials and products shall 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. Refer to discipline specific chapters for further details. All items that are to be purchased from the United States must be documented in the design analysis.

1.6. **JAPANESE PREFECTURAL DIFFERENCES**

The designer should take care to account for differences in prefectural infrastructure based on project location. For example, power requirements are different between Okinawa, Yamaguchi and Kanagawa.
CHAPTER 2 – SUBMITTAL REQUIREMENTS

2.1. GENERAL

This chapter covers requirements for each design submittal phase. Design is typically accomplished in the following phases:

Table 1: Design Submittal Phases

<table>
<thead>
<tr>
<th>Design Phase Name</th>
<th>Design Percent Complete</th>
<th>Code Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming Charrette</td>
<td>0%</td>
<td>Code 0</td>
</tr>
<tr>
<td>Parametric Design</td>
<td>15%</td>
<td>Code 3</td>
</tr>
<tr>
<td>Concept Design</td>
<td>35%</td>
<td>Code 2</td>
</tr>
<tr>
<td>Intermediate Design</td>
<td>65%</td>
<td>Code 6</td>
</tr>
<tr>
<td>Final Design</td>
<td>100%</td>
<td>Code 6</td>
</tr>
<tr>
<td>Backcheck</td>
<td>100%</td>
<td>Code 6</td>
</tr>
<tr>
<td>Ready to Advertise (RTA)</td>
<td>100%</td>
<td>Code 6</td>
</tr>
</tbody>
</table>

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

2.2. DESIGN DEVELOPMENT

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

- ER 1110-1-8155 Specifications
- ER 1110-345-700 Design Analysis, Drawings and Specifications
- CEPOD-C526 POD Regional In-House Design
- ERDC/ITL TR-12-6 A/E/C CAD Standard

2.3. DESIGNER RESPONSIBILITY

The designer shall be responsible for creating a high quality integrated design.
The Integrated Design approach is defined by UFC 1-200-02 Section 2-2. The UFC cites ASHRAE 189.1 Informative Appendix F for integrated design principles and ASHRAE 189.1 Section H1.1.1 for the charrette process. Ensure that each project has implemented an integrated design approach that meets the requirements of UFC 1-200-02 and ASHRAE 189.1.

Identify the integrated approach with the Design Quality Management Plan (DQMP plan).

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 Japan District. All electronic files shall be compatible with the Japan District's existing CAD system. Verify CAD system requirements with the Japan District Technical Services Section.

2.5. PARAMETRIC DESIGN REQUIREMENTS

Follow the requirements of the Scope of Work for parametric design requirements. Follow the DoDEA Facilities Management Guide Parametric Design for DoDEA school projects.

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. 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 Japan District Technical Services Section.

Concept design submittal shall consist of the following:

2.6.1. DESIGN ANALYSIS

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

Table 2: Design Analysis Outline

<table>
<thead>
<tr>
<th>ITEM NUMBER</th>
<th>DISCIPLINE</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GEN</td>
<td>GENERAL DESCRIPTION:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. Purpose</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Authorization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Criteria</td>
</tr>
</tbody>
</table>
|   | GEN | Include a discussion of:  
|   |   | a. Existing conditions  
|   |   | b. Project goals  
|   |   | c. Design assumptions  
| 3 | ALL | a. Design Calculations  
|   |   | b. Referenced criteria  
|   |   | c. Include placeholder sections for topics not required in the concept submittal, but needed for intermediate submittal  
|   |   | d. Life Cycle Cost Analysis  
|   |   | e. Description of materials and methods of construction to be used.  
| 4 | CIVIL | a. Site analysis that discusses the opportunities and constraints of the site and include the recommendations from the Installation’s Master Plan, Design Guide and Appearance Plan  
|   |   | b. Preliminary erosion control analysis  
|   |   | c. Preliminary grading narrative  
|   |   | d. Site specific traffic analysis  
|   |   | e. Site specific drainage analysis of existing and proposed conditions  
|   |   | f. Narrative descriptions of water and wastewater systems, including existing condition and capacity.  
| 5 | LANDSCAPING | Preliminary plant material analysis that reflects the selection of plant material native to the project area, if required.  
| 6 | ENVIRONMENTAL | Hazard analysis (lead based paint, asbestos, radon, etc., if required)  
|   |   | Natural and/or Archeological Site Survey, as applicable  
| 7 | LIFE SAFETY | a. Life Safety and Fire protection analysis in accordance with (IAW) UFC 3-600-01  
| 8 | STRUCT | a. List all design loads and assumptions  
|   |   | b. Provide design calculations for all load derivations.  
|   |   | c. General description of the foundation system  
|   |   | c. General description of the lateral load resisting system.  
|   |   | d. Name of computer programs used for analysis.  
|   |   | e. Preliminary calculations to size structural members including, but not limited to columns, beams, joists, girders, lateral force resisting system.  
| 9 | AT | a. Narrative that describes the approach used and basis for AT measures, and narrative that describes compliance with IAW UFC 4-010-01.  

| 10 | PCA | a. Determine PCA method per UFC 4-023-03 when facility is three stories or taller  
b. Name of 3D computer program to be used.  
c. General description of how PCA is being applied to the structure.  
d. Provide preliminary PCA calculations.  

| 11 | ARCHITECTURE | a. Identify the purpose, functions, capacities and facility's hours of operation.  
b. The desired image or visual appearance to include the design of the exterior and interiors of the building.  
c. Number of civilian, military and visiting personnel to use the project.  
d. Types of activities, equipment and vehicles involved.  
e. Anticipated life of the functions to be accommodated.  
f. Type and method of construction; either permanent, temporary or relocatable.  
g. Functional areas, occupant capacities and space allowances  
h. Exterior and interior finish materials, to include textures, colors and damage resistance  
i. Accessibility requirements  

| 12 | LIFE SAFETY | a. Life Safety and Fire protection analysis IAW UFC 3-600-01  

| 13 | MECH/PLUMBING | a. Equipment requirements and calculations  
b. Radon mitigation requirements analysis, as applicable  

| 15 | ELECTRICAL | a. Design Analysis Narrative explaining the electrical scope, existing electrical conditions and proposed design approaches.  
b. 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.  

| 16 | TELECOM | a. Design Analysis Narrative explaining the telecommunications scope, existing conditions and proposed design approaches.  
b. Design Analysis Appendix showcasing datasheets of proposed telecommunications equipment/items to be used in the project.
### SUSTAINABLE DESIGN

1. Project narrative indicating compliance with UFC 1-200-02
2. Reporting compliance checklist or scorecard (based on customer specific requirements)
3. Third Party Certification checklist, if applicable (i.e., LEED, Green Globes, CASBEE, Guiding Principles Compliance, etc.)

### APPENDIX

Include the DD Form 1391

### RENOVATIONS

Verification of implementation triggers for Seismic (UFC 3-310-04) and Antiterrorism (UFC 4-010-01) requirements based on Property Replacement Values versus renovation costs of the existing building(s).

### 2.6.2. DESIGN DRAWINGS

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

*Table 3: Concept Design Drawings*

<table>
<thead>
<tr>
<th>ITEM NUMBER</th>
<th>DISCIPLINE</th>
<th>DRAWING TYPE</th>
<th>ADDITIONAL REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GEN</td>
<td>Title Sheet and general sheets with preliminary haul route</td>
<td>General Sheets to include project index</td>
</tr>
<tr>
<td>2</td>
<td>GEN</td>
<td>Project Site Plan and Area Plan</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>GEN</td>
<td>Construction Notes and legend pages, phases (as required)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CIVIL</td>
<td>a. Project site plan</td>
<td>Including AT standoff setbacks for EWI, EWII and ESQD arc if applicable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Area Site Plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Preliminary Exterior Utility Plans</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Complete subsurface investigation and analysis</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>ARCH</td>
<td>a. Plans</td>
<td>Functional relationships and analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Work area use</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Security requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Traffic flow patterns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Roof plan illustrating stormwater flow and control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Building Code</td>
<td></td>
</tr>
<tr>
<td>ITEM NUMBER</td>
<td>DISCIPLINE</td>
<td>DRAWING TYPE</td>
<td>ADDITIONAL REQUIREMENTS</td>
</tr>
<tr>
<td>-------------</td>
<td>------------</td>
<td>--------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>c.</td>
<td>Life Safety Egress Floor Plans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>Exterior Building Elevations</td>
<td>Showing principal shapes, fenestrations and finishes</td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>Building Section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>Interior Finish Selection</td>
<td>General concepts presented</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>STRUCT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Structural Notes</td>
<td></td>
<td>Including but not limited to:</td>
</tr>
<tr>
<td>1) Design Loads</td>
<td>Risk Category</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Special Inspections</td>
<td>AT classification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) Geotechnical Information</td>
<td>Identify lateral force resisting system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4) Materials</td>
<td>Specify Japanese materials or provide justification and include cost for US materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Foundation Plan</td>
<td>Dimensions including but not limited to:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Footings, piles, pile caps, tie beams, grade beams, etc.</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>Floor Plan(s)</td>
<td>Including but not limited to:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>Roof Plan</td>
<td>Including but not limited to:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Column size and locations, joist, girder, and truss dimensions and locations, openings coordinated with architecture, lateral force resisting system location, and roof deck</td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>Building Sections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>MECH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Preliminary HVAC layout</td>
<td>Including equipment capacities and sizes</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>PLUMBING</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Preliminary plumbing layout</td>
<td>Including equipment capacities and sizes</td>
<td></td>
</tr>
<tr>
<td>ITEM NUMBER</td>
<td>DISCIPLINE</td>
<td>DRAWING TYPE</td>
<td>ADDITIONAL REQUIREMENTS</td>
</tr>
<tr>
<td>-------------</td>
<td>------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>9</td>
<td>ELECTRICAL</td>
<td>a. Electrical Legend, General Notes, Abbreviations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Preliminary electrical layout:</td>
<td>See Chapter 13 for descriptions of Electrical Design Submittal Requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Existing/Demo Site Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>New Power/Lighting Site Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>General Interior Power Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>General Interior Lighting Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Typical Details</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Riser and/or One-line Diagram</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>TELECOM</td>
<td>a. Telecom Legend, General Notes, Abbreviations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Preliminary telecom layout:</td>
<td>See Chapter 14 for descriptions of Telecom Design Submittal Requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Existing/Demo Site Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>New Telecom Site Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>General Interior Telecom Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Typical Details</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Riser Diagram</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>FIRE PROTECTION</td>
<td>a. Preliminary fire protection floor plans</td>
<td></td>
</tr>
</tbody>
</table>

**2.6.3. SPECIFICATIONS**

Include a list of Technical Specification (Divisions 02 through 49) sections in PDF format, including section numbers and title, proposed for the project.

**2.6.4. COST ESTIMATE**

Provide a current working estimate. Refer to the Japan District Cost Estimating Guide.

**2.6.5. QUALITY CONTROL**

The designer shall conduct a thorough Quality Control of all documents to be submitted to the Government for review. Submit Quality Control plan in accordance with the Scope of Work.
2.7. INTERMEDIATE DESIGN REQUIREMENTS

Prepare the intermediate design and technical 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 Japan District.

The intermediate design effort shall be a continuation of the concept design. The intermediate design goals are to show the project is on schedule and at an acceptable level of quality and completeness and 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 intermediate design. The designer QC review shall consist of a full Detail Check and Independent Technical Review. Submit all QC documentation with the intermediate design submittal. Complete coordination amongst design disciplines shall be conducted to review and resolve design conflicts.

Intermediate design shall consist of the concept design in addition to the following:

2.7.1. DESIGN ANALYSIS

The design analysis will 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: Design Analysis*

<table>
<thead>
<tr>
<th>ITEM NUMBER</th>
<th>DISCIPLINE</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GEN</td>
<td>GENERAL DESCRIPTION:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. Purpose</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Authorization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Criteria</td>
</tr>
<tr>
<td>2</td>
<td>GEN</td>
<td>Include a discussion of:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. Existing conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Project goals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Design assumptions</td>
</tr>
<tr>
<td>3</td>
<td>ALL</td>
<td>a. Design Calculations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Referenced criteria</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Initial calculations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Include placeholder sections for topics not required in the concept submittal, but needed for intermediate submittal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e. Life Cycle Cost Analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f. Description of materials and methods of construction to be used.</td>
</tr>
<tr>
<td>ITEM NUMBER</td>
<td>DISCIPLINE</td>
<td>REQUIREMENT</td>
</tr>
<tr>
<td>-------------</td>
<td>------------</td>
<td>-------------</td>
</tr>
</tbody>
</table>
| 4           | CIVIL      | a. Site analysis that discusses the opportunities and constraints of the site and include the recommendations from the IDG / Installation Master Plan  
            |            | b. Erosion control analysis  
            |            | c. Grading narrative  
            |            | d. Site specific traffic analysis. Threat scenario analysis for Entry Control Facilities and Access Control Points  
            |            | e. Site specific drainage analysis of existing and proposed conditions and calculations justifying proposed finished floor elevations.  
            |            | f. Narrative descriptions of water and wastewater systems, identifying including existing conditions and capacity. |
| 5           | LANDSCAPING| Preliminary plant material analysis that reflects the selection of plant material native to the project area, if required |
| 6           | ENVIRONMENTAL | Hazard analysis (lead based paint, asbestos, radon, etc., if required)  
            |            | Natural and/or Archeological Site Survey, as applicable |
| 7           | LIFE SAFETY | a. Life Safety and Fire protection analysis IAW UFC 3-600-01 |
| 8           | STRUCT     | a. List all design loads and assumptions  
            |            | b. Provide design calculations for all load derivations.  
            |            | c. Provide design calculations for the foundation system  
            |            | d. Provide design calculations for the lateral load resisting system, diaphragm, chord and collector elements.  
            |            | e. Calculations to size structural members including, but not limited to columns, beams, joists, girders, lateral force resisting system.  
            |            | f. Provide design calculations for non-structural components, supports and attachments. |
| 9           | AT         | a. 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.  
            |            | b. Provide blast resistant window calculations.  
            |            | c. Provide performance requirements for exterior blast doors, if required. |
| 10          | PCA        | a. Determine PCA method per UFC 4-023-03  
            |            | b. Name of 3D computer program to be used.  
<pre><code>        |            | c. General description of how PCA is being applied to the structure. |
</code></pre>
<table>
<thead>
<tr>
<th>ITEM NUMBER</th>
<th>DISCIPLINE</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>d.</td>
<td></td>
<td>Provide preliminary PCA calculations.</td>
</tr>
<tr>
<td>11</td>
<td>ARCHITECTURE</td>
<td>a. Identify the purpose, functions, capacities and facility’s hours of operation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. The desired image or visual appearance to include the design of the exterior and interiors of the building.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Number of civilian, military and visiting personnel to use the project.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Types of activities, equipment and vehicles involved.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e. Anticipated life of the functions to be accommodated.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f. Type and method of construction; either permanent, temporary or relocatable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>g. Functional areas, occupant capacities and space allowances</td>
</tr>
<tr>
<td></td>
<td></td>
<td>h. Exterior and interior finish materials, to include textures, colors and damage resistance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>i. Accessibility requirements</td>
</tr>
<tr>
<td>12</td>
<td>LIFE SAFETY</td>
<td>a. Life Safety and Fire protection analysis IAW UFC 3-600-01</td>
</tr>
<tr>
<td>13</td>
<td>MECH / PLUMBING</td>
<td>a. Designed HVAC systems types, capacities, and controls, including a description of the selected system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Designed plumbing system types, including description of the selected system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Compressed air system type, capacity, and controls</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Designed POL system types, including a description of the selected system (as required)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e. Energy modeling assumptions, climate zone classifications, building envelope requirements and results of the energy modeling and design energy use calculations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f. Commissioning requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>g. Radon survey data with mitigation system, as applicable</td>
</tr>
<tr>
<td>14</td>
<td>ELECTRICAL</td>
<td>a. Design Analysis Narrative explaining the electrical scope, existing electrical conditions and proposed design approaches.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Design Analysis Appendix showcasing datasheets of proposed electrical equipment/items to be used in the project.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. 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.</td>
</tr>
<tr>
<td>ITEM NUMBER</td>
<td>DISCIPLINE</td>
<td>REQUIREMENT</td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
</tbody>
</table>
| 15         | TELECOM     | a. Design Analysis Narrative explaining the telecommunications scope, existing electrical conditions and proposed design approaches.  
             |             | b. Design Analysis Appendix showcasing datasheets of proposed telecommunications equipment/items to be used in the project.  
             |             | c. Design Analysis Calculations detailing all pertinent telecommunications design calculations as described in this document. |
| 16         | SUSTAINABLE DESIGN | a. Project narrative indicating compliance with UFC 1-200-02  
             |             | b. Reporting compliance checklist or scorecard (based on customer specific requirements)  
             |             | c. Third Party Certification (TPC) checklist, if applicable  
             |             | d. TPC Notebook  
             |             | e. Templates completed on TPC Online with supplementary documentation uploaded |
| 17         | APPENDIX    | Include the DD Form 1391  
             |             | Life Cycle Cost Analysis  
             |             | Whole Building Energy Simulations  
             |             | Owner Project Requirements |
| 18         | RENOVATIONS | Verification of implementation triggers for Seismic (UFC 3-310-04) and Antiterrorism (UFC 4-010-01) requirements based on Property Replacement Values versus renovation costs of the existing building(s). |

### 2.7.2. DESIGN DRAWINGS

*Table 5: Design Drawings Outline*

<table>
<thead>
<tr>
<th>#</th>
<th>DISCIPLINE</th>
<th>DRAWING TYPE</th>
<th>ADDITIONAL REQUIREMENTS</th>
</tr>
</thead>
</table>
| 4 | LIFE SAFETY   | Building Life Safety Code Analysis                | Including Egress Floor Plans and code analysis  
| 5 | CIVIL         | a. Project site plan                              | Including standoff setbacks for EWI, EWII and ESQD arc if applicable | 
|    |               | b. Area Site Plan                                 |                         | 
|    |               | c. Preliminary Exterior Utility Plans             |                         | 

13
<table>
<thead>
<tr>
<th>#</th>
<th>DISCIPLINE</th>
<th>DRAWING TYPE</th>
<th>ADDITIONAL REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>d. Complete subsurface investigation and analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. existing conditions (topography)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e. demolition plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f. grading plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>g. road sections, plans and profiles</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>h. utility plans and profiles</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>i. civil and site details</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>j. geotechnical boring logs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Air Barrier</td>
<td>Identify the extent of the Air Barrier on the A-000 series, and indicate through the entire set how the air Barrier is applied, in accordance with UFC 3-101-01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Building Code</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Exterior Building Elevations</td>
<td>Showing fenestration, finishes and coordination between disciplines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Interior Elevations</td>
<td>Showing coordination between finishes, interdisciplinary and features of the buildings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e. Building Section</td>
<td>Sections indicating the major conditions through the building</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e. Wall Sections</td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>DISCIPLINE</td>
<td>DRAWING TYPE</td>
<td>ADDITIONAL REQUIREMENTS</td>
</tr>
<tr>
<td>---</td>
<td>------------</td>
<td>--------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td></td>
<td>f. Schedules</td>
<td>Include AT requirements for exterior windows</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wall Types</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Door</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Window</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Louver</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exterior Finishes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Room Finish</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interior Finish Legend</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. Details</td>
<td>Preliminary details indicating the method and approach of the design intent.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>STRUCT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Structural Notes</td>
<td>Update the Foundation Plan from the Concept Submittal to include but not limited to: Coordination with architecture, mechanical, electrical, and plumbing for openings, slab recesses, control joints, seismic joints, etc. Coordinate footing and pier locations with new and existing utilities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Foundation Plan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Floor Plans</td>
<td>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 with architecture, mechanical, electrical, and plumbing for floor openings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Roof Plan</td>
<td>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 with architecture, mechanical, electrical, and plumbing for roof openings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Foundation Schedule and Details</td>
<td>Details include foundation sections showing connections to walls, slab, grade beams, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Wall Sections and Details</td>
<td>Details to include shear transfer, opening details, boundary elements, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>DISCIPLINE</td>
<td>DRAWING TYPE</td>
<td>ADDITIONAL REQUIREMENTS</td>
</tr>
<tr>
<td>---</td>
<td>------------</td>
<td>--------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td></td>
<td>g. Column Schedules and Details</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>h. Beam/Girder Schedules and Details</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. Slab Schedules and Details</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>j. Building Sections</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>k. Shear Wall and Building Frame Elevations as applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>l. Non-Structural Components, Supports and Attachments</td>
<td>Reference ASCE 7 Chapter 13 for design requirements</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>MECH</td>
<td>a. Mechanical Legend, General Notes, Abbreviations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Plans:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Site</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HVAC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Piping</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compressed Air</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Sections</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. DDC points List</td>
<td>Points of Control for the DDC for the utility monitoring system. Identify the installation monitoring system and the compatibility of the proposed installed system.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>f. Equipment Schedules</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Air Handling Units</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exhaust Fans</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heat Recovery Units</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chillers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compressor, Dryer, Accumulator Tank</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*Any other HVAC Design</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>g. Isometrics</td>
<td>Refrigerant and Chilled Water piping diagrams</td>
<td></td>
</tr>
<tr>
<td></td>
<td>h. riser diagrams</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>DISCIPLINE</td>
<td>DRAWING TYPE</td>
<td>ADDITIONAL REQUIREMENTS</td>
</tr>
<tr>
<td>---</td>
<td>------------</td>
<td>--------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td></td>
<td>i. Schematics and Equipment Control Sequences</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>j. Details</td>
<td>Preliminary details indicating the method and approach of the design intent. Preliminary one line diagrams.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>PLUMBING</td>
<td>a. Plumbing Legend, General Notes, Abbreviations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Plans:</td>
<td>Include sub-pipe system layout for radon mitigation requirements, as applicable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plumbing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Sections</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Equipment Control Sequences</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e. Schedules</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plumbing Fixtures</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plumbing Equipment</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f. Isometric/Riser Diagrams</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>g. Details</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>ELECTRICAL</td>
<td>a. Electrical Legend, General Notes, Abbreviations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Plans:</td>
<td>See Chapter 13 for descriptions of Electrical Design Submittal Requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Demolition Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lighting Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mech. Connections Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lightning Protection Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grounding Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cathodic Protection Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Schedules</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lighting Fixture Schedule</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mech. Connections Schedule</td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>DISCIPLINE</td>
<td>DRAWING TYPE</td>
<td>ADDITIONAL REQUIREMENTS</td>
</tr>
<tr>
<td>----</td>
<td>-------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Panel Schedules</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Electrical Riser and/or One-line Diagram</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e. Electrical Details</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>TELECOMM</td>
<td>a. Telecom Legend, General Notes, Abbreviations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Plans:</td>
<td>See Chapter 14 for descriptions of Telecom Design Submittal Requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Demolition Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>New Telecom Site Plan(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Building Telecommunications Plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Telecom Riser Diagram</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Telecom Details</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>FIRE PROTECTION</td>
<td>a. Fire Suppression Legend, General Notes, Abbreviations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Fire Alarm &amp; Mass Notification Legend, General Notes, Abbreviations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Plans</td>
<td>Fire Hydrant Locations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fire Alarm &amp; Mass Notification System Plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fire Suppression System Plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site Plans</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Code Analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e. Details</td>
<td>Riser Layout to be included</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f. Fire Alarm Matrix</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>FOOD SERVICE (as required)</td>
<td>a. Food Service Legend, General Notes, Abbreviations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Plans</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Equipment Plans</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Schedules</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Equipment Schedule</td>
<td></td>
</tr>
</tbody>
</table>
2.7.3. SPECIFICATIONS

The specifications for intermediate design shall consist of:

1. Technical (Divisions 02 through 49) specifications in SpecsIntact (.sec) format, with changes from Unified Facilities Guide Specifications shown by enabling tracked changes.
2. Division 01 design-related attachments (e.g. TPC checklist, Draft DD1354, 01 11 00.00 10-A ACCEPTABLE ALTERNATIVES FOR JAPANESE STANDARDS, etc.).

Coordination and input is required with Japan District Technical Services Section prior to intermediate design submittal regarding design elements within Division 01 specifications.

2.7.4. COST ESTIMATE

The cost estimate shall include:

1. Current working estimate for budget purposes, pdf report summary to include electronic native software format for review
2. Estimate narrative with assumptions, notes, data sources, basis, etc.
3. Quantity take-off documentation and calculations
4. Vendor quotes and other supporting cost data
5. Construction Schedule

2.7.5. QUALITY CONTROL

The designer shall conduct a thorough Quality Control of all documents to be submitted to the Government for review. Submit completed Detail Check Review (DCR) and Independent Technical Review (ITR) documents. Provide completed DCR checklists and completed ITR annotated comment sheets. Quality control requirements are covered in Chapter 4.

2.8. FINAL DESIGN REQUIREMENTS

The designer shall prepare the final design and technical specifications based on the intermediate design and review comments received from the intermediate 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 reviewer and signature of the Designer of Record or Principal of the A/E Firm responsible for the design as testimony that this submittal has been reviewed and found to be suitable for bidding. 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 Dr. Checks with the submission.

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

2.8.2. SPECIFICATIONS
A completed set of technical (Division 02 through 49) specifications shall be developed in SpecsIntact (.sec) format. Technical specifications shall incorporate all comments and revisions from the previous submission by enabling tracked changes. All errors from verification reports (address, bracket, duplicate reference, unresolved reference, section, submittal, and title) generated by SpecsIntact shall be resolved. Submit updated Division 01 design-related attachments (e.g. TPC checklist, Draft DD1354, 01 11 00.00 10-A ACCEPTABLE ALTERNATIVES FOR JAPANESE STANDARDS, etc.). Continuing coordination and input is required with POJ Technical Services Section prior to final design submittal regarding design elements within Division 01 specifications.

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

Sustainability needs to be fully documented. Completed Reporting Compliance requirements finalized, a completed LEED Notebook and completed LEED Online templates with uploaded supplementary information to LEED Online.

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 3-310-04) and Antiterrorism (UFC 4-010-01) requirements.

2.8.4. COST ESTIMATE
Complete final working cost estimate ready to advertise that includes estimate narratives, quantity take-off documentations and calculations, vendor quotes and all supporting cost data and final construction schedule.
2.8.5. QUALITY CONTROL

The designer shall conduct a thorough Quality Control of all documents to be submitted to the government for review. Submit Detail Check Review (DCR) and Independent Technical Review (ITR) documents to include: Completed DCR checklists; completed ITR annotated comment sheets; IAW; and the project Scope of Work.

2.9. BACKCHECK DESIGN REQUIREMENTS

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

The backcheck submittal shall be complete in every respect and shall be ready for advertising. The drawings shall show the name of the reviewer and signature and professional seal of the Principal of the firm responsible for the design as testimony that the submittal was reviewed and found to be suitable for bidding. The submittal shall incorporate all previous review comments; and Biddability, Constructability, Operability, Environmental and Sustainability (BCOES) review comments made during the concept and 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 Dr. Checks with the submission.

Backcheck design shall consist of, but not limited to, the following:

1. Complete backcheck Design Construction Drawings ready to advertise.
2. Complete set of backcheck Technical Specifications ready to advertise.
3. Complete backcheck Design Analysis ready to advertise.
4. Complete backcheck working cost estimate ready to advertise to include estimate narratives, quantity take-off documentations and calculations, vendor quotes, and all supporting cost data and final construction schedule.
5. The designer shall conduct a thorough Quality Control of all documents to be submitted to the government for review. Submit Detail Check Review (DCR) and Independent Technical Review (ITR) certifications.
CHAPTER 3 – SPECIFICATIONS

3.1. **GENERAL**

Architect-Engineer (A-E) firms and personnel performing design for Japan District shall be responsible for Division 02-49 specification sections, with Japan District Technical Services Section coordination effort required for design aspects of Division 01 specification sections (e.g. HPSB/TPC Checklist, DD1354, Scope of Work, Section 01 45 35 SPECIAL INSPECTIONS).

3.2. **DESIGN CRITERIA**

**Engineering Regulations**

ER 415-1-10. Construction Contractor Submittal Procedures.

**Engineering Manuals**

EM 385-1-1 Corps of Engineers Safety and Health Requirements.

3.3. **GUIDE SPECIFICATIONS**

Guide specifications referenced throughout the Japan District Design Guide refer to the Unified Facility Guide Specifications (UFGS), and shall be used in writing specifications. The UFGS is available at the Whole Building Design Guide website (http://www.wbdg.org), and can be modified using the free SpecsIntact software (available at https://specsintact.ksc.nasa.gov/). Designers are required to use UFGS and SpecsIntact. 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 guide specifications shall be deleted, and additional information shall be included in the proper part of each section. Those sections required in the Technical Provisions where no guide specifications are available shall be prepared and submitted by the designer in accordance with the MasterFormat and UFGS guidelines. Where various choices (indicated as “brackets”) are provided in the guide specifications, the proper choice for the specific design shall be selected and other choices deleted. Where 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 Japan.

3.4. **PREPARATION OF PROJECT SPECIFICATIONS**

Specifications shall be furnished to Japan District in the native SpecsIntact (.sec) file format.
3.4.1. CONTENT

The technical 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, except for instances as indicated in Paragraph MATERIAL DESCRIPTIONS below. 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:

a. Size or capacity.
b. Materials of construction.
c. Detailed description of equipment construction and function.

3.4.2. 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 (where to purchase) is contained in UFG Section 01 42 00 entitled: SOURCES FOR REFERENCE PUBLICATIONS, 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) staffed by the Project Manager (PM) through the appropriate offices of Japan 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 be 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. LOCAL JAPANESE STANDARDS AND METHODS

A list of previously approved Acceptable Alternative Japanese Standards are provided as an attachment in the Division 01 Specifications – Attachment 01 11 00.00 10-A. This attachment contains a list of all currently approved acceptable alternatives for technical specifications.
Division 02 through Division 49. Local Japanese standards or methods of construction that are not included in this list can be submitted for approval to the Contracting Officer.

A submittal for approval requires:

a. Technical specification
b. U.S. Standard specified in the technical specification
c. Proposed Japanese alternative standard
d. Synopsis providing the justification of the proposed alternative standard.

If the proposed alternative is accepted, it will be added to the list of acceptable alternatives found in Attachment 01 11 00.00 10-A and be included in the contract documents. All acceptable alternatives will be listed within this attachment only and shall not be listed within the technical specifications.

3.4.5. 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 should contact Technical Services Section - Japan District, 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 should 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, Japan District should be contacted for disposition of material, equipment or the structure in order that detailed instructions may be given in the Technical Specifications or Contract Clauses.

3.4.6. PROJECT TABLE OF CONTENTS

A Table of Contents for the project specifications shall be prepared in Microsoft Word format (.doc or .docx), with attachments and appendices indicated. A template of the Table of Contents can be obtained upon request from Technical Services Section, Japan District.

3.4.7. GUIDE SPECIFICATIONS

When editing 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 Japan District Technical Lead, Project Manager, and Technical Services Section is required at this time.

3.5.2. **PREPARATION OF AMENDMENTS**

The following rules shall apply when editing specifications for amendments:

1. To delete words: **Overstrike Appearance shall be used, so a reviewer is able to read what was deleted.**

2. New text shall appear **bold and underscored.**

Paragraphs shall not be renumbered when making deletions by amendment. 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. Submit the revised specification sections to Japan District in native SpecsIntact (.sec) file 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 shall be listed on a separate list 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 customer.
3.6.3. SHOP DRAWINGS AND SUBMITTALS

The designer shall identify all required submittals and shop drawings and categorize them for review or information per ER 415-1-10. 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 only upon approval and coordination with Japan District.
This page was intentionally left blank.
CHAPTER 4 – QUALITY CONTROL REQUIREMENTS

4.1. CRITERIA

Engineering Regulations

ER 1110-1-12 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

4.2. DEFINITIONS

4.2.1. 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 Japan District). The expectations for quality shall be reflected in the Quality Control Plan.

4.2.2. QUALITY ASSURANCE

Quality assurance (QA) is the Government oversight of the quality control processes 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 Quality Control Plan (QCP). Typical QA activities may include:

1. Reviewing and approving the QCP prepared by the designer
2. Ensuring that activities described in QCP have been/are being performed
3. Verifying that designers, Detail Check Review (DCR) and Independent Technical Review (ITR) members are the same members as identified in the QCP
4. Ensuring that an ITR is conducted per ER 1110-1-12 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 customer’s needs
5. Verifying that appropriate staff signed Quality Control certifications
6. Ensuring that all QA review comments have been adequately resolved
7. Verifying that the product received satisfies contract requirements
8. Engaging in frequent dialogue with the designer to ensure that the project will satisfy Japan District requirements and avoid lost effort
4.2.3. QUALITY CONTROL

Quality Control (QC) is the process that ensures the performance of tasks meets the agreed upon requirements of the customer, 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 QCP; operational techniques and activities that are used to fulfill requirements for quality.

4.3. QUALITY CONTROL PLAN

The designer shall submit a draft project specific QCP with the original fee proposal. The draft QCP shall contain, at the minimum, features listed below. Within two weeks after the project start, the designer shall provide a completed project specific QCP that shall address all quality control features listed below. The Government shall accept the QCP before the designer proceeds with any further work. The QCP shall be a living document and shall be updated as required throughout all stages of the design.

The QC process will be enforced throughout the design process and into the Contract Award phase. The designer shall conduct QC measures during the Bid Solicitation period, which will include Detail Check Review and Independent Technical Review of documents revised during the Bid Solicitation period.

4.3.1. PROJECT SCHEDULE

Include a Project Schedule showing key milestones and review periods.

4.3.2. ROLES AND RESPONSIBILITIES

Identify the entire Design Team to include the Designer of Record “DOR” for each discipline, Detail Check Review (DCR) 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 Detail Check 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 team members shall be designers that are not involved in the project and shall conduct a thorough independent technical review. The DOR and DCR or ITR members shall not be the same. The designer shall notify Japan District in writing of any revision to the DOR, DCR team, and ITR team members as indicated in the QCP during the design process.

4.3.3. COORDINATION PROCEDURES

Describe designer interdisciplinary coordination procedures. Clearly identify step-by-step the QC coordination process between design disciplines, including the DCR 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.
The designer shall conduct a final Quality Control review of all printed submittal documents 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 and documents re-printed prior to submitting to the Government.

QC is the responsibility of the design team. The Government should not be reviewing the design package for quality issues. The Detail Check and Independent Technical Review shall be conducted by the design team prior to submittal to the Government. Submittals shall be considered incomplete and rejected by the Government if completed DCR and ITR documentation are not provided. Re-submittal shall be at the cost of the designer.

4.3.4. **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 process by which the input and output will be checked and validated.

4.3.5. **SUSTAINABILITY COMPLIANCE**

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

4.3.6. **LESSONS LEARNED**

Provide a description and list of applicable Lessons Learned from similar projects.

4.3.7. **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.

4.3.8. **DETAIL CHECK REVIEW**

Detailed Check Review (DCR) is a QC effort and refers to quality checks, technical checks, and reviews of design documents occurring as routine management practice during the project development process. The DCR is not the Independent Technical Review (ITR) and is to be completed before the ITR. The DCR is integral to the quality control effort and is performed by each discipline’s supervisor or senior Architect/Engineer.

A DCR shall be conducted prior to the completion of each design phase. DCR comments are to be reviewed by the designer and if the comments are concurred shall be incorporated into the design package. The DCR performer shall backcheck for non-concurrence and work with designer to resolve outstanding comments. This process shall be completed prior to the printing of the submittal (or electronic submittal) package to the government.
Provide all DCR checklists and describe how and when they are utilized. Completed DCR checklists shall be submitted at each deliverable stage. Sample checklists that may be used by the designer during DCR are available from Japan District upon request.

The DCR serves to:

1. Confirm that calculations are correct (a complete math check).
2. Confirm that appropriate formula(s) from reference manuals are used correctly.
3. Confirm that input to design software is correct.
4. Confirm that results of calculations and investigations are correctly displayed on the contract documents (plans and specifications).
5. Confirm that contract documents are technically complete and correct.
6. Ensure that intent and delineation of design documents are clear to all parties.

4.3.9. INDEPENDENT TECHNICAL REVIEW (ITR)

Independent Technical Review (ITR) is a holistic, comprehensive review of the project design. The designer shall perform an ITR of the design team’s product prior to the completion of each design phase to the government. This process shall be completed prior to the printing (or electronic) of the submittal package at each deliverable stage to the government. Completed ITR annotated comment sheets shall be submitted at each deliverable stage.

This review shall be accomplished by an independent technical review team composed of experts in the disciplines involved in the development of the design product. The ITR team shall be technically knowledgeable with U.S. codes, laws, regulations and requirements. Reviewers shall be experienced to be capable of focusing on potential problem areas of the design. The ITR is intended to ensure that a technically competent design has been produced but does not relieve the designer of responsibility for the design. ITR comments are to be reviewed by the designer and if the comments are concurred shall be incorporated into the design package and reviewed by the ITR reviewer for concurrence or non-concurrence. This process shall be repeated as required until all ITR comments have been resolved and incorporated in the design package. Annotated ITR comments shall not state “will incorporate in the next submittal”.

At the Final Submittal to the Government, the designer shall provide a signed certification by the ITR 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 Japan District upon request).
The ITR serves to verify:

1. The project meets the customer’s scope, intent and quality objectives.
2. Formulation and evaluation of alternatives are consistent with applicable regulations and guidance.
3. Concepts and project costs are consistent with expectations and market trends.
4. Ensure the recommended alternative is feasible and will be safe, functional, constructible, environmentally sustainable, economically justified, and within the U.S. Government interest.
5. Relevant engineering and scientific disciplines have been effectively integrated and coordinated.
6. Consistency and avoid conflicts in contract documents among disciplines.
7. Appropriate computer models and methods of analysis were used and basic assumptions are valid.
8. The source, amount, and level of detail of the data used in the analysis are appropriate for the complexity of the project.
9. The project complies with accepted industry practices and materials; construction methods and materials are appropriate for local (Japanese) implementation.
10. Content and documentation are sufficiently complete for the current phase of the project and provide an adequate basis for future development efforts.

4.3.10. QUALITY ASSURANCE REVIEW

The Japan District shall perform a quality assurance review of all designer work to confirm that quality control processes were followed during the project design process. During the quality assurance review, Japan District performs a technical review to determine whether the designer met quality requirements and utilized quality control processes. Japan District review of the designer-developed quality control documentation (QCP, ITR and DC comments and responses) is part of the quality assurance review process. The designer shall be solely responsible for conducting a thorough QC review in accordance with their QCP and for completing a quality design product that complies with Japan District’s BCOES process.
This page was intentionally left blank.
CHAPTER 5 – ANTITERRORISM

5.1. 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 covers six of the minimum standards (Standards 1, 2, 6, 7, 10, and 12) that are a challenge to meet with the site constraints common on U.S. Installations in Japan. Physical Security, Force Protection, and Access Control Points/Entry Control Facilities are separate design considerations not covered in this Chapter.

5.2. 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: UNIFIED FACILITIES CRITERIA (UFC)

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

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

PDC TR 12-08 Protective Design Center Technical Report, Standoff Distances for Japanese Conventional Construction
5.3. **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

5.4. **BLAST ANALYSIS**

The designer shall determine if a Blast Analysis is required and conduct one 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 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.

5.5. **STRUCTURAL COMPONENTS**

Structural components that do not conform to Table 2-3 of the UFC 4-010-01 and Table 1 of the PDC TR 12-08 must be analyzed dynamically using SBEDS_5.

5.6. **STANDARD 1: STANDOFF DISTANCES**

Standoff distance for building structural elements (not including windows and doors) can be determined by using Table B-1 and B-2 of UFC 4-010-01. Standoff is based on applicable charge weight and building occupancy. Use Explosive Weight I and Explosive Weight II when structure is within 60m of the controlled perimeter. Use Explosive Weight II for buildings further than 60 meters from the controlled perimeter.

There are three types of occupancies:

1. Low Occupancy (less than 11 people or density less than 40sm per person)
2. Inhabited (11 or more occupants and density greater than 40 sm per person)
3. Primary Gathering (50 or more occupants and density greater than 40sm).

Document building population in the Design Analysis and provide the density calculations. Buildings with “Low Occupancy” classification are exempt from AT requirements.
Table B-2 indicates the conventional construction standoff distance (CCSD) required depending on the construction material used. Please note that the CCSD only refers to the structure, and does not include standoff required for windows and doors. To maximize economical construction, the standoff distance selected should be greater than the CCSD distance. If the standoff selected less than the CCSD, building hardening will be required in accordance with UFC 04-020-01.

5.7. **STANDARD 2: UNOBSSTRUCTED SPACE**

Unobstructed space is the designated standoff distance around the building based on Explosive Weight II. Unobstructed space is typically governed by the blast capacity of windows and shall extend out to the standoff distance.

5.8. **STANDARD 6: PROGRESSIVE COLLAPSE RESISTANCE**

All new buildings, three stories or more must comply with UFC 4-023-03 *Design of Buildings to Resist Progressive Collapse*. All existing buildings where the renovation cost is greater than 50% of the replacement cost must comply. 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 Japan are predominantly cast-in-place reinforced concrete buildings. Buildings composed of precast concrete elements will not be allowed.

Progressive Collapse design requirements employ three different types of design/analysis approaches: Tie Force Method, Alternate Path 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 must 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.
5.9. STANDARD 7: STRUCTURAL ISOLATION

“Inhabited” or “Primary Gathering” building classification applies to the entire building envelope, although portions of the above buildings may be “Low Occupancy”. Low Occupancy portions may be structurally isolated such as hangar from administration areas the hangar will be “Low Occupancy” and administration areas will be “Inhabited”.

5.10. STANDARD 10: WINDOWS AND SKYLIGHTS

Windows are typically designed for Explosive Weight II. However when window standoff is less than 60 meters from the controlled perimeter, the designer must account for both Explosive Weight I and II, whichever governs. UFC 4-010-01 allows for three different window design methods: dynamic, testing and static (ASTM F2248 and ASTM E1300). PDC TR 12-08 is a design guide for locally available windows in Japan. PDC TR 12-08 does not apply to skylights.

Japan Architects/Engineers and Window Manufacturers are not familiar with blast design. U.S. window designs showing blast pressures and impulse will need to be imported from the U.S. Japan District goal is to use Japanese products to the furthest extent possible. Testing of windows by Japanese manufacturers is not likely. Static method used by some U.S. manufacturers is uncommon for Japanese Architects/Engineers to apply. Also, static method is more conservative than dynamic analysis. Through experience, dynamic analysis is the recommended method of window design. Windows described in the PDC TR 12-08 are based on dynamic analysis.

5.10.1. PDC TR 12-08

In window design the first step is to check with the PDC TR 12-08, if available sizes may be used on the project. Glazing was designed dynamically using the SBEDS_W program. Frame $I_{min}$ for blast was based on deflection criterion L/60 at 2 x STP (Static Test Pressure). Window frame manufacturer should check wind loads based on allowable stress with a deflection criterion of L/175. Frame minimum section properties shall be based on the governing condition between blast and wind.

Windows that do not conform to the parameters of PDC TR 12-08 may be designed in accordance with Dynamic Analysis Section 5.10.3.

5.10.2. STANDARD WINDOW GEOMETRY

Figure 1 depicts the window geometries (i.e. height, width, number of sashes, and height of sill) based on Table 4 of the PDC-TR 12-08 Standoff Distances for Japanese Conventional Construction.
5.10.3. **DYNAMIC ANALYSIS**

Dynamic analysis guidance is presented in PDC TR 10-02. Any of the glazing, framing members, connections, and supporting structural elements shall be designed using dynamic analysis. Use SBEDS_W to analyze window glazing and mullions dynamically. Provide performance equivalent to or better than the applicable level of protection. Design load for dynamic analyses will be the appropriate pressures and impulses from the applicable explosive weights at the actual standoff distances at which the windows are sited.

Design loading applied over areas tributary to the element being analyzed.

5.10.4. **BLAST REQUIREMENTS - WINDOWS**

Windows and other glazing required to comply with Antiterrorism requirements in accordance with UFC 4-010-01 shall be designed such that the specific design requirements (e.g. laminated glazing material and thickness, PVB interlayer thickness, bite depth, air gap width (for IGUs), minimum frame section properties, etc.) are specified on the design documents. Performance blast requirements other than for anchorage and frame-to-frame connections will not be allowed.
Frame minimum section properties shall be based on the governing condition between blast or wind pressure; $I_{\text{min}}$ for blast is based on PDC TR 06-8 response limits; wind is based on deflection criterion $L/175$. Prescriptive design of windows is to ensure that Japanese materials are incorporated into the design to the greatest extent practical, that the project will be biddable and constructible, and the facility can be maintained locally. The following minimum design information is required for bidding and manufacturing of windows by Japanese manufacturers to meet Antiterrorism requirements:

**SINGLE PANE-LAMINATED**

1. Glass Type – Annealed, Heat Strengthened, or Fully Tempered  
2. Glass Thickness  
3. PVB Interlayer Thickness (24 MPa)  
4. Bite Depth  
5. Silicone Strength (1.0 or 1.7 MPa)

**IGU-MONOLITHIC OUTER PANE AND LAMINATED INNER PANE**

1. Glass Type – Annealed, Heat Strengthened, or Fully Tempered  
2. Glass Thickness  
3. PVB Interlayer Thickness (24 MPa)  
4. Bite Depth  
5. Air Gap Width  
6. Silicone Strength (1.0 or 1.7 MPa)

**FRAME – PROVIDE $I_{\text{min}}$**

1. Jamb Member  
2. Head/Sill Member  
3. Transom Member  
4. Mullion Member  
5. Confirm with local window manufacturer that sections with $I_{\text{min}}$ are available

**ANCHORS**

Requirements in PDC-TR 12-08: minimum of two anchors at jamb, head, and sill; maximum anchor spacing of 400mm and frame-to-frame connections

1. Provide out of plane blast line loads for jamb, head, and sill for anchorage.  
2. Provide out of plane end blast reactions for mullion or transom for frame to frame connections.

**5.10.5. DRAWING REQUIREMENTS**

Antiterrorism (Blast) Window requirements shall be indicated in the Architectural set of the design drawings. **NOTE:** Based on Japanese construction practices, Japanese contractors
consider window design work to be part of the Architectural drawing set, not the Structural drawing set.

5.11. **STANDARD 12: BLAST EXTERIOR DOORS**

For buildings classified as “Inhabited or Primary Gathering”, exterior doors that enter into “Inhabited Areas” are required to be blast resistant. Blast resistant doors shall be tested accordingly:

1. Unglazed Doors – ASTM F2247 or ASTM F2927
2. Glazed Doors – ASTM 2927

To avoid using blast resistant doors which are very expensive, Alternative Design as described in UFC 4-010-01, shall be the first option. Below are three “Alternative Design Options” and related requirements and criteria associated with each option.
### 5.11.1. ENTRANCE DOORS IN DIRECT ALIGNMENT OF MAIN ENTRY

#### Vestibule (A)

![Diagram of Vestibule (A)](image)

<table>
<thead>
<tr>
<th>Application</th>
<th>Method</th>
<th>Criteria</th>
<th>Application</th>
<th>Method</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Standard Door (Non-blast rated door)</td>
<td>n/a</td>
<td>n/a</td>
<td>Blast rated door</td>
<td>ASTM F2247 &amp; ASTM F2927</td>
<td>UFC 4-010-01 B-3.3.1 &amp; B-3.3.2</td>
</tr>
<tr>
<td>Blast rated door</td>
<td>ASTM F2247 &amp; ASTM F2927</td>
<td>UFC 4-010-01 B-3.3.1 &amp; B-3.3.2</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Glazing</td>
<td>ASTM F2827 if tested w/ the door or PDC-TR 12-08</td>
<td>UFC 4-010-01 Standard 10</td>
<td>Glazing</td>
<td>PDC-TR 12-08</td>
<td>UFC 4-010-01 Standard 10</td>
</tr>
<tr>
<td>Analyzed door (Justified by SBEDS Ver5)</td>
<td>Where it is not possible to apply Alternative Design (i.e. intercept door) design door to remain in frame</td>
<td>UFC 4-010-01 B-3.3.3 Alternative design</td>
<td>Standard Door (Non-blast rated door)</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Glazing</td>
<td>Only small vision glazing possible, 200mmx200mm</td>
<td>UFC 4-010-01 Standard 10</td>
<td>Glazing</td>
<td>PDC-TR 12-08</td>
<td>UFC 4-010-01 Standard 10</td>
</tr>
</tbody>
</table>
### 5.11.2. ENTRANCE DOORS OFFSET OF MAIN ENTRY

#### Vestibule (B)

![Diagram](image)

<table>
<thead>
<tr>
<th>Application</th>
<th>Method</th>
<th>Criteria</th>
<th>Application</th>
<th>Method</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Standard Door (Non-blast rated door)</td>
<td>Position door such that it will not be propelled into routinely occupied spaces</td>
<td>UFC 4-010-01 B-3.3.3 Alternative design</td>
<td>Standard Door (Non-blast rated door)</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Glazing</td>
<td>FDC-TR 12-08</td>
<td>UFC 4-010-01 Standard 10</td>
<td>Glazing</td>
<td>FDC-TR 12-08</td>
<td>UFC 4-010-01 Standard 10</td>
</tr>
</tbody>
</table>

### 5.11.3. ENTRANCE DOORS OFFSET OF MAIN ENTRY

#### Vestibule (C)

![Diagram](image)

<table>
<thead>
<tr>
<th>Application</th>
<th>Method</th>
<th>Criteria</th>
<th>Application</th>
<th>Method</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Standard Door (Non-blast rated door)</td>
<td>Position door such that it will not be propelled into routinely occupied spaces</td>
<td>UFC 4-010-01 B-3.3.3 Alternative design</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Glazing</td>
<td>PDC-TR 12-08</td>
<td>UFC 4-010-01 Standard 10</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>
This page was intentionally left blank.
CHAPTER 6 – CIVIL

This chapter provides guidance and instructions for the civil design of facilities and infrastructure. Items covered in this section include site layout, pavements, grading, drainage, water supply and distribution systems, sanitary sewage systems, topographic survey and geotechnical report requirements, and landscaping.

6.1. DESIGN CRITERIA

The designer shall use criteria established in the United Facilities Criteria (UFC). The designer is responsible for determining the applicability of these design criteria to each project and incorporating any appropriate Service Component criteria in order to comply with all necessary design requirements.


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

Accessibility Standards.

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

Military Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA).

SDDCTEA Pamphlet 55-17: Better Military Traffic Engineering 2011

Marine Corps.


Defense Facilities Administration Agency.

Structures Standardized Design Criteria for Civil Engineering Under the Facilities Improvement Projects (Civil DDD)

The Civil DDD provides standard Japanese construction details for site, utilities, and landscaping, and is available upon request from the Japan District Civil/Structural Section.
6.2. **DESIGN SUBMITTAL REQUIREMENTS**

6.2.1. **PROGRAMMING CHARRETTE**

A programming charrette will be held at the base, with representatives from the base, their command headquarters, the Corps of Engineers, and the designer being in attendance. The programming 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.

6.2.2. **PRE-DESIGN MEETING**

**PRE-DESIGN CONFERENCE**

The purpose of the conference is to provide an opportunity for the designer to gather project information and requirements. A site visit shall be performed, and base mapping, utility and other pertinent site data gathered during the conference. 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.

**CHARRETTE DESIGN**

The 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, Japan District, and the designers attending. The designer shall coordinate with all of 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.

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 high-ranking officers on 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 document, or meeting minutes, that are prepared by the designer upon completion of the charrette.
6.2.3. PARAMETRIC DESIGN

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 to a road map. The Location Plan shall show the project’s location, 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 the removals required by the construction of this project. 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, walls, storage tanks, foundations, athletic facilities, and existing contours. Label and hatch all items known to 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 fencing, pavements, and structures shall be labeled to indicate material types. Plan sheets shall show a line differentiating between new and existing pavements and different pavement types (concrete, bituminous, or gravel). Key dimensions shall be shown. Proposed work will be clearly evident from existing features. The layout shall incorporate applicable regulations and restrictions for clearances and setbacks; i.e., antiterrorism, airfield and explosive clearance zones, etc., Drawing orientation shall generally be with north pointing to the top (or to the left) of the sheet.

UTILITY PLAN
The Utility Plan shall show the site layout including all existing utilities (i.e. water, storm, sewer, gas, electrical, etc.) with sizes. All proposed utilities shall be shown at proposed locations with tentative sizes. Utilities shall be shown from their tie-in point with existing infrastructure up to a point 1.5 meters from the building envelope. All potential interferences with utility routings including any existing infrastructure shall be depicted and noted.

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

DESIGN ANALYSIS
Give the basis and reasons for design, i.e., goals, objectives and priorities. Clearly explain the recommended site development concept. The DA shall include:

1. The general geology of the project site, its history, and whether hazardous and toxic waste contamination may be present.
2. Any available and relevant existing subsurface data at the site and whether additional subsurface investigation is required for the design of the project.
3. The status of any ongoing subsurface investigation.
4. The entities responsible for providing any required additional subsurface investigation, the Geotechnical Report, and the geotechnical specifications.
5. Criteria used to design utilities systems, and/or components thereof.
6. Adequacy of water distribution system. Should the information prove unobtainable, the designer shall promptly contact the Japan District Technical Lead.
7. The capacity of the existing wastewater and storm drain system to accept additional flow generated by the proposed project.
8. Whether concrete curb and gutter will be used.
9. Pipe size that will be used for the cost estimate and a rough estimate of earthwork quantities.
10. If borrow material is available on site.
11. Approximate amount of fill under buildings and roads.
12. Minimum and/or maximum grades (% slope).
14. Pollution prevention measures and other environmental constraints identified in the environmental documentation.
15. A separate section on unresolved items or criteria required to complete the final design.

6.2.4. CONCEPT DESIGN

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.

UTILITY PLAN
Include Utility Plan requirements from previous submittal and include locations of proposed valves (including PIV’s), lift stations, manholes, new fire hydrants, and fire department connection (FDC) on the building.

For water supply lines, trunk or outfall sewers, and force mains:

1. Provide separate layout sheet showing new routing with tentative sizes;
2. Existing utilities and aboveground features which could affect construction;
3. Right-of-way for off-base portions; and locations of manholes, relief valves, blowoffs, isolation valves, etc.

For pumping stations:

1. Provide site plan showing structure location and exterior piping;
2. Floor plan with equipment layout and single line piping with tentative sizes;
3. One drawing section through showing pertinent elevations.

For water and wastewater treatment plans:

1. Provide site plan showing major unit treatment items including their relationship to existing facilities and exterior yard piping;
2. Schematic flow diagrams for process flow, solids handling, chemical feed, and service water;
3. Hydraulic profile flow rates per scope of services;
4. Floor plan with equipment layout and single line piping with tentative sizes;
5. One section through structure showing pertinent elevations.

GRADING AND DRAINAGE PLAN

The Grading and Drainage Plan shall show the basic site layout including all existing utilities to remain and existing contours. 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. The designer shall edit the following notes accordingly and add to the Grading and Drainage Plan.

1. Existing contours were interpolated from a topographic survey made (Give Date). Survey horizontal datum is (Give Datum) and vertical datum is (Give Datum).
2. Benchmark (Give location, description, and elevation).

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.

DESIGN ANALYSIS

The design analysis shall include the following:

1. List of design criteria
2. The goals, objectives and priorities. Clearly explain the recommended site development.
3. Composition and volume of anticipated traffic.
4. Pavement design calculations and results using soil data provided in the soils report.
5. For water systems provide narrative description (including operation and controls), available flow and residual pressures, peak and average 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 and insulation and/or heating requirements.

6. For wastewater systems, provide narrative description (including operation and controls), 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 with pertinent information, pumping rates, hydraulic transient (surge) analysis, wastewater effluent analysis, and any special requirements of industrial wastewater systems. Address energy conservation measures taken in the site design. Document pollution prevention measures and other environmental considerations made during design.

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

6.2.5. INTERMEDIATE DESIGN

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.

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 must be included.

1. Provide preliminary profiles of all gravity sewers, waterlines, and sewer force mains.
2. Profiles may be omitted for short waterline unless necessary to assure adequate cover or avoid interference with other underground facilities.
3. Indicate existing pipe material where new lines connect.
4. Indicate type of connection and elevation.
5. Provide location of all valves, fire hydrants, and similar appurtenances.
6. 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 section showing all required elevations.
7. For water supply lines, outfall sewers, and force mains, include survey ties and/or bearings, stationing in both plan and profiles, contours in plan, and appropriate notes, etc. for pavement crossings.
8. For water and wastewater treatment plants provide preliminary equipment layout showing all required piping, valves, meters, pumps, etc.
9. Provide preliminary equipment schedules showing capacity, head, etc. for major items of equipment.
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) (Horizontal: Vertical) shall be provided at locations not covered by typical sections or as needed.

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 finished and existing grades, new and existing 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 when graphical clarification is necessary for design interpretation or construction quality. Provide pavement details showing interface between new and existing pavements and new pavements of different sections. Use standard detail drawings from the Civil DDD where applicable.

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

DESIGN ANALYSIS
The Design Analysis shall also include a summary of the basic information and conclusions presented in the previous submittal. In addition to water and wastewater items required in the concept preliminary design provide, if applicable, narrative and calculations for ultimate disposal to wastewater facilities, pilot testing for treatment facilities, and hydraulic transient (surge) analysis for pumping stations for potable and fire water systems. For mechanical items such as pumps, treatment equipment, etc., provide a listing of at least three manufacturers whose equipment will perform the desired function. If the project utilizes non-government facilities for water supply and/or wastewater treatment, provide documentation showing coordination. Provide drainage area map showing the 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. Provide preliminary earthwork quantity calculations with a discussion of the earthwork balancing. Provide copies of pertinent correspondence and conversation summaries.

6.2.6. FINAL DESIGN
The Final Design documents must include all information for bidding and construction of the project. Specific requirements for plans, specifications and design analysis are as follows:
DRAWINGS
The corrected and approved plans from previous submittals may be used as the basis for the final plans. All details necessary for bidding and complete construction must be included. The following information is required (when applicable) in addition to the previously stated requirements for plans.

VICINITY MAP AND LOCATION PLAN
Vicinity Map consists of a small scale drawing of the overall project area, similar to a road map. Location Plan consists of a small scale drawing showing the surrounding area, community or Government installation and the project site. A reproducible Standard Drawing base sheet or CADD file may be provided, if available, by the Japan District for the designers use. The Location Plan shall show:

1. **Contractor's Access and Haul Routes.** Show access and haul routes with any load limits. Coordinate requirements with local engineering and construction offices.

2. **Waste and Borrow Sites/Areas.** The designer shall determine the waste and/or borrow sites for all non-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 existing regulations for pollution control and environmental quality as established by the city, county, state, and federal governmental agencies. The designer shall check waste areas for types of materials which may, or may not, be disposed of.

3. **Contractor's Staging Area and Parking.** Show areas for contractor storage, temporary fencing, sheds, and parking for subcontractors and their employees. Coordinate requirements with the engineering and construction offices.

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. If feasible, a schematic sketch of new structures with foundation depths noted shall be shown on the boring logs; thus indicating required cut and fill and soil strata on which foundation elements will bear. 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.

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

SITE PLAN
The Final Design Site Plan will incorporate approved comments from previous design submittal. 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 clearly evident from existing features. Applicable regulations and restrictions for clearances and setbacks shall be met.

UTILITY DRAWINGS
The Final Design utility drawings will incorporate approved comments from previous design submittal. The Utility Plan shall be fully dimensioned and labeled as necessary to field locate each item to be constructed. New work will be clearly evident from existing features. Provide finalized profiles and sufficient sections and details to permit construction.

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) (Horizontal: Vertical) shall be provided at locations not covered by typical sections or as needed.

EROSION AND SEDIMENT CONTROL PLANS
Provide Erosion and Sediment Control Plans for projects which disturb more than one acre. 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.

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 meter minimum intervals along profiles for roads, and streets.

STORM DRAINS, CULVERTS, AND SUBDRAINS
Profiles of all new storm drains, subdrains, 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. Class, gauge, etc. of all storm drain, subdrain, and culvert pipes shall be indicated. This information may also be included in the Storm Drain and Subdrain Schedule drawings.
SITE GRADING SECTIONS
Grading sections through new buildings and parking areas shall show finished and existing grades, new and existing utilities, pavement sections in detail, spot elevations, dimensions, slope percentage, ditches, etc.

ROAD SECTIONS
Provide grading sections at 15 meter intervals along major roads, and streets.

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.

SITE DETAILS
Provide detailed drawings of site furnishings, accessories, handicapped parking and provisions, appropriate water and sewer details, concrete pavement joint details, chain-link fence details, and specific construction techniques, applications, and finishes when graphical clarification is necessary for design interpretation and construction quality. Provide pavement details showing interface between new and existing pavements and new pavements of different sections. Use standard detail drawings from Civil DDD where applicable.

LANDSCAPE PLAN
If landscaping is included in the project scope, a Landscape Plan shall be prepared.

1. Plants. The Landscape Plan shall show all trees, shrubs, plant beds, landscape-related furnishings, landscape edging. 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, i.e., 3 meter high or 20 Liter container; the method of transplanting, balled and burlapped, container grown; and special comments such as 1-year old seedlings, or "symmetrical form with branching at 2 meter height minimum". This Plan shall also show any wetlands plantings or any other re-vegetation requirements necessary for the project.

2. Sodding. Show all unsurfaced ground areas disturbed by construction to be sodded 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. Seeding is not common practice in Japanese construction.

LANDSCAPE DETAILS
Provide details for installing plants and constructing plant beds, landscaping furnishings and accessories. The Civil DDD 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 Report and include a copy of the 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 drain pipes, design storm discharge and velocity for each storm drain pipe, maximum discharge capacity of each storm drain 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. Include anticipated service life of all allowable storm drain pipe materials. Include discussion of watertight joint requirements for storm drains. The Designer shall determine whether watertight joints are required for new storm drains. Include discussion of any permanent stormwater best management practices (BMP’s) incorporated into the project such as detention basins, bioretention areas, etc. Provide discussion of any temporary or permanent erosion and sediment controls incorporated into the project.

6.2.7. RTA DESIGN
GENERAL REQUIREMENTS
Plans, specifications, and design analysis shall have all comments incorporated.

6.3. DRAWING COMPOSITION
6.3.1. 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 1:250 and 1:400 meters (1 inch = 20’ and 1 inch = 30’) are acceptable drawing scales for site drawings. Other drawing scales must be approved by the Japan District. CAD files of actual field survey data shall be used design.
6.3.2. 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 Japan 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 of removals can be shown on the Site Plan.

6.3.3. 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.

6.4. GEOTECHNICAL INVESTIGATION AND REPORT

The designer shall plan and perform such geotechnical subsurface investigation at the project site as required, and provide to the design team a comprehensive Geotechnical Report as early in the design as practicable but not later than the Intermediate Design submittal. The designer shall be responsible for obtaining all utility clearances and a digging permit prior to subsurface work. 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 Japan District. All computations, studies, analyses, and recommendations shall be included in the report. For larger structures, alternative foundation systems shall be presented if more than one system will economically perform the task especially in the case where deep foundations are required to bypass weak and/or compressible layers of soil.

6.5. TOPOGRAPHIC SURVEYS

A topographic survey shall be furnished by the designer for all projects that require grading and utility work. The survey shall incorporate the following requirements.

TOPOGRAPHIC MAPPING

Topographic mapping shall be conform to A/E/C Standards.
ANNOTATION AND SYMBOLOGY

General annotation will include street names, building numbers, feature descriptions, and surface types. Map features shall be shown by the appropriate symbology.

ACCURACY

The project control survey shall meet or exceed Third Order horizontal and vertical accuracy criteria as defined by the Standards and Specifications of Geodetic Control Surveys established by the U.S. Department of Commerce. The mapping procedures should be such as to provide a map scale of 1:250 with a 0.250m contour interval. The terrain surface shall be a digital terrain model (DTM) collected in such a fashion as to support processing as a triangulated irregular network (TIN), and contours generated from the resultant surface. The ground surface should be collected as a DTM with break-features and/or form-lines suitable for generation of 0.250m contours, with spot elevations accurate to National Map Accuracy Standards (NMAS).

TYPICAL SCALES

Typical scales for engineering design site surveys is 1:250.

CONTOUR INTERVAL

Contour interval will be typically 0.250 meter. Each fourth contour will be bolder than others.

SPOT ELEVATIONS

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

SURVEY LIMITS

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

RECORDS REVIEW AND UPDATING

The contractor shall collect existing records of utilities from each agency or department responsible for maintenance of appropriate utilities.

UTILITIES

Locations of all utilities shall be from the most accurate information available. 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 3D CAD files and thoroughly annotated.

**ABOVE AND BELOW GROUND UTILITIES (ELECTRIC)**

Power lines and communication lines, street light poles, guy wires, vaults (including handholes and manholes), transformers and substations.

**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 a POC immediately.

**WASTERWATER SEWERS AND STORM DRAINS**

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.

**ROADS, DRIVES, PARKING LOTS, WALKS AND TRAILS**

All roads shall have spot elevations at 10 meter 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 view 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.

**BUILDINGS AND STRUCTURES**

All permanent 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. These elevations shall be 3D line strings to be used as break lines when developing the TIN (triangulated irregular network) for contour processing.
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 as indicated in the CADD standards.

TREES, SHRUBS AND LANDSCAPING MATERIAL

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

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.

OTHER VISIBLE SURFACE FEATURES

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

6.6. SITE LAYOUT

6.6.1. BUILDING LOCATION

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

6.6.2. 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. UFC 3-201-01 provides guidance on the geometric design of walks. Follow the ABA for accessibility requirements. Follow Antiterrorism (AT) Standards 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 the particular vehicle(s) using the drive. Setbacks between roads, drives, and buildings as required by the AT Standards shall be met. Entrances to and from access drives should have a minimum turning radii for the largest vehicle expected to use the drive. Throat widths and lengths shall accommodate incoming and outgoing traffic. A minimum of 30.4 meters (100 feet) of unobstructed sight distance for turns from parking lots and service drives onto the access drive shall be provided.
6.7. PARKING

6.7.1. PRIVATELY-OWNED VEHICLE (POV) PARKING

Off street parking facilities should be located near the facilities served. Setbacks required by the AT Standards shall be met. There are two typical POV parking stall sizes on U.S. Installations in Japan. The UFC 3-201-01 parking stall size of 2.74 meters wide by 5.64 meters long is based on a full size design vehicle from Figure 2.1 of the AASHTO Green Book. The design vehicle used in Host Nation funded projects and the Civil DDD is the mid-size vehicle with a parking stall size of 2.5 meters wide by 5.0 meters long. Verify with the Installation Traffic Study for the appropriate design vehicle.

Table 3 lists the standard parking lot dimensions based on Japanese design vehicle sizes.

*Table 6: Japanese POV Parking Lot Dimensions*

<table>
<thead>
<tr>
<th>Feature</th>
<th>Size (mm) W x H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking Stall - 90°</td>
<td>2500 x 5000</td>
</tr>
<tr>
<td>Parking Stall - 60°</td>
<td>2900 x 5000</td>
</tr>
<tr>
<td>Parking Aisle - 90°</td>
<td>6000 W</td>
</tr>
<tr>
<td>Parking Aisle - 60°</td>
<td>4800 W</td>
</tr>
<tr>
<td>Two Way Driveway</td>
<td>6000 W</td>
</tr>
<tr>
<td>Turning Radius (Driveway)</td>
<td>5000</td>
</tr>
<tr>
<td>Turning Radius (Parking)</td>
<td>1500</td>
</tr>
<tr>
<td>Separation between Parking</td>
<td>1540</td>
</tr>
</tbody>
</table>
Figure 2: POV Parking Lot Figure
6.7.2. SIZE AND LAYOUT OF FACILITIES

Most POV parking should be designed with 90-degree stalls. Angled parking may be used when it is the only practical method, or is requested by the User. See UFC 3-201-01 for parking stall sizes for 90-degree and angled parking layouts. Pending data from Installation’s traffic study and approval from each Installation’s engineering division, parking stalls may be sized to match Japanese POV design vehicles (2.5m x 5.0m). Adjust end islands as shown in the UFC to allow for a 4.5-meter (15-foot) inside turning radius by vehicles. Provide for more than one entrance and exit in parking lots with more than 100 parking spaces. Follow the ABA for the design of accessible parking stalls. Provide motorcycle parking and bike racks on concrete paving.

6.7.3. 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.

6.7.4. GOVERNMENT VEHICLES (GOV) VEHICLE PARKING

Space allowances for design of GOV parking shall be determined by the size of the vehicles and their maneuvering capabilities. Vehicle types and sizes are normally available from the User. See UFC 3-201-01 for some general guidelines on vehicle sizes and minimum turning requirements. Additional vehicles are listed in AASHTO. The designer will document vehicle parking design considerations in the Design Analysis.

6.7.5. DUMPSTER ENCLOSURE

If the facility user requires a dumpster on site, a concrete dumpster pad and sanitation vehicle access 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 in Japan is to have poured in place concrete walls on three sides, with a swing gate for access. Minimum setbacks as required by the AT Standards shall be met.

6.8. ROADS

Pavement design for roads and parking areas shall be the responsibility of the designer. Both flexible and rigid pavement designs shall be considered and the most economical section chosen. Pavement for roads and parking areas should be designed using 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. In general, POV parking areas and access roads shall have flexible pavement.

6.8.1. GEOMETRY

OCONUS Installation streets and roads are considered an extension of the host country’s road system, and should use traffic control device standards and criteria of the host standard. UFC 3-
Section 2-5.2 references SDDCTEA Pamphlet 55-17 for design of vehicle circulation and parking systems. SDDCTEA Pamphlet 55-17 Section 4.9 states that for OCONUS installations, host country standards should be followed for traffic control devices and geometric design of roads and parking systems. However, following host nation standards does not preclude conforming to any applicable antiterrorism and ABA accessibility requirements.

### 6.8.2. 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.

### 6.8.3. 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 predesign conference. Regulatory signage and striping shall be designed in accordance with the Japanese regulations and law. Refer to the Manual of Uniform Traffic Control Devices for signage not covered in Japanese requirements. When replacing pavement due to resurfacing, utility excavations, etc., ensure that roadway markers are replaced.

### 6.8.4. SIDEWALKS

Provide a minimum drop of 150 mm (6 inches) at all personnel doors. Sidewalks leading to main building entrances should 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 should have at least three risers and will be provided with handrails. Special attention shall be given to sidewalks that are on the north (shaded) side of buildings. These walks should be designed to ensure a freeze/thaw cycle does not result in the formation of ice on the walk. Expansion joint sealant shall be a cold-applied type. Typically, Japanese construction practice only uses reinforcement in concrete sidewalks for odd-shaped slabs. Provide underlay paper in accordance with JIS P3401 for concrete sidewalks as shown in Civil DDD concrete sidewalk detail.

### CURB RAMPS

For curb ramps along ABA accessible paths, ABA standards shall govern. The change is level from asphalt to concrete curb ramp is 20mm in the Civil DDD. ABA standards require a 6.4mm maximum vertical change in level, or 13mm maximum change in level for beveled edges. Additionally, for Curb Ramp Detail on R-15 of Civil DDD, 1800mm length (3 curb blocks) shall be used in lieu of 1200mm length (2 curb blocks) for lower slope during the 150mm drop.
6.9. **GRADING**

Table 3.1 in 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.

6.9.1. **PARKING AREA GRADES**

Follow Table 3.1 in UFC 3-201-01 and ABA requirements for ABA accessible stalls and paths.

6.9.2. **RAMP GRADES**

The maximum desirable grade for ramps is 7 percent. The absolute maximum ramp grade shall be 10 percent and for short distances only.

6.9.3. **GUTTER GRADES**

The minimum desirable gutter grade shall be 0.8 percent. The absolute minimum gutter grade shall be 0.5 percent.

6.9.4. **LONGITUDINAL SIDEWALK GRADES**

The maximum longitudinal sidewalk grade adjacent to the roadway shall be less than or equal to the adjacent roadway grade. Sidewalks without railings shall have a maximum grade not exceeding 5 percent. Sidewalks with handrails and landings shall have a maximum slope of 8.333 percent (1V:12H) slope with 1.5 m (5 feet) level landings at 9.1 m (30 feet) maximum spacing and at the top and bottom of the slope. See ABA Standards for additional requirements. Requirement listed here are per AASHTO Guide for Planning, Design and Operation of Pedestrian Facilities.

6.9.5. **GRADES AWAY FROM BUILDING**

The grade within 3 m (10 feet) of buildings shall have a desirable minimum slope of 5 percent and a desirable maximum slope of 10 percent. The grade around the perimeter of buildings shall have desirable minimum drop of 150 mm (6 inches) from the finished floor.

6.9.6. **DITCHES**

Ditches shall have a minimum slope of 0.3 percent. Trapezoidal ditches shall have a minimum width of 1.25 m (4 feet). The bottom of ditches shall be a minimum of 0.1 m (0.3 feet) below the bottom of adjacent pavement courses.
6.10. **STORM DRAINAGE**

Design of storm drainage facilities shall conform to the requirements in UFC 3-201-01. Sizing of storm drainage systems for developed portions of military installations such as administrative, industrial, and housing areas as well as roadway culverts shall be based on rainfall of 10-year frequency. Protection of military installations against flood flow originating from areas exterior to the installation will normally be based on 25-year or greater 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. In addition to the storm events described above, provisions shall be made to prevent major property damage and loss of life for the storm runoff expected to have a one percent chance of occurring in any single year.

6.10.1. **DETERMINATION OF STORM RUNOFF**

Determination of peak discharges for smaller drainage areas may be accomplished using the Rational Method described in UFC 3-201-01. The Rational Method is commonly used in Japan for drainage areas greater than 80 hectares. For large drainage areas, verify the Rational Method results used in the existing storm drain system are comparable to results using TR-55.

For areas where detailed consideration of ponding is required, computation should be by unit-hydrograph and flow-routing procedures.

6.10.2. **STORM DRAINAGE SYSTEM LAYOUT**

The storm drainage system shall be designed so as 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. The distance between drainage structures shall not be more than approximately 90 m (300 feet) for conduits with a minimum dimension smaller than 750 mm (30 inches) but in no case further than 150 m (500 feet). 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. Where possible, a minimum drop of 0.05 m (0.2 feet) between inverts of equal diameter storm drain pipes shall be provided at the centerline of drainage structures. Where storm drain pipes are of different diameters, the pipe crown elevations should be matched at the drainage structure.

6.10.3. **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.
6.11. **FENCING**

Provide wire sizes in mm diameter common to Japanese construction for chain-link fencing. Design security fences in accordance with UFC 4-022-03 Security Fences and Gates. 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.

6.12. **SPECIAL SITE SECURITY REQUIREMENTS**

The Designer must coordinate with the Installation to determine any special site security or screening requirements. All special security requirements that will impact the construction contractor must be included in the contract specifications.

6.13. **LANDSCAPE**

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. Plantings should supplement the energy efficiency of the building through wind control, temperature modification, and glare and reflection reduction, and, also reduce noise and control erosion. 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.

Refer to the Installation’s design guide for site specific landscape requirements.


6.14.1. **SEWERS**

The designer shall verify the Installation to determine if sewers in the area are overloaded. Verify system capacity if sewers are known to be overloaded or if large sewage flows will be generated by the new facility. Do not route wastewater, other than domestic sewage, to the sanitary sewage system without adequate pretreatment and/or verification of compatibility with the existing treatment system. Shut-off valves for raw sewage or sludge shall not be gate valves. Small lift stations (100 gpm to 300 gpm) should be of the submersible pump type with plug and check valves in a separate valve manhole. Where flows indicate pump capacities substantially below 100 gpm, consideration should be given to use of a submersible, grinder-type pump station (duplex) with shut-off and check valves located in the wet well. Force mains for grinder pump stations shall be 50 mm through 75 mm diameter. Wet wells and valve manholes shall be precast concrete based on vehicle loading.
6.14.2. **WATERLINE AND FORCE MAINS**

For design of waterlines and force mains, use maximum Hazen-Williams "C" value of 130 for plastic pipe and 120 for other pipe materials.

6.14.3. **WATER PRESSURE AT CFAS SASEBO**

At CFAS Sasebo, waterline pressures are typically above average. Designer shall take this into account for any new or repair work affecting the water system. For example, the Civil DDD thrust block details are not rated for such pressures and thus may not be used as shown.

6.14.4. **CORROSION PROTECTION FOR AIR FORCE PROJECTS**

For Air Force projects, specify a bonded coating for corrosion protection of underground pipes. AFI 32-1054 prohibits use of unbonded coatings, such as loose polyethylene wraps, for protection of underground pipes without prior approval by AFCEC/COS. Polyethylene encasement is acceptable if soil resistivity exceeds 10,000 ohm-centimeters and AFCEC/COS approves. Ensure the geotechnical investigation includes field resistivity test for soils if seeking this exception.
This page was intentionally left blank.
CHAPTER 7 – STRUCTURAL

7.1. 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.

7.2. 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.


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 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 A706  Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A992  Standard Specification for Structural Steel Shapes

INTERNATIONAL CODE COUNCIL (ICC) PUBLICATION

International Building Code (IBC)
International Existing Building Code (IEBC)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO) PUBLICATION


JAPANESE ARCHITECTURAL STANDARD SPECIFICATION (JASS)

JASS 5 Reinforced Concrete Work
JASS 6 Steel Work

JAPANESE INDUSTRIAL STANDARDS (JIS)

JIS A5005 Concrete Aggregate
JIS A5308 Ready Mixed Concrete
JIS A6204 Air Admixture
JIS A6514 Components for Metal Roof Decks
JIS A6517 Steel Furrings for Wall and Ceiling
JIS B1180 Hexagon Head Bolts and Hexagon Head Screws
JIS B1186 Tests of High Strength Hexagon Bolt, Hex Nut and Plain Washers for Friction Grip Joints
JIS G3101 Rolled Steels for General Structures
JIS G3112 Steel Bars for Concrete Reinforcement
JIS G3136 Rolled Steels for Building Structures
JIS G138 Rolled Steels for Bars for Building Structures
JIS G3444 Carbon Steel Tubes for General Structure
JIS G3466 Carbon Steel Square and Rectangular Tubes for General Structure
JIS G3350 Light Gauge Steel Sections for General Structures
7.3. **STRUCTURAL LOADINGS**

Structural loadings 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.

7.4. **DEAD LOADS**

Dead loads shall be selected in accordance with ASCE 7, as applicable.
7.5. **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.

7.5.1. **VEHICULAR LOADS**

For vehicles exceeding 4536 kg (10,000 lbs) design in accordance with UFC 3-301-01 and AASHTO Bridge Design Specification.

7.5.2. **HANGARS**

See design requirements in UFC 3-301-01.

7.6. **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.

7.7. **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 1996 (Missiles A & D except for Essential Facilities) or ISO 16932-2007 (Missiles A & C except for essential Facilities).

7.7.1. **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.

7.8. **SEISMIC LOADS**

All facilities shall be designed to withstand seismic loading in accordance with UFC 3-310-04 and ASCE 7. Spectral response accelerations shall be obtained from UFC 3-301-01.
7.8.1. **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.

7.9. **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 5 Antiterrorism.

7.10. **BUILDING CONSTRUCTION**

Buildings on US Military Installations in Japan are predominantly constructed of cast-in-place reinforced concrete. Hangars and warehouses are typically steel construction. Buildings constructed of precast/prestressed concrete elements (solid planks, hollow core, tritrees) and masonry are uncommon in Japan, except for piles. Precast piles are common in Japan.

7.11. **FOUNDATION DESIGN**

The designer will perform the subsurface investigation and the foundation analysis. 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.

7.11.1. **DEEP FOUNDATIONS**

Consideration should be given to noise/vibration mitigation and cost reduction when selecting the pile installation method. Precast prestressed high strength concrete (PHC) pile is the most common pile in Japan. Typical installation is by pre-drilling to the bearing layer then driving the pile for the last meter. Another typical method pile installation method is called the Cement Milk method which vibrates the pile into place and encases the lower end of the pile in a soil-
cement block. The Cement Milk method causes less vibration than a driven pile. The Cement Milk method typically costs 10-50% more and results in a bearing capacity approximately 30% less.

Other common types of piles are helical piles, steel pipe piles and drilled piers. Helical piles may be used where there are space constraints, liquefaction issues, inclined bedrock, or soil contamination. Helical piles, although are more expensive, can provide larger axial capacities and therefore require less piles. For marine structures, steel pipe piles are typical. Drilled piers are used for large structures with large loads which are not common in US military installations in Japan.

Batter piles in building construction are not permitted.

7.11.2. SHALLOW FOUNDATIONS

Soil Cement Slurry (SCS) is a soil improvement method in Japan which strengthens the existing soil to minimize earthwork and soil disposal cost. This method can be used when the firm bearing layer is less than 4 m from the bottom of the footing and the soil bearing capacity of less than 80 MPa.

Soil Cement Columns (SCC) can be used when soil bearing is located at 3 meter to 6 meter depth from the bottom of the footing.

Verify the required design soil bearing capacity for shallow foundations with JGS (Japanese Geotechnical Society) 1521 Load Plate Test.

7.12. CONCRETE DESIGN

Concrete design shall be in accordance with JASS 5, UFC 3-301-01, UFC 3-320-06FA, and current ACI publications that are applicable to the design. The water cement ratio for any concrete strength shall not be more than 0.50. The following detailed design instructions also apply.

7.12.1. TYPICAL JAPANESE CONCRETE STRENGTHS AND USAGES

Table 7: Concrete Strengths and Usages

<table>
<thead>
<tr>
<th>28-DAY STRENGTH</th>
<th>USE AND APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>24MPa (3481 psi) Compressive Strength</td>
<td>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.</td>
</tr>
<tr>
<td>30MPa (4351 psi) Compressive Strength</td>
<td>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.</td>
</tr>
</tbody>
</table>
33 MPa (4786 psi) Compressive Strength | Minimum strength requirement for concrete exposed to freezing-and-thawing cycles
---|---
36 MPa (5221 psi) Compressive Strength | For precast concrete members, except 6000 psi compressive strength may be permitted if rigid control is exercised over plant and production.
3.85 to 4.48 MPa (560 to 650 psi) Flexural Strength ** | Heavy-duty slabs-on-grade, i.e., slabs subjected to heavy loads.

** Available flexural strength depends upon the concrete materials specific to the geographical location of the project involved.

### 7.12.2. OTHER AVAILABLE CONCRETE STRENGTHS

Other most commonly used concrete strengths are 18 MPa (2610 psi), 21 MPa (3046 psi), and 27 MPa (3916 psi).

### 7.13. REINFORCING BARS

*Table 8: Japanese Reinforcing Bars*

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

### 7.13.1. REBAR AVAILABILITY

For concrete design, the following reinforcing are locally available in Japan:
Table 9: Rebar Availability

<table>
<thead>
<tr>
<th>BAR SIZE DESIGNATION</th>
<th>ASTM</th>
<th>JIS</th>
<th>STRENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>D16 &amp; Smaller</td>
<td>ASTM A615/ASTM A706</td>
<td>JIS G3112 SD295A</td>
<td>295 MPa (43 ksi)</td>
</tr>
<tr>
<td>D19 &amp; Larger</td>
<td>ASTM A615/ASTM A706</td>
<td>JIS G3112 SD345</td>
<td>345 MPa (50 ksi)</td>
</tr>
<tr>
<td>D29 &amp; Larger</td>
<td>ASTM A615/ASTM A706</td>
<td>JIS G3112 SD390</td>
<td>390 MPa (56.5 ksi)</td>
</tr>
</tbody>
</table>

Reinforcing strength 390 MPa (71 ksi) listed in the table above is the minimum requirement for accidental explosion resistance and can only be procured by special order. SD390 shall be used for longitudinal bars of special moment frames. Reinforcing strength 420 MPa (60 ksi), not listed in the table, does not exist in Japan. All other reinforcing not shown in the above table can only be procured by special order.

7.13.2. USAGE LIMITATIONS

Except for stirrups, ties and bars used in slabs-on-grade, the minimum reinforcing bar size shall be D13. Nosing bars shall not be used in exterior concrete stairs.

7.13.3. SPLICES

The three methods of splicing in Japan are lap, mechanical and welded splices. Lap and welded splices are the most common. Gas Pressure Welded Splice is the name of the welded splice method and is unique to Japan. Gas pressure welding is typically applied to the splicing of rebar D19 and larger. Welders are required to be qualified in accordance with JIS Z3801, JIS Z3841, and JIS Z3881. Gas pressure welding shall be carried out in accordance with JASS 5 and JRJI. Weld shall develop 125% of the minimum yield tensile strength of the spliced bar. Perform mechanical testing of steel in accordance with ASTM A370 or JIS Z2201 and JIS Z2241.

7.14. 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 3-320-06FA.

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. Where compressible filler is used as a cushion, its thickness shall not be less than 50 mm (2 inches). An isolation joint consisting of 13.6kg (30 lb.) felt or a 13mm (1/2-inch) expansion joint material is required where slabs abut vertical surfaces. All interior slabs shall be designed and constructed in accordance with ACI 360R. The requirement and location of vapor retarders shall be determined per figure 4.7 of ACI 360R. If a vapor retarder 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.

7.14.1. 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 3-320-06FA. The "k" factor shall be furnished by the foundation analysis and adjusted for the type of soil and saturated conditions without frost.

7.14.2. 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.

7.14.3. 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 foundation walls and footings to frost depth, shall be rigidly attached to foundation walls, and have 300mm of uncompacted fill under the slab.

7.14.4. 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.

7.14.5. CONCRETE FLOOR SLAB FINISHES

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

7.15. CONCRETE WALL THICKNESSES

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

7.16. MASONRY

Masonry as a structural building element or rainscreen is uncommon in Japan. Due to the seismic conditions, the construction culture uses cast in place concrete as the predominate construction methodology. In Japan, masonry is typically used for property walls, trash enclosure walls and plumbing walls in buildings. Japanese 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 must 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.

7.17. STRUCTURAL STEEL

Structural steel shall be designed in accordance with UFC 3-301-01, JASS 6, 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. 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.

7.17.1. STANDARD JAPANESE STRUCTURAL STEEL

*Table 10: Standard Japanese Structural Steel*

<table>
<thead>
<tr>
<th>SHAPE</th>
<th>ASTM</th>
<th>JIS</th>
<th>STRENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>H Shape</td>
<td>ASTM A36</td>
<td>JIS G3101 SS400</td>
<td>235MPa (34 ksi)</td>
</tr>
<tr>
<td></td>
<td>ASTM A572 &amp; A992</td>
<td>JIS G3136 SN490</td>
<td>325 MPa (47ksi)</td>
</tr>
</tbody>
</table>
### Channels

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASTM A36</td>
<td>JIS G3101 SS400</td>
<td>235MPa (34 ksi)</td>
</tr>
</tbody>
</table>

### Angles

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASTM A500, Grade B</td>
<td>JIS G3466 STKR400</td>
<td>235MPa (34 ksi)</td>
</tr>
</tbody>
</table>

### Plates

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASTM A53, Grade B</td>
<td>JIS G3444 STK400</td>
<td>235MPa (34 ksi)</td>
</tr>
</tbody>
</table>

### Tubes

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASTM A53, Grade B</td>
<td>JIS G3444 STK400</td>
<td>235MPa (34 ksi)</td>
</tr>
</tbody>
</table>

### Bolt

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASTM A325</td>
<td>JIS B1186</td>
<td></td>
</tr>
</tbody>
</table>

### Anchor Bolt

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASTM F1554</td>
<td>JIS G3138 SNR400B</td>
<td>235MPa (34 ksi)</td>
</tr>
</tbody>
</table>

See the following web sites for a catalogue of structural steel shapes:


#### 7.17.2. JAPANESE STRUCTURAL STEEL DESIGNATION

*Table 11: Japanese Structural Steel Designation*

<table>
<thead>
<tr>
<th>SHAPE</th>
<th>DESIGNATION</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>H Shape</td>
<td>H (height) x B (width) x t1 (web) x t2 (flange)</td>
<td>H440x300x11x18</td>
</tr>
<tr>
<td>Channels</td>
<td>H (height) x B (width) x t1 (web) x t2 (flange)</td>
<td>C200x90x11x14.5</td>
</tr>
<tr>
<td>Angle</td>
<td>A (height) x B (width) x t1 (A) x t2 (B)</td>
<td>L 200x90x9x14</td>
</tr>
<tr>
<td>Tube</td>
<td>A (height) x B (width) x t (wall thickness)</td>
<td>Tube 60 x 30 x 1.6</td>
</tr>
<tr>
<td>Pipe</td>
<td>D (outside diameter) x t (wall thickness)</td>
<td>Pipe 150 dia. x 10</td>
</tr>
</tbody>
</table>

#### 7.17.3. CONNECTION DESIGN

The structural engineer shall provide the connection design. Japanese fabricators do not typically design connections. Japanese fabricators prefer bolted connections for all structures including trusses. Specify galvanized anchor bolts for columns.

#### 7.17.4. WELDING

Japanese fabricators prefer field welding to be minimized. Perform non-destructive testing of welds in accordance with AWS D1.4 Section 7. Radiographic testing is uncommon in Japan. Ultrasonic testing is the typical method used for welding inspection.
7.18. **STEEL JOISTS AND JOIST GIRDERS**

Structural steel beams are typically used in lieu of steel joists and joist girders in Japanese construction.

7.19. **STEEL DECKING**

Metal roofing and siding shall not be used as a diaphragm. Lateral loads are typically resisted by tension rods. Metal roofs are typically 200mm in depth.

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

- **Metal Roofing**: ASTM A446, JIS A6514
- **Composite Metal Deck**: ASTM A446, JIS G3352

7.20. **COLD-FRAMED 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 3-310-04A. 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 450mm and 300mm.

- **Studs**: ASTM A446, JIS A6517 SS400
- **Window/Door Framing**: ASTM A36, JIS G3350 SSC400, 235 MPa (34 ksi)

7.21. **SPECIAL CONSTRUCTION**

7.21.1. **PRE-ENGINEERED METAL BUILDINGS**

Pre-engineered metal buildings in Japan are available for temporary structures. They are not used for permanent structures on U.S. Installations.

7.21.2. **STANDING SEAM METAL ROOFING SYSTEMS**

Structural standing seam metal roof systems shall comply with UFGS 07 61 14.00 20 Steel Standing Seam Roofing and UFC 3-320-03A. 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.

7.21.3. **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.

7.22. BLAST RESISTANT CONSTRUCTION

7.22.1. CONCRETE STRUCTURES

Concrete structures to be used for the manufacture, maintenance, inspection, or storage of explosive materials shall be designed in accordance with UFC 3-340-02. The following information will be required for such designs and will be furnished to the designer by the Japan District: 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.

7.22.2. 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.

7.22.3. STEEL FRAMES AND COLD-FRAMED 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.

7.22.4. ARMS STORAGE ROOMS

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

7.22.5. WATER STORAGE RESEVOIRS

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.
This page was intentionally left blank.
CHAPTER 8 – ARCHITECTURE

8.1. GENERAL

Excellence in architectural design for both the interior and exterior of facilities is the primary goal for all design projects. Reaching this goal requires a commitment to architectural quality and a design that is sensitive to both the surrounding community and to the specific functional needs of the customer. Careful attention shall be given to the customers’ 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. New facilities shall be creative yet harmonious with those existing facilities that are considered to be architecturally appropriate. It should be recognized that quality design does not imply added expense, and can often provide savings in operating, maintenance, and construction costs. Materials for both interior and exterior of facilities shall be selected and used with proper consideration for aesthetics, constructability, sustainability, durability and maintainability. Design decisions and material selections must have the supporting data necessary to justify the design adopted.

8.2. DESIGN CRITERIA

The design of facilities shall be in accordance with the instructions contained in this Chapter and in other applicable chapters of the Japan District Design Guide. 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. If this is an Air Force project, Army codes and regulations may be applicable. The designer shall be responsible to research and comply with all necessary design requirements. In cases were 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 of applicable requirements. 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 in the list shall be brought to the attention of the Japan District Architecture Section to verify if it should be followed.

8.3. DESIGN FOR SAFETY

Applicable provisions of the OSHA Occupational Safety and Health Standards shall be incorporated into the design where not inconsistent with customer design criteria. In cases of conflict, the safety standards established in the customer design criteria shall take precedence.
Questions on applicability should be referred to the Japan District Project Manager for resolution. See Chapter 13 SAFETY AND HEALTH for additional requirements.

8.3.1. SPECIAL COORDINATION

The interrelationship between the requirements for Fire Protection, Life Safety, Sensitive Compartmental Information Facility (SCIF) Construction, Sound Control, Blast Control, Antiterrorism-Force Protection, Sustainable Design, Energy saving strategies, and Physical Security must be carefully studied. For example, individual doors that will satisfy more than single design requirements are generally not available. This can often mean that vestibules with multiple doors are necessary to cover any group of differing requirements, and unless they are correctly placed, can in turn interfere with one of the operations.

Japanese contractors do not provide the full set of design drawings and specifications to all of their sub-contractors. It is important to clearly indicate on the design drawings all necessary information for a sub-contractor to construct their component. For instance, on the Architectural Reflected Ceiling Plan, please indicate all symbols on the symbols legend. Do not note to see Electrical drawings for lighting symbols. The sub-contractor who will be installing the ceiling will not receive the Electrical drawings, so there will be questions during construction which can be avoided if all of the information is included on the Reflected Ceiling Plan.

8.3.2. DESIGN FOR PEOPLE WITH DISABILITIES

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 must be sensitive to the special needs of people with disabilities, and should assure the incorporation of accessible features into the design. The Design Analysis shall clearly document the ABA Design Guidelines and/or contain written exemptions.

8.4. BUILDING ENVELOPE REQUIREMENTS

8.4.1. INTRODUCTION

UFC 3-101-01 chapter 3 identifies the basic requirements for building envelope design. This portion of the design guide will provide guidance on how to design to these requirements while maximizing local Japanese construction methodology and materiality that meets the climate specific needs of the varied environmental conditions of Japan.

This chapter will discuss how to apply the continuity of the barriers regarding the rain screen or water deflection layer, the insulation or thermal barrier, the air barrier, the water drainage plane, and the waterproof barrier.
8.4.2. CLIMATE ZONE DATA

When identifying how ASHRAE or IECC will be applied please reference the climate zone data in Chapter 16 Climate Data.

8.4.3. JAPANESE STANDARD DESIGN DETAILING – MLIT (Ministry of Land, Infrastructure, Transport and Tourism)

Japan has created a standardized detailing system that allows you to pick from a catalog selection of detailing that will be universally accepted by manufacturers and understood by contractors. Where as in the US, manufacturers pride themselves on the uniqueness of the products this is not the case in Japan. Standardize sizes, materials, and construction methodology are all pre-defined as a kit-of-parts, making detailing much less of an emphasis on design. It is not uncommon to flip through a set of drawings only to find the same exact details represented from one project to another.

In order to design to maximize construction efficiency and cost, it is highly recommended to reference the MLIT drawings when designing.

8.4.4. FENESTRATION

When considering designing fenestration in Japan it is important to understand how it is constructed. Where in the United States a single window manufacturer is used to create a monolithic glazing unit, in Japan there are two separate manufactures; one for the frame and one for the glazing. This makes it challenging to determine the whole U value assembly and if it can be achieved when the manufactures are operating individually. For Exterior Windows, it is recommended to utilize the window sizes that are indicated in the PDC TR 12-08 to the maximum extent possible. The window sizes indicated in the TR 12-08 have been analyzed by USACE Protective Design Center to meet the minimum requirements for AT IAW UFC 4-010-01.

8.4.5. OPENINGS

GLAZING

Window and door glazing performance shall be selected based on the energy conservation goals established for the project, and should include such factors as appropriate U-value, solar heat gain coefficient, and shading coefficient. Glass sizes and thickness will be based on the wind load requirements of the specific geographic location and the Antiterrorism blast load requirements of the facility. Each design load shall be confirmed by the structural engineer.

TRANSLUCENT SYSTEMS

Translucent fiberglass systems is typically shipped from the United States due to the fire rating requirements. However, in non-fire rated wall assemblies local material of insulated polycarbonate plate systems is common practice and recent developments have created increased production in sustainable systems for higher isolative values.
DOORS

Metal doors and frames are recommended for general use. Wood doors and frames may be used at interior locations where appropriate in family housing construction, to match existing conditions, or in administrative facilities where appearance is important. Aluminum doors and frames or storefront systems are generally recommended for building entrances. Entrance doors, windows and frames should be weather resistance, protected from the weather and of sufficient strength to withstand constant use. Wood entrance doors should be avoided. Service (overhead, etc.) doors in air conditioned facilities should be insulated. Exterior doors must be coordinated to comply with UFC 4-010-01 as required. Blast Loads shall be confirmed with the structural engineer.

Standard Japanese Door systems is as provided below.

*Table 12: Japanese Typical Door Dimensions*

<table>
<thead>
<tr>
<th>Door Type</th>
<th>Size (mm) W x H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Door</td>
<td>900 x 2100</td>
</tr>
<tr>
<td>Single Door w/ Half Door</td>
<td>400 (small leaf ) 900 (large leaf) x 2100</td>
</tr>
<tr>
<td>Double Door</td>
<td>1800 x 2100</td>
</tr>
<tr>
<td>Coil Door</td>
<td>900 x 1800</td>
</tr>
<tr>
<td>Large Coil Door</td>
<td>2350 x 1940</td>
</tr>
</tbody>
</table>

8.4.6.  INSULATION

In order to utilize Japanese products to the maximum extent possible while maintaining US code it is vital to understand the constraints about insulation.

Fire protection, insulation is required to comply with the ASTM E84 regarding fire protection. This means that Japanese products have to be tested and comply with the regulations when applying this insulation in the interior space of a building. There are two products types that meet these requirements. Phenolic foam and glass wool insulator. The designer is responsible for verifying the following R-values/U-values in the following tables.
Below are the options for interior insulation and corresponding R values (SI)

Table 13: Interior Insulation R Values, values are from Japan Energy Standard

<table>
<thead>
<tr>
<th>Category</th>
<th>Name of Building Material</th>
<th>Heat Transfer Coefficient $\lambda$ (W/(m·K))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass wool heat insulator</td>
<td>Glass wool heat insulator, equivalent to 10K</td>
<td>0.050</td>
</tr>
<tr>
<td></td>
<td>Glass wool heat insulator, equivalent to 16K</td>
<td>0.045</td>
</tr>
<tr>
<td></td>
<td>Glass wool heat insulator, equivalent to 20K</td>
<td>0.042</td>
</tr>
<tr>
<td></td>
<td>Glass wool heat insulator, equivalent to 24K</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>Glass wool heat insulator, equivalent to 32K</td>
<td>0.036</td>
</tr>
<tr>
<td>High performance glass wool heat</td>
<td>High performance glass wool heat insulator, equivalent to 16K</td>
<td>0.038</td>
</tr>
<tr>
<td>insulator, equivalent to 16K</td>
<td>High performance glass wool heat insulator, equivalent to 24K</td>
<td>0.036</td>
</tr>
<tr>
<td></td>
<td>High performance glass wool heat insulator, equivalent to 32K</td>
<td>0.035</td>
</tr>
<tr>
<td></td>
<td>High performance glass wool heat insulator, equivalent to 40K</td>
<td>0.034</td>
</tr>
<tr>
<td></td>
<td>High performance glass wool heat insulator, equivalent to 48K</td>
<td>0.033</td>
</tr>
<tr>
<td>Glass fiber wool loose fill</td>
<td>Glass fiber wool loose fill, equivalent to 13K</td>
<td>0.052</td>
</tr>
<tr>
<td>Phenolic foam heat insulator</td>
<td>Phenolic foam, insulating board, type 1, No.1</td>
<td>0.022</td>
</tr>
<tr>
<td></td>
<td>Phenolic foam, insulating board, type 1, No.2</td>
<td>0.022</td>
</tr>
</tbody>
</table>

Typical Exterior insulation types in Japan are located below. Please note items that are not included, such as tapered rigid insulation. Tapered rigid insulation is uncommon in Japan. In Japan it is typical construction practice to slope the structure and attach the continuous insulation on top. This differs from the US where it is typical to have a flat structure and slope the insulation.
Below is a list of typical exterior insulation products used and their associated R values (SI)

Table 14: Exterior Insulation R Values, values are from Japan Energy Standard

<table>
<thead>
<tr>
<th>Category</th>
<th>Name of Building Material</th>
<th>Heat Transfer Coefficient $\lambda$ (W/(m·K))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat insulator</td>
<td>Insulation fiber heat insulator fiber board</td>
<td>0.052</td>
</tr>
<tr>
<td></td>
<td><strong>Bead method polystyrene foam heat insulator</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No.1</td>
<td>0.034</td>
</tr>
<tr>
<td></td>
<td>No.2</td>
<td>0.036</td>
</tr>
<tr>
<td></td>
<td>No.3</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>No.4</td>
<td>0.041</td>
</tr>
<tr>
<td>Polystyrene foam heat insulator</td>
<td>Extruded polystyrene foam heat insulator</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type 1, b A</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>Type 1, b B</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>Type 1, b C</td>
<td>0.036</td>
</tr>
<tr>
<td></td>
<td>Type 2, b A</td>
<td>0.034</td>
</tr>
<tr>
<td></td>
<td>Type 2, b B</td>
<td>0.032</td>
</tr>
<tr>
<td></td>
<td>Type 2, b C</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>Type 3, a A</td>
<td>0.028</td>
</tr>
<tr>
<td></td>
<td>Type 3, a B</td>
<td>0.026</td>
</tr>
<tr>
<td></td>
<td>Type 3, a C</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>Type 3, a D</td>
<td>0.022</td>
</tr>
<tr>
<td></td>
<td>Type 3, b A</td>
<td>0.028</td>
</tr>
<tr>
<td></td>
<td>Type 3, b B</td>
<td>0.026</td>
</tr>
<tr>
<td></td>
<td>Type 3, b C</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>Type 3, b D</td>
<td>0.022</td>
</tr>
<tr>
<td>Urethane foam heat insulator</td>
<td>Rigid urethane foam heat insulator</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type 1</td>
<td>0.029</td>
</tr>
<tr>
<td></td>
<td>Type 2, No.1</td>
<td>0.023</td>
</tr>
<tr>
<td></td>
<td>Type 2, No.2</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>Type 2, No.3</td>
<td>0.027</td>
</tr>
<tr>
<td></td>
<td>Type 2, No.4</td>
<td>0.028</td>
</tr>
<tr>
<td>Polyethylene foam heat insulator</td>
<td>Polyethylene foam heat insulator</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type 1, No.1</td>
<td>0.042</td>
</tr>
<tr>
<td></td>
<td>Type 1, No.2</td>
<td>0.042</td>
</tr>
<tr>
<td></td>
<td>Type 2,</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>Type 3,</td>
<td>0.034</td>
</tr>
<tr>
<td>Phenolic foam heat insulator</td>
<td>Phenolic foam heat insulator</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type 1, No.1, AI, All</td>
<td>0.022</td>
</tr>
<tr>
<td></td>
<td>Type 1, No.1, BI, BII</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td>Type 1, No.1, CI, CII</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>Type 1, No.1, DI, DII</td>
<td>0.019</td>
</tr>
<tr>
<td></td>
<td>Type 1, No.1, EI, EII</td>
<td>0.018</td>
</tr>
<tr>
<td></td>
<td>Type 1, No.2, AI, All</td>
<td>0.022</td>
</tr>
<tr>
<td></td>
<td>Type 1, No.2, BI, BII</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td>Type 1, No.2, CI, CII</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>Type 1, No.2, DI, DII</td>
<td>0.019</td>
</tr>
<tr>
<td></td>
<td>Type 1, No.2, EI, EII</td>
<td>0.018</td>
</tr>
<tr>
<td></td>
<td>Type 1, No.3, AI, All</td>
<td>0.022</td>
</tr>
</tbody>
</table>
Calculating the total wall assembly R value will comply with ASHRAE, version per UFC 1-200-02 per each customer’s requirements. The R value will be presented in metric or SI units. Please note typical conversion tables for imperial to metric for reference during design.

**Table 15: Thermal R Value Conversion IP to SI**

<table>
<thead>
<tr>
<th>IMPERIAL TO METRIC (IP TO SI)</th>
<th>CONVERT R&lt;sub&gt;IP&lt;/sub&gt; TO ALL OTHER UNITS</th>
<th>CONVERT U&lt;sub&gt;IP&lt;/sub&gt; TO ALL OTHER UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R&lt;sub&gt;IP&lt;/sub&gt;</td>
<td>U&lt;sub&gt;IP&lt;/sub&gt;</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------</td>
<td>----------------</td>
</tr>
<tr>
<td>50.000</td>
<td>0.020</td>
<td>0.114</td>
</tr>
<tr>
<td>38.000</td>
<td>0.026</td>
<td>0.149</td>
</tr>
<tr>
<td>30.000</td>
<td>0.033</td>
<td>0.189</td>
</tr>
<tr>
<td>19.000</td>
<td>0.053</td>
<td>0.299</td>
</tr>
<tr>
<td>12.000</td>
<td>0.083</td>
<td>0.473</td>
</tr>
<tr>
<td>10.000</td>
<td>0.100</td>
<td>0.568</td>
</tr>
<tr>
<td>9.000</td>
<td>0.111</td>
<td>0.631</td>
</tr>
<tr>
<td>8.000</td>
<td>0.125</td>
<td>0.710</td>
</tr>
<tr>
<td>6.000</td>
<td>0.167</td>
<td>0.946</td>
</tr>
<tr>
<td>5.000</td>
<td>0.200</td>
<td>1.136</td>
</tr>
<tr>
<td>3.000</td>
<td>0.333</td>
<td>1.893</td>
</tr>
<tr>
<td>2.000</td>
<td>0.500</td>
<td>2.839</td>
</tr>
<tr>
<td>1.000</td>
<td>1.000</td>
<td>5.678</td>
</tr>
</tbody>
</table>
Table 16: Thermal R Value Conversion from SI to IP

<table>
<thead>
<tr>
<th>METRIC TO IMPERIAL (SI TO IP)</th>
<th>CONVERT $R_{SI}$ TO ALL OTHER UNITS</th>
<th>CONVERT $U_{SI}$ TO ALL OTHER UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{SI}$</td>
<td>$U_{SI}$</td>
<td>$U_{IP}$</td>
</tr>
<tr>
<td>8.60</td>
<td>0.12</td>
<td>0.02</td>
</tr>
<tr>
<td>5.30</td>
<td>0.19</td>
<td>0.03</td>
</tr>
<tr>
<td>4.40</td>
<td>0.23</td>
<td>0.04</td>
</tr>
<tr>
<td>3.30</td>
<td>0.30</td>
<td>0.05</td>
</tr>
<tr>
<td>2.30</td>
<td>0.43</td>
<td>0.08</td>
</tr>
<tr>
<td>1.90</td>
<td>0.53</td>
<td>0.09</td>
</tr>
<tr>
<td>1.70</td>
<td>0.59</td>
<td>0.10</td>
</tr>
<tr>
<td>1.10</td>
<td>0.91</td>
<td>0.16</td>
</tr>
<tr>
<td>0.90</td>
<td>1.11</td>
<td>0.20</td>
</tr>
<tr>
<td>0.70</td>
<td>1.43</td>
<td>0.25</td>
</tr>
<tr>
<td>0.27</td>
<td>3.70</td>
<td>0.65</td>
</tr>
<tr>
<td>0.25</td>
<td>4.00</td>
<td>0.70</td>
</tr>
<tr>
<td>0.19</td>
<td>5.26</td>
<td>0.93</td>
</tr>
</tbody>
</table>

| 2.84  | 0.35  | 2.00  | 0.500  |
| 3.12  | 0.32  | 1.82  | 0.549  |
| 3.92  | 0.26  | 1.45  | 0.690  |
| 4.54  | 0.22  | 1.25  | 0.800  |
8.4.7. THERMAL BRIDGE MITIGATION

Thermal bridges will be avoided throughout the building envelope.

Japanese Energy Standard has defined the method of mitigating thermal bridges for concrete wall to roof structures by ensuring that a continuous insulation overlap of a min. 300mm occurs. Note the diagram below for application example.

---

Figure 3: Japanese MLIT Cold Climate Mitigation Diagram; 1 / 7-01

---

Figure 4: Japanese MLIT Warm Climate Mitigation Diagram; 2 / 7-02

8.4.8. MOISTURE BARRIER

In order to apply the moisture barrier correctly with Japanese materials it is first important to define how and when a vapor barrier/vapor retarder and an air/moisture barrier are applied within a project. The below information is provided by the National Building Science Corporation.

The below excerpts are from BSD-106: Understanding Vapor Barriers, Joseph Lstiburek, April 15, 2011.

ASHRAE Fundamentals, Chapter 23 defined the vapor retarder as “the element that is designed and installed in an assembly to retard the movement of water by vapor diffusion.”

The unit of measurement typically used in characterizing the water vapor permeance of materials is the “perm,” with several difference classes of permeance.
Table 17: ASHRAE Vapor Retarder Classification

<table>
<thead>
<tr>
<th>Type</th>
<th>Class</th>
<th>Permanence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vapor impermeable</td>
<td>Class I Vapor Retarder</td>
<td>0.1 per or less</td>
</tr>
<tr>
<td>Vapor semi-impermeable</td>
<td>Class II Vapor Retarder</td>
<td>1.0 perm or less and greater than 0.1 perm</td>
</tr>
<tr>
<td>Vapor semi-impermeable</td>
<td>Class III Vapor Retarder</td>
<td>10 perm or less and greater than 1.0 perm</td>
</tr>
<tr>
<td>Vapor permeable</td>
<td></td>
<td>Greater than 10 perms</td>
</tr>
</tbody>
</table>

Test procedures for vapor retarders can be found in ASTM E-96 Test Method A (the desiccant method or dry cup method), when providing vapor retarders utilizing Japanese materiality it is important to identify to the maximum extent possible how each material complies with these classification types.
Understanding the application of vapor barrier/retarder for the typical wall assembly type for Japan is noted in the example provided by Building Science Corporation.

Figure 5: Concrete Structure with interior Frame Wall Cavity Insulation, per Building Science Corporation

This wall assembly is fairly typical (with the exception that rigid insulation would be replaced with phenolic foam) for Japan in climate zones classified as 1A-4C, climate zones 5A and above would require different consideration.

8.4.9. DAMPROOFING AND WATERPROOFING

In addition to a foundation drainage system (perforated drain pipe, coarse gravel, filter fabric, etc.), all occupied spaces below grade shall have the exterior walls finished with a waterproofing material. The designer shall determine which waterproofing material types shall be used depending on the severity of below grade water present and the type of occupied space. In addition to the exterior wall finishing, a more extensive water drainage systems may be required.

8.4.10. WATER VAPOR ANALYSIS

The designer shall perform a job specific vapor transmission analysis based on project specific climate and specified wall components and materials. Indicate the temperature and relative humidity for the inside and the outside of the building, a complete listing of building components, their thickness, thermal resistance and permeance, as well as building location and
8.4.11. EXTERIOR WALL AND ROOF ASSEMBLIES

Typical practice in Japan utilizes cast in place concrete for the structural wall, slab and roof assembly. For roof assemblies, the use of poured in place concrete is typical for low-slope roofs and for steep slope roofs or long-span roof assemblies a steel framing system would be typical practice.

The cast in place concrete wall assembly is typical also for the rain screen system, meaning that all insulation, furring etc. is done on the interior of the wall. Keep this in mind when performing initial gross square footage calculations as per UFC 3-101-01 section 2-2.

8.5. ROOFS

Consideration of the most appropriate roofing systems materials must occur early in the design process. Designers shall consult UFC 3-110-03, Roofing, which provides general guidelines and major considerations for selecting an appropriate roofing system. Specific roofing system design shall also be in accordance with UFC 3-110-03, Roofing. Additionally, each Army Post and Air Force Base may have special roofing requirements that can involve such things as preferred roofing system types, placement or type of insulation, minimum and maximum slopes, and other features which could impact the appearance and structure of the facility. For example, some Installations prohibit flat (low-slope) roofs. Designers should review Installation Design Guides or Facility Excellence Plans for guidance on acceptable or preferred roofing systems.

8.5.1. JAPANESE ROOF DRAINAGE STANDARDS

Below is the drain pipe diameter and bearable roof area for typical Japanese standard construction. For the table below the pipe diameter and receivable maximum roof area is based on the maximum rainfall of 180mm/hr.

*Table 18: Roof Drainage Standards, provided by Toda*

<table>
<thead>
<tr>
<th>PIPE DIAMETER (nominal diameter) (mm)</th>
<th>MAXIMUM ROOF AREA (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vertical drain and vertical pipe²)</td>
</tr>
<tr>
<td>80³)</td>
<td>110</td>
</tr>
<tr>
<td>100</td>
<td>240</td>
</tr>
<tr>
<td>125</td>
<td>430</td>
</tr>
</tbody>
</table>
8.5.2. STANDING SEAM METAL ROOFING SYSTEMS

Standing seam metal roofing systems may be used where desired for architectural aesthetics and/or where high roofing reliability is required. Slopes of 2 inches per foot or greater are preferred, but lower slopes may be permitted. Slopes less than 2 inch per foot must be approved by the District Project Architect prior to the concept design submittal. When a standing seam metal roof is considered, UFGS Section 07 61 14.00 20 (Steel Standing Seam Roofing) shall be used to specify the system unless specifically approved by the Japan District Project Architect. To help assure a leak-free standing seam metal roofing system, an ice/water guard membrane underlayment installed on top of the insulation is strongly recommended along the roof edges, including valleys, ridges, and hips which are prone to leaking.

In Japan, structural steel metal decking is uncommon, typically purlins are used. In addition to that, the shape of the standing seam metal roofing material may vary significantly from the United States. Be sure to research local manufactures standard profile shapes to confirm that the aesthetic and drainage requirements have been met.

8.5.3. BUILT-UP MEMBRANE SYSTEMS

The most common roofing application typically found on Installation in Japan. In general, roofing systems other than built-up roofing should be considered first. However, where flat (low slope) roofs are permissible by Installation Design Guides or Facilities Excellence Plans and where permitted by the Installation customer, built-up roofing may be used. The primary roof slope shall be 1/2-inch per foot minimum and the structural roof deck shall be sloped to provide the primary roof slope. Secondary slopes in valleys and crickets shall also be at least 1/2-inch per foot. The UFGS Section 07 51 13 (Built-Up Asphalt Roofing) includes a variety of special requirements designed to improve the quality of the installed roofing system, including increased Contractor quality control.
8.5.4. SINGLE-PLY SYSTEMS

Where flat (low-slope) roofs are permissible by Installation Design Guides or Facilities Excellence Plans, single-ply roofing systems such as EPDM or PVC may be considered for use on facilities with low-slope roof designs. The governing criteria for single-ply roof systems must be determined for each individual project. Use a fluid-applied membrane roofing system applied directly to the concrete roof deck for facilities in Okinawa. The Installation customer may have preferred single-ply systems, so the designer must consult with the District Project Architect prior to the concept design phase. Primary roof slopes shall be a minimum of 1/2-inch per foot and secondary slopes in valleys and crickets shall be at least 1/4-inch per foot.

8.5.5. WARRANTIES

Specify a comprehensive, single source manufacturer material and watertight warranty for the roofing system selected. The warranty terms, exclusions, and limits must be clearly enumerated in the specifications. In the United States, the length of the warranty should normally be for 20 years but could vary depending on the project circumstances, however, in Japan the warranties are typically 10 years. The Installation customer shall be consulted on the terms of the warranty desired and understanding the limitations of local materiality. Good watertight warranties generally add some additional cost to the project and the customer should be given the opportunity to weigh the cost vs. benefit ratio for the warranty chosen. See UFC 3-110-03, Roofing for additional information on roofing system warranties.

8.6. NON-STRUCTURAL METAL STUDS

Japanese standard metal stud partitions are significantly smaller and have equally smaller spacing than in the United States. Please note the table below for standard Japanese stud sizes and spacing.

Table 19: Non-Structural Metal Stud Sizes

<table>
<thead>
<tr>
<th>Stud Name</th>
<th>Size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WS-50</td>
<td>50 x 45 x 0.8</td>
</tr>
<tr>
<td>WS-65</td>
<td>65 x 45 x 0.8</td>
</tr>
<tr>
<td>WS-75</td>
<td>75 x 45 x 0.8</td>
</tr>
<tr>
<td>WS-90</td>
<td>90 x 45 x 0.8</td>
</tr>
<tr>
<td>WS-100</td>
<td>100 x 45 x 0.8</td>
</tr>
</tbody>
</table>

Due to the size of the metal studs in Japan, the spacing becomes dependent on the gypsum board in order to add rigidity to the system. Please note the requirements for metal stud spacing.
Table 20: Non-Structural Metal Stud Spacing

<table>
<thead>
<tr>
<th>Stud Spacing</th>
<th>Layer of Gypsum Board</th>
<th>Application of Gypsum</th>
</tr>
</thead>
<tbody>
<tr>
<td>303mm</td>
<td>Single Layer</td>
<td>Vertical</td>
</tr>
<tr>
<td>455mm</td>
<td>Double Layer</td>
<td>First Layer: Horizontal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second Layer: Vertical</td>
</tr>
</tbody>
</table>

8.7. **GYPSUM BOARD**

Gypsum board thickness in Japan are of a smaller panel size and thickness than in the United States, please note the industry standards for gypsum board.

Gypsum board Size: 900mm (W) x 1800mm (H)

Gypsum board thickness: 9mm, 12.5mm (most common) and 15mm

8.7.1. **FIRE RATED PARTITION WALLS**

For all U.S. funded projects designed and construction for Japan; to the maximum extent possible, all fire rated partition walls shall be constructed of reinforced concrete.

8.8. **JAPANESE SOUND ATTENUATION**

Sounds attenuation testing is different in Japan. Japan does not use the Sound Transmission Class (STC) rating system. The measurement used in Japan is Transmission Loss (TL). Sound Rated Partition design shall be coordinated with an Acoustical consultant to ensure that the proper sound transmission requirements can be achieved using Japanese materials. If this is unachievable, sound attenuation partition assemblies and other must be provided from the U.S. and cost for shipping and handling must be included in the project cost.

8.9. **FINISHES**

8.9.1. **PAINT - JAPAN PAINT MANUFACTURING ASSOCIATION (JPMA)**

In Japan, the paint colors are standardized using the JAPAN PAINT MANUFACTURING ASSOCIATION paint guide. Paint colors shall be from the JPMA (www.toryo.or.jp/eng/) standard paint colors. Exterior colors shall comply with the Installation Exterior Appearance Plan or Installation Design Guide. Color matching process in Japan is different from the U.S. color matching process. Benjamin Moore paints is available in Japan, http://benjaminmoore.co.jp/english/

The paint numbering system changes each time they release a new version and typically starts with a different lettering system. Please note below the numbering system.
Table 21: JPMA Edition History

<table>
<thead>
<tr>
<th>Year of Release</th>
<th>Edition</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>H Edition (current)</td>
</tr>
<tr>
<td>1995</td>
<td>T Edition</td>
</tr>
<tr>
<td>1993</td>
<td>S Edition</td>
</tr>
<tr>
<td>1991</td>
<td>R Edition</td>
</tr>
</tbody>
</table>

The color swatches are available for purchase only and not available online. You can purchase the swatches at the following website. [http://www.toryo.or.jp/eng/](http://www.toryo.or.jp/eng/)

Table 22: Standard Installation Exterior Color Palette

<table>
<thead>
<tr>
<th>Location</th>
<th>Paint Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior Wall/Façade</td>
<td>F19-80F</td>
</tr>
<tr>
<td>Eave</td>
<td>F09-30D</td>
</tr>
<tr>
<td>Exposed Metal such as (but not limited to)</td>
<td>F09-30D</td>
</tr>
<tr>
<td>stairs, handrails, guardrails</td>
<td></td>
</tr>
<tr>
<td>Downspouts</td>
<td>F09-30D</td>
</tr>
<tr>
<td>Exterior Doors</td>
<td>F09-30D</td>
</tr>
</tbody>
</table>

Table 23: Exterior Color Guide

<table>
<thead>
<tr>
<th>F19-80F (JPMA)</th>
<th>F09-30D (JPMA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Sample No.1" /></td>
<td><img src="image2.png" alt="Sample No.2" /></td>
</tr>
</tbody>
</table>
FINISH SCHEDULES

When calling out finishes on finish schedules, it is typical practice to simply identify the JPMA color guide number and any additional requirements such as sheen, VOC, etc.

8.9.2. CEILINGS

When designing ceilings it’s important to take into consideration the seismic requirements within Japan. Due to the increased seismic concerns typical practice in Japan is to create a rigid ceiling approach either out of acoustical ceiling material backed with gypsum board or simply gypsum board with a rigid framing system hung by rods to the structural deck. This limits access to the above plenum space and ceiling hatches are typically installed for convenience of access.

8.10. MISCELLANEOUS REQUIREMENTS

8.10.1. CONTROL JOINTS

To prevent cracking, gypsum wallboard and plastered surfaces shall be provided with control joints at corners and at other designated intervals given in the guide specifications or where shown on the drawings. Control joints in concrete walls shall be extended through the applied finish. Control joints shall be located on the plans, coordinated with structural drawings, and indicated on elevations. Control joints shall be designed, detailed, and placed in unobtrusive locations for gypsum wallboard partitions and ceramic tile surfaces in accordance with criteria and references in the guide specifications.
8.10.2. **RADON MITIGATION**

Radon mitigation is a common requirement for facilities in Okinawa. Radon mitigation shall conform to UFC 3-101-01 paragraph 2-5.1. Sub-pipe system under the slab on grade shall be designed by the plumbing engineer.
CHAPTER 9 – INTERIOR

9.1. 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.

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 is the selection and specification of all building related finishes and products. Included in the SID is paint, carpet, laminates, flooring, vinyl base, signage, etc. The FF&E package is the document that dictates the item selection, procurement, provision and installation of all furniture, furnishings, and equipment needed for the installation.

Although commonly referred to as the CID, frequently the term is used to denote the FF&E package. Clarify with the PDT which effort is really required for the project. If an SID is to be provided as well as an FF&E package (a true CID), the designer shall coordinate with the project architect to provide all necessary building finish selections, schedules, and color boards to fully explain the color schemes. In all cases, the designer shall fully coordinate the SID package with the FF&E package so that the project is unified and cohesive.

Interior design can be considered in two areas: Building related design (SID) and Furniture-related design (FF&E).

The FF&E may sometimes be abbreviated as FFE in the plans and specification. The meaning will be the same for both FF&E and FFE in this document. FF&E is the preferred abbreviation.

9.2. INTERIOR DESIGNER QUALIFICATIONS

All work shall be performed by a professional interior designer with qualifications based on education, experience and examination. Designers will have completed a recognized program of academic training in interior design, will have significant interior design experience, and be NCIDQ certified or state registered, licensed, or certified.

9.3. DESIGN CRITERIA

The design of buildings shall be in accordance with the instructions contained in this chapter and in other applicable chapters of the Japan District Design Guide. Additional applicable design criteria include Unified Facilities Guide Specifications, Using Service and Command criteria publications, and design criteria documents. Applicable requirements shall be incorporated from recognized national standards including the National Fire Codes, Life Safety Code, Americans with Disabilities Act/Architectural Barriers Act (ADA/ABA) Accessibility Guidelines for
Buildings and Facilities, Occupational Safety and Health Standards (OSHA), and the International Building Code.

**Technical Instructions**

(TI) – Design Criteria TI 800-01

**Unified Facility Guide Specifications (UFGS)**

UFC 1-200-01 General Building Requirements
UFC 3-600-01 Fire Protection Engineering for Facilities
UFC 3-100-01 Architecture
UFC 3-120-10 Interior Design
UFC 4-021-01 Design and O&M: Mass Notification Systems

American Society for Testing and Materials (ASTM)

National Fire Protection Association (NFPA)

International Building Code (IBC)

Occupational Safety and Health Administration (OSHA) Standards

Air Force Manuals and Engineering Technical Letters (ETLs)

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) - Handbook of Fundamentals

**9.4. OVERVIEW OF MILITARY INTERIOR DESIGN**

Interior design is required on new building construction and renovation projects regardless of funding source or type of project. A Comprehensive Interior Design (CID) will be provided, unless otherwise directed, and includes 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.

**9.4.1. STRUCTURAL INTERIOR DESIGN (SID)**

The Structural Interior Design includes building related design elements and components generally part of the building itself, such as walls, ceilings, floor coverings and built in casework. The interior designer's knowledge and involvement in the project from the programming stage forward affords maximum success in accomplishing the user’s goals and requirements. The interior designer must be involved with the programming and space planning to help achieve the client’s goals for space utilization, and with determining the desired interior finish materials and their respective aesthetic, durability and maintenance qualities or characteristics. In addition, the
interior designer must provide a furniture footprint based on the project program. The SID will be performed by a qualified interior designer.

9.4.2. FURNITURE, FIXTURES & EQUIPMENT (FF&E)

The Furniture, Fixtures & Equipment is the selection, layout, specification and documentation of workstations, seating, storage, filing, visual display items, accessories, window treatments, and artwork including contract documentation to facilitate pricing, procurement and installation. The FF&E package is based on the furniture footprint developed in the SID portion of the interior design. Items such as markerboards, bulletin boards and some window treatments may be specified in either the SID or the FF&E.

9.5. FINISH, COLOR, AND FURNISHING SELECTION

All work shall comply with UFC 3-120-10 Interior Design. Careful consideration shall be given to the aesthetics, function, maintainability, and quality of all design selections.

9.5.1. SAFETY AND ANSI COLOR REQUIREMENTS

In addition to aesthetics, two safety color codes are currently being used by professionals in the design field: those of the Occupational Safety and Health Administration (OSHA) and American National Standards Institute (ANSI). Both share some of the same conventions, such as the use of the color red for indicating fire protection equipment. For detailed specifics regarding the application of either system, the designer should refer directly to an OSHA or ANSI guidebook.

9.6. BUILDING RELATED INTERIOR DESIGN

Includes the coordination of interior and exterior materials and coordination and specification of finish materials, and specialties, including color, texture, pattern and quality which is consistent with the design theme.

9.6.1. CARPET

Japanese carpet typically do not comply with NFPA 101 Chapter 10 – Interior Finish, Contents and Furnishings paragraph 10.2.7 – Interior Floor Finish Testing and Classification. Carpet used in projects for Japan must comply with these requirements.

9.7. FURNITURE, FIXTURES AND EQUIPMENT (FF&E)

FF&E is the selection, layout, specification and documentation of furniture includes but is not limited to workstations, seating, tables, storage and shelving, filing, trash receptacles, clocks, framed artwork, artificial plants, and other accessories. Contract documentation is required to facilitate pricing, procurement and installation. The FF&E package is based on the furniture footprint developed in the SID portion of the interior design. The FF&E package shall be
optimally 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. Locate furniture in front of windows only if the top of the item falls below the window and unless otherwise noted, do not attach furniture including furniture systems to the building. If project has classified data and/or non-classified networks, furniture layout to be coordinated with the proper separation requirements. Verify that all separation requirements for classified systems have been incorporated in the design.

9.7.1. FURNITURE PRESENTATION REQUIREMENTS

Where required by the project SOW, the interior designer for the project shall prepare a FF&E package necessary for client approval of the interior design scheme. The FF&E package shall consist of the selection of all freestanding furniture, furnishings, equipment, accessories and pre-wired workstation components. Provide three copies of all information in separate 3-ring binders, one of which shall be kept on file at MED, and shall include the following:

CERTIFICATION DOCUMENT

The certification document verifies that three (3) vendors were found for each specified furniture item which meet the specifications and which met the requirements of the client, based on function, maintenance, ergonomics, aesthetics and budget constraints. The certification document shall be signed by the project Interior Designer.

DESIGN NARRATIVE

Include a detailed description of the design intent.

ITEM CODE LEGEND

Provide a spreadsheet indicating each item code ID with a brief item description, quantity and item location.

SPECIFICATION

Provide a technical and aesthetic specification for each item when doing open market procurement.

FURNITURE ILLUSTRATIONS AND FINISH SAMPLES

A furniture illustration sheet shall be provided for each item of FF&E and shall consist of a picture of the item and a fabric and/or finish color sample. Fabric and finish colors shall be selected to coordinate with the building room finish colors.
PRE-WIRED WORKSTATION LAYOUTS

If pre-wired workstations are required for the project, an enlarged layout of each different type of workstation shall be provided. Additionally, perspective or all elevations shall be drawn for each workstation typical. Panel layout plans shall be provided as needed.

MANUFACTURER’S SUMMARY LIST

The manufacturer’s summary list shall include the name of each manufacturer with the address, telephone number and point of contact.

9.7.2. COLOR BOARDS

COLOR BOARDS FOR FF&E PACKAGES

Provide three sets of color boards to show area color fabric and finish schemes. Samples must be large enough to show texture and patterns in the selected finishes.

COLOR BOARDS FOR SID PACKAGES

Three sets of color boards depicting the building related materials and finishes shall be provided. Display samples shall indicate true pattern, color and texture and shall be labeled to identify color, pattern, and style. See paragraph entitled PRELIMINARY BUILDING RELATED COLOR AND FINISH BOARDS for color board requirements. One set of color boards shall be kept on file at MED. Color boards shall be prepared as part of the SID regardless of whether a CID is part of the project scope.
CHAPTER 10 – LIFE SAFETY & FIRE PROTECTION

10.1. 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 2-1.15.

10.2. 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

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

10.3. 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 CAN NOT be substituted with Japanese manufactured products:

1. Fire Suppression System including valves, alarm valves, sprinkler heads (pipes and fittings of Japanese manufacturer may meet the functional requirements)
2. Fire Pumps including motors, controllers, drives, and valves
3. Fire Alarm and Mass Notification Systems including panels, initiating devices, notification appliances, smoke alarms (conductors and conduits of Japanese manufacturers may meet the functional requirements)
4. Engineering Technician requirements for development of fire suppression systems and alarm shop drawings, calculations, and material submittals
5. Fire doors and frame assemblies GREATER than 60 minutes  
6. Fire Dampers and Smoke Dampers  
7. Interior Finishes with Flame Spread and Smoke Development ratings  
8. Insulation with Flame Spread and Smoke Development ratings  
9. Plenum rated cables  

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

10.4. **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.

10.5. **FIRE ALARM, DETECTION, & MASS NOTIFICATION SYSTEMS**

Fire alarm, detection and mass notification systems shall be provided in accordance with UFC 3-600-01. 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.

10.6. **LIFE SAFETY**

Refer to UFC 3-600-01 for requirements.

10.7. **WATER SUPPLY**

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

10.8. **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 for 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 provided with fire dampers. The type and location of these fire protection devices shall be coordinated with the mechanical engineer and shown on the contract documents.
This page was intentionally left blank.
CHAPTER 11 – MECHANICAL

11.1. 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 Unified Facilities 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.

11.2. 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.

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)
Guides,
Handbooks, & Standards
American Society of Mechanical Engineers (ASME) Publications
ASTM International (ASTM)
Army Architectural & Engineering Instructions Design Criteria (ARMY AEI)
Director of Central Intelligence Directive (DCID)
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)
11.3. **DESIGN CONSIDERATIONS**

Conditions used in designing the mechanical systems shall be obtained from UFC 3-400-02 or ASHRAE Guide Books. Utilize Climate Data to determine the appropriate climate zone for the installation in Japan.

11.3.1. **OUTDOOR DESIGN CONDITIONS**

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

11.3.2. **INDOOR DESIGN CONDITIONS**

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

11.4. **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. Initial Mechanical room sizing shall be in accordance with Paragraph 4.1 entitled "MECHANICAL EQUIPMENT ROOM SIZING".

11.4.1. **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 and panelboards (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".
11.4.2. 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. 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.

11.4.3. VIBRATION ISOLATION / EQUIPMENT PADS
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.

11.4.4. 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.

11.4.5. 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. 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.

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

11.4.7. 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.
11.4.8. 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 Unified Facilities Guide Specifications.

11.4.9. ANTITERRORISM

Antiterrorism requirements shall be provided in accordance with UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings (Including change 1).

11.5. EXTERIOR HEAT DISTRIBUTION

Exterior heat distribution systems shall extend from and include the point of connection, to the existing system, to the service entrance at the facility. The design shall comply with the requirements of UFC 3-430-01FA, Heating and Cooling Distribution Systems.

11.5.1. DETERMINATION OF EXISTING HEAT DISTRIBUTION SYSTEMS

Generally, new distribution systems will be an extension of the existing distribution system at the Installation and will be connected to the existing distribution system at the installation. The designer must determine what medium is available at the Installation. The Department of Defense defines heat distribution systems as follows:

*Table 24: DoD Heat Distribution Definition*

<table>
<thead>
<tr>
<th>ITEM</th>
<th>ACRONYM</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Temperature Hot Water</td>
<td>HTHW</td>
<td>201-450 degrees F</td>
</tr>
<tr>
<td>Low Temperature Water</td>
<td>LTW</td>
<td>150-200 degrees F</td>
</tr>
<tr>
<td>Low Pressure Steam</td>
<td>LPS</td>
<td>Up to 15 psig</td>
</tr>
<tr>
<td>High Pressure Steam</td>
<td>HPS</td>
<td>Over 15 psig</td>
</tr>
<tr>
<td>Condensate Return</td>
<td>-</td>
<td>Up to 200 degrees F</td>
</tr>
</tbody>
</table>

11.5.2. SELECTION OF HEAT DISTRIBUTION SYSTEMS

After the medium type used on the installation has been determined, the heat distribution system type must then be selected. There are four basic types of distribution systems that can be used on government installations:

- **a.** Aboveground (AG) (high and low profile)
- **b.** Concrete Shallow Trench (CST)
- **c.** Buried Conduit (BC) (pre-approved type)
d. Buried Conduit (BC) (non pre-approved type).

11.5.3. ABOVEGROUND SYSTEMS

The aboveground systems are the least expensive and lowest maintenance systems available. However, the Installations typically object to aboveground systems due to aesthetics. These systems are a good application in industrial areas since the entire piping systems are aboveground. In all cases, the Installation must approve the use of aboveground systems before they are included in the design. Aboveground systems can be used for all the listed media. Design shall conform to the applicable Unified Facilities Guide Specifications.

11.5.4. CONCRETE SHALLOW TRENCH (CST) SYSTEMS

CST systems are the preferred buried system. These systems consist of shallow concrete tunnels located at grade, which allows access to piping along the entire route. These systems can be used for all listed media. The design shall conform to the applicable Unified Facilities Criteria.

11.5.5. BURIED CONDUIT (PRE-APPROVED TYPE)

Due to many premature failures, buried conduit (pre-approved type) are the last choice in buried distribution systems. These systems consist of insulated steel carrier pipe enclosed in a drainable and dryable steel conduit. They may be used for HTHW, LPS, HPS, and condensate return media. However, they must not be used unless there is an unusual situation that precludes the use of any other system (e.g. flood plain areas) and only after approval has been given by the Japan District. The design shall be in accordance with the requirements of the applicable Unified Facilities Criteria.

11.5.6. BURIED CONDUIT (NOT PRE-APPROVED TYPE)

These systems are used exclusively for low temperature water. These systems consist of an insulated metallic or nonmetallic carrier pipe covered by a nonmetallic conduit. Due to the lower pressures and temperatures of this medium, these systems have proven to be effective. The design shall be in accordance with the requirements of the applicable Unified Facilities Criteria.

11.6. DESIGN HEAT DISTRIBUTION

The design of these distribution systems is addressed in detail in UFC 3-430-01FA. The design is accomplished by a design team including mechanical (usually the lead design group), structural, electrical, and civil engineers. The tasks of each of these groups includes, but is not limited to:

**Mechanical** - Expansion compensation, piping system design (fittings, valves, insulation), equipment selection, equipment sizing, and pipe sizing and routing.

**Structural** - Reinforced concrete design, pipe supports, valve manhole design, and other miscellaneous structural designs.

**Electrical** - Electrical service to equipment and controls, and cathodic protection (if required).
Civil - Excavation and backfill, grading, road crossings (for buried systems), area drainage design, system plans and profiles, and site coordination to ensure the system (especially CST) fits into the site properly.

11.6.1. EXISTING SYSTEM CAPACITY

The designer must determine whether there is adequate capacity in the existing heat distribution system to meet the requirement of the new facility. The designer shall obtain central plant data that indicates what the impact of the new load will have on the central plant. In addition, the designer must determine if the existing lines that are to be connected to have adequate capacity to meet the new load. Each installation should have hydraulic analysis data for the existing system. This information must be obtained by the designer. If assistance is needed, Japan District design personnel may be able to assist in locating the hydraulic data. The designer must update the hydraulic analysis as part of the system design.

11.6.2. GENERAL DESIGN CONSIDERATION

Regardless of which of the system is being designed, the following are some items that must be addressed by the project designers:

Survey - A survey in the location of the distribution system must be done complete with soil borings and information on ground water, soil types and soil resistivity.

Utilities - A utility investigation must be performed to identify the type, size, and depth of all existing utilities within a minimum of 7.5 m (25 ft) of the new distribution system. This investigation includes the determination of where to connect the new distribution system to the existing. All connections must be at existing system anchor points to avoid damage to the existing system.

Pipe Sizing - All new pipes must be sized in accordance with UFC 3-430-01FA procedures.

Expansion - Expansion compensation calculations must be done to ensure the new lines do not exceed the allowable stresses, forces and moments. A computer generated finite element analysis program shall be sued to determine these values. Only loops and bends are to be used for expansion compensation. No expansion joints will be permitted.

Valve Manholes - Concrete valve manholes must be completely designed including structural grated or concrete covers, internals (including valves, traps, drip legs and vents), clearances, and reinforced concrete design. The applicable Unified Facilities Criteria shall be followed.

Drainage - All valve manholes must either gravity drain to an existing storm drain line (provide backflow protection) or to a remote sump basin complete with duplex sump pumps which discharge to an existing storm drain line or to grade.

Grading - Regardless of system, grading must be designed to ensure ground water does not enter the valve manholes.
**Plan/Profile** - Plan and profiles shall be drawn for all systems showing system routing and slope, stationing, all utility and other interferences, all roads and buildings clearly labeled, types of surface conditions (asphalt, grass, etc.), new and existing grade contour lines (plan), exact support locations, and dimensioning to ensure accurate routing.

**11.6.3. SPECIFIC DESIGN CONSIDERATIONS**

In addition to the general design considerations listed previously, each system has specific items that must be addressed to complete the design. A summary of these items is included here. Detailed explanations of the design procedures, along with applicable design details and tables for each system, are included in UFC 3-430-01FA.

**DESIGN OF ABOVEGROUND SYSTEMS**

The aboveground system design shall include detailed piping layouts, pipe support design (low or high profile type), insulation selection, jacketing selection (to protect against moisture), transition details to buried systems, and vent, drain and trap designs.

**DESIGN OF CONCRETE SHALLOW TRENCH SYSTEMS**

The CST design shall include detailed piping layouts showing all support locations, clearances inside the trench system, insulation and jacketing selection, concrete trench wall and floor design (cast-in-place), concrete top design (precast or cast-in-place) complete with lifting devices, all road crossings, grading to keep ground water from ponding over the trench system, sealant types and locations, a minimum system slope of 1:240 to ensure the trench floor will drain to the valve manholes, and vent locations. All drains and traps must be located in the valve manholes. Vents may be located in the trench system only if access is provided to them with manhole lids poured in the trench top.

**DESIGN OF BURIED CONDUIT (PRE-APPROVED TYPE)**

The pre-approved type of buried conduit is not allowed in most designs, as discussed previously. However, if approval is given to use this system, the designer shares design responsibilities with the manufacturer.

**Manufacturer's Responsibility** - This system is transported to the site in factory assembled sections. The manufacturer is responsible for the design of pipe supports, expansion compensation devices, end seals, insulation types, conduit design, and cathodic protection of the conduit (all sites in the Japan District will require a Class A system with cathodic protection). The manufacturer will also submit expansion stress calculations that the designer must review for compliance at the submittal phase.

**Designer's Responsibility** - The designer is responsible for all the general design considerations listed previously and shall also include the design of the buried conduit system penetration into the concrete valve manhole and the detailed routing of the system on the site.
BURIED CONDUIT (NON PRE-APPROVED TYPE)

Although this system is similar to the pre-approved buried conduit in that it is delivered to the site in factory assembled sections, much more is in the designer's control than with the not pre-approved system. The designer must design the items listed for general design considerations and in addition shall design detailed piping layouts, insulation type and thickness, conduit selection, carrier pipe selection, and valve manhole entrances.

11.7. EQUIPMENT IDENTIFICATION

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

11.8. SEISMIC DESIGN REQUIREMENTS

Design shall follow the requirements of UFC 3-310-04 “Seismic Design for Buildings”, and technical specifications 13 48 00 Seismic Protection for Miscellaneous Equipment and 13 48 00.00 10 Seismic Protection for Miscellaneous Equipment.

11.8.1. ESSENTIAL FACILITIES

These are critical facilities that are necessary for post-disaster recovery and must be kept operating continuously during and after an earthquake. This includes facilities where damage from an earthquake may cause significant loss of strategic and general communications and critical mission response capability. Structural Designers shall determine the site classification in accordance with UFC 3-310-04. Seismic Use Group III (Essential facilities) shall be as defined in Appendix D of UFC 3-310-04 and supplemented by the following:

1. Facilities involved in handling or processing sensitive munitions, nuclear weaponry or materials, gas and petroleum fuels, chemical or biological contaminants.
2. Facilities involved in operational missile control, launch, tracking or other critical defense capabilities.
3. Mission-essential and primary communication or data handling facilities.
4. Hospitals and other medical facilities having surgery, and emergency treatment areas.
5. Fire and police stations.
6. Tanks or other structures containing, housing, or supporting water or other fire-suppression materials or equipment required for the protection of essential or hazardous facilities or special occupancy structures.
7. Emergency vehicle and equipment shelters and garages.
8. Structures and equipment in emergency preparedness centers.
9. Stand-by power generating equipment for essential facilities.
10. Structures and equipment in communication centers and other facilities required for emergency power.
11.8.2. 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.

11.8.3. SPECIAL OCCUPANCY STRUCTURES
Special Occupancy structures shall be as defined in UFC 3-310-01 Table 1 and UFC 3-310-04.

11.8.4. STANDARD OCCUPANCY STRUCTURES
All structures having occupancies or functions not listed above.

11.8.5. 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.

11.8.6. MISCELLANEOUS EQUIPMENT
Equipment shall be supported and braced in accordance with Appendix B and D of UFC 3-310-04. 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.

11.9. 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 Unified Facilities Guide Specifications.

11.9.1. DUCTWORK
All heating and air conditioning supply ducts shall be insulated in accordance with UFC 3-410-01, Chapter 4-2.6.8 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.

11.9.2. PUMPS
Hot water and chilled water circulating pumps shall be insulated.
11.9.3. **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.

11.10. **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.

11.10.1. **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.

11.10.2. **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, should be made between the different types of compressors before final selection is made. The analysis shall be included in the Design Analysis.

11.10.3. **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.
11.10.4. 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.

11.10.5. FOUNDATION

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

11.10.6. 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.

11.10.7. PIPING

Compressed air piping will be Schedule 40, galvanized or black steel or Type K copper as allowed by Unified Facilities Guide Specification 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.

11.10.8. UNDERGROUND PIPING

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

11.10.9. 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.

11.10.10. 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.

11.10.11. REFRIGERATED DRYER

Some compressed air applications require moisture removal in addition to that provided by an aftercooler. 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.

11.11. **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.

11.11.1. **GENERATOR SET SELECTION**

Designer notes contained in UFC 3-540-01 and the Unified Facilities Guide Specifications should be reviewed and understood prior to initiating design. It is not uncommon 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 must 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.

11.11.2. **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 should 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 must be made to ventilate the room. Consideration should 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.

11.11.3. **MECHANICAL VENTILATION**

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

11.11.4. **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.

11.11.5. **FUEL OIL SYSTEM**

The design and installation of fuel oil systems shall conform to NFPA 31 and NFPA 37.
11.11.6. **EXTERIOR FUEL OIL STORAGE TANK**

Fuel oil storage tanks shall be installed underground unless specifically requested by the Customer to be 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. If the fuel tank is requested by the Customer to be installed above ground, the designer shall ensure that the Customer is aware that fuel conditioners may have to be added to the fuel in winter to prevent fuel gelling at low temperatures. Fuel oil storage tanks shall be sized per UFC 3-540-01 unless directed otherwise.

11.11.7. **FUEL OIL DAY TANK**

An auxiliary or day tank should 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 valved 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.

11.11.8. **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.

11.11.9. **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.

11.12. **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.

11.12.1. **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.

11.12.2. EQUIPMENT CONNECTIONS

In general the final connection to gas equipment should 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 must 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 must 
conform with ANSI Z21.45 except flexible connectors for movable food service equipment must 
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.

11.13. BOILER OIL SYSTEM

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

11.13.1. 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.

11.13.2. ABOVEGROUND FUEL OIL STORAGE TANK

All aboveground storage 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.

11.13.3. BELOWGROUND FUEL OIL STORAGE TANK

All buried storage tanks shall be double walled with leak monitoring system. Where tank is 
below boiler room floor elevation, provide a foot valve, or ball or lift check-valve in the fuel oil 
supply line.

11.13.4. EXTERIOR PIPING

Exterior piping shall be double walled in accordance with Local and Federal regulations.
11.14. **INTERIOR FUEL SYSTEM**

11.14.1. **FUEL OIL DAY TANK**

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.

11.14.2. **APPURTENANCES**

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

11.14.3. **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.

11.15. **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. At the United State Air Force Academy, the control valves that will be used in the HTHW system in the mechanical room are manufactured by Landis and Staefa, Inc. and will be provided by the Air Force as government furnished equipment. These control valves have not been tested to the requirements of ASME B16.34. The designer must 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 should be given to providing multiple boilers, with a combined capacity meeting the facilities heating requirement, to increase system reliability.

11.15.1. BOILER

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. Low NOx boilers, 20 ppm or less, shall be provided at Fort Carson. Boilers shall have a minimum turndown ration of 7:1.

11.15.2. BOILER CONNECTION

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

11.15.3. LOW-WATER CUTOFF

Float-type safety water feeders with low water cutoffs shall be provided for hot water boilers where required by the ASME Boiler & Pressure Vessel Code or by the manufacturer.

11.15.4. WATER COLUMN CONNECTIONS

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

11.15.5. 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".

11.15.6. COMBUSTION AIR

For facilities where sealed combustion boilers are utilized, combustion air and vent piping shall be provided in accordance with the manufacturers 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.
11.15.7. 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 Japan District.

11.15.8. 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.

11.15.9. 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.

11.15.10. 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.

11.15.11. 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.

11.15.12. 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.
11.15.13. ELECTRIC RESISTANCE HEATING

Electric resistance heating is not permitted except by USACE approval.

11.15.14. 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.

11.15.15. 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.

11.15.16. 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.

11.15.17. CONTROL SETTINGS

HVAC Control Drawing temperature settings of occupied zones to ensure personnel comfort shall be in accordance with UFC3-410-01.

11.16. 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.).

11.16.1. 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.

11.16.2. BOILER

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 prepurge and postpurge of combustion chamber.

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

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

11.16.5. WATER COLUMN CONNECTIONS
Provide crosses at right-angle turns on water column connections to boiler.

11.16.6. 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".

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

11.16.8. DISTRIBUTION PIPING
Distribution Piping shall follow the guidance in ASHRAE.

11.16.9. CONDENSATE PIPING
Condensate Coolers shall follow guidance in ASHRAE.

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

11.16.11. 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.

11.16.12. 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.
11.16.13. **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.

11.16.14. **COMBUSTION AIR**

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

11.16.15. **HUMIDIFIERS**

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

11.16.16. **FREEZE-PROOF COILS**

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

11.17. **VENTS AND STACKS**

Stacks shall be in accordance with NFPA 211. 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.

11.18. **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 Unified Facilities Guide Specification.

11.18.1. **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.

11.18.2. **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.
11.18.3. CONDENSERS
Provide head pressure control on all refrigerant condensers.

11.18.4. 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.

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

11.18.6. 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.

11.18.7. 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.

11.19. 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. The cooling system shall be meet the requirements of Unified Facilities Guide Specification.

11.19.1. DESIGN TEMPERATURES
Outside design temperatures for 1% shall be for air-cooled condensers, condensing units, for cooling towers, and evaporative condensers as obtained from UFC 3-400-02 or ASHRAE.

11.19.2. 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.

11.19.3. 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 fumigatis 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.

11.19.4. 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.

11.19.5. PIPE MATERIALS

Chilled water piping shall utilize welded or grooved mechanical joint type piping and fittings.

11.19.6. 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.

11.20. 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 Unified Facilities Guide Specifications.

11.20.1. BASIC DESIGN PRINCIPLES

All designs will be based on the following basic principles:

1. Interior design conditions selected, including temperature, humidity, filtration, ventilation, air changes, etc., will be suitable for the intended occupancy.
2. 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.
3. The design will be as simple as possible.
4. Adequate space will be provided to access items that require maintenance such as filters, coils and drain pans, and strainers.
5. Recovered heat will be used for reheat where possible.
6. Utilize energy recovery to the greatest extent that a life cycle cost analysis finds feasible.

11.20.2. 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.

11.20.3. 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.

11.20.4. 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.

11.20.5. OUTDOOR AIR INTAKES

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

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

11.20.6. 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 should 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 Unified Facilities Guide Specification (UFGS) shall be followed.
11.20.7. **ECONOMIZER CYCLE**

Provide outside air "temperature economizer cycle" for comfort air conditioning or equipment cooling only when humidity control is not required. Provide only on systems greater than 5000 m³/hr (3000 CFM) and operated 8 or more hours per day. Enthalpy control for economizer cycle shall not be provided.

11.20.8. **DUCTWORK DESIGN**

All ductwork for heating/ventilating only systems shall be insulated per Unified Facilities Guide Specification for air conditioned ductwork where future air conditioning of building is anticipated.

1. Supply air duct systems for variable air volume (VAV) systems shall be sized using the static regain method.
2. Return air ductwork shall be routed into each area isolated by walls which extend to the roof structure; the use of transfer ducts or openings shall not be used.
3. 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:

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

11.20.9. **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 Customer 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:

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

11.20.10. SPECIAL CRITERIA FOR HUMID AREA

The following criteria will be used in the design of air conditioned facilities located in areas where the wet bulb temperature is 19.5°C (67°F) or higher for over 3,000 hours and the outside design relative humidity is 50 percent or higher, where the wet bulb temperature is 23°C (73°F) or higher for over 1500 hours and the outside design relative humidity is 50 percent or higher, based on 2.5 percent dry bulb and 5.0 percent wet bulb temperatures.

11.20.11. 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 should 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.

11.20.12. 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.

11.20.13. 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.

11.20.14. VENTILATION

Outside air will be conditioned at all times through a continuously operating air-conditioning system.
11.20.15. 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.

11.20.16. OUTDOOR DESIGN TEMPERATURES

The one percent wet bulb temperature will be used in cooling calculations and equipment selections.

11.20.17. CLOSETS AND STORAGE AREAS IN AIR CONDITIONED FACILITIES

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

11.20.18. REHEAT

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

11.20.19. ECONOMIZER CYCLE

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

11.20.20. EVAPORATIVE COOLING

Evaporative cooling will be used where the facility in question is eligible for air-conditioning, and evaporative cooling can provide the required indoor design conditions based on the appropriate outdoor design conditions. In many locations where evaporative cooling cannot provide the required indoor conditions year-round, it should be further considered where preliminary life cycle calculations show that it is cost effective as a supplement to the primary cooling system. For special applications where close temperature or humidity control is required, two stage evaporative cooling or indirect evaporative cooling will be considered in life cycle cost analysis as a supplement to, not in lieu of, primary cooling system.

11.21. 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 Unified Facilities Guide Specifications.

11.21.1. 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 birdscreen. If feasible, locate intakes and exhausts on different building faces.

11.21.2. 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. Fans larger than 3400 m³/hr (2000 CFM) in capacity shall be provided with V-belt drives. 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.

11.21.3. GENERAL ITEMS
Incorporate the following as applicable:

1. Ventilation for variable air volume systems will ensure proper ventilation rates at low and high system air flow.
2. Year-round supply (make-up) air shall be provided to equal the total quantity of all exhaust hoods.
3. 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.
4. Utilize energy recovery to the greatest extent that a life cycle cost analysis finds feasible.

11.21.4. 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 grilles. Exhaust registers, in lieu of grilles, shall be provided in areas with rigid ceilings.

11.21.5. SHOWER AREAS
Shower areas shall be exhausted at the rate specified in ASHRAE 62.1.
11.21.6. COPY ROOMS

Where practical, photocopiers and laser printers should be located in a separate room. Copy rooms with photocopiers and laser printers 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.

11.21.7. 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.

11.21.8. BOILER AND FURNACE ROOM

The boiler room shall be cooled via ventilation of outside air to a temperature of no greater than 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.

11.21.9. 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).

11.21.10. LAUNDRY ROOMS

Ensure exhaust fan in laundry room are sized for appropriate air change. Cloth dryer exhaust venting must 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)

11.21.11. AUTOMOTIVE MAINTENANCE SHOPS

Shops will be provided with a suitable engine exhaust ventilating system. General ventilation shall be provided per NFPA 30A.
11.21.12.  BATTERY ROOMS
Battery rooms shall be ventilated at four air changes per hour.

11.21.13.  VEHICLE EXHAUST SYSTEMS
The design shall comply with ASHRAE, NFPA 90A, NFPA 90B and NFPA 96 and meet all the requirements of the Unified Facilities Guide Specifications.

11.21.14.  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 should 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.

11.22.  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.

11.23.  MEDICAL FACILITY REQUIREMENTS
Design requirements shall be in accordance with ASHRAE and other furnished criteria.

11.24.  HVAC TEMPERATURE CONTROL SYSTEM
HVAC Temperature control systems shall utilized direct digital controls in accordance with UFC 3-410-02 and the Unified Facilities 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. 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.
11.24.1. 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:

11.24.2. CONTROL SCHEMATICS

Control schematics shall comply with 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.

11.24.3. 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 subsectioned 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.

11.24.4. LEGENDS

A legend defining all symbols used on submittal drawings and documents shall be provided.

11.24.5. 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.

11.24.6. READABILITY

As many of the above items pertaining to the same HVAC system shall be included on the same drawing without compromising readability.
11.25. **UTILITY CONTROL SYSTEM (UCS) / ENERGY MONITORING AND CONTROL SYSTEMS (EMCS)**

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 Unified Facilities Guide Specification, unless otherwise stated.

11.25.1. **CUSTOMER COORDINATION**

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

1. The type of existing UMCS / EMCS system.
2. Justification of proprietary specifications.
3. Lon / BACnet compliance.
4. The existing EMCS system expansion capabilities.
5. 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.
6. Of the selected Input/Output (I/O) points, determine which points will be for control and which points will be for monitoring purposes only.

11.25.2. **CONCEPT DESIGN REQUIREMENTS**

The following items shall be addressed in the design submittal:

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

11.25.3. **FINAL DESIGN REQUIREMENTS**

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

1. The building system including all required HVAC control panels will be shown on the drawings, as has been coordinated with the customer or outlined by other furnished criteria.
2. Sensors and EMCS connections shall be shown on the floor plans and on Temperature Control schematics.
3. Provide a separate dedicated 20 amp/120-volt power circuit to each HVAC control panel.
4. I/O summary sheets shall be on the drawings. Failure modes shall be shown on the I/O sheets.
6. 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 UCS / EMCS.

11.25.4. 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.

11.25.5. AIR HANDLING UNITS

Air handling unit filters shall be artificially loaded during testing and balancing operations. Air handling unit flow air flow shall be set for maximum with the filters fully loaded.

11.26. GUIDE SPECIFICATIONS

The Unified Facilities 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. Unless instructed otherwise, specifications shall be in review format with editing adjustments identified. (In electronic versions: deletions shall be flagged by light red lettering, additions by light green lettering; in printed versions: Deleted text shall be identified by redline, new text identified by underlining.)
11.27. **ELEVATORS**

Elevator design and ventilation shall follow ANSI A17.1 and the Unified Facilities Guide Specifications.

**11.27.1. ELEVATOR MACHINE ROOMS**

USACE ECB 2014-22 will be followed regarding machine rooms requiring the compliance with ITG 2013-01. It can be found on the Whole Building Design Guide website at the following link: http://www.wbdg.org/ccb/browse_cat.php?c=212. It should be noted that ITG 2013-01 does not conflict with IBC (International Building Code) Chapter 30 nor UFC 3-600-01 Fire Protection Engineering for Facilities.
This page was intentionally left blank.
CHAPTER 12 – PIPING / PLUMBING

12.1. 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 Unified Facilities 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.

12.2. 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/reference/pa dod.php.

12.3. GENERAL PIPING REQUIREMENTS

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

1. 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.
2. All pumps, regardless of service, shall be non-overloading allowing the pump to operate at any point on its characteristic curve.
3. 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 must 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.
4. Provide isolation valves, balancing valve, flow measuring device, and pressure/temperature test ports at all heating and/or cooling terminal units.
5. All coils shall be provided with valved drain and air vent connections.
6. 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.

7. Strainers shall be provided with a valved blowdown connection and, where indicated, piped to a floor drain.

8. Water and natural gas service lines shall be metered where they enter the building.

9. 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".

10. All exterior, underground non-metallic piping shall be buried with locator wire and pipe detection tape.

11. All pipe, ductwork, and equipment supports and hangers shall be coordinated with the roof design to avoid overloading of any of the structural elements.

12.4. 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.

12.5. SEISMIC DESIGN CONSIDERATIONS

12.5.1. PIPING IN BUILDINGS

Pipes in buildings are categorized as pipes related to fire protection systems, critical piping in essential and hazardous facilities, and all other piping.

12.5.2. FIRE PROTECTION IN BUILDINGS

All water pipes for fire protection systems will be designed under the provisions of the applicable NFPA Chapters. [To avoid conflict with NFPA recommendations, the criteria in the following paragraphs are not applicable to piping expressly designed for fire protection.]

12.5.3. CRITICAL PIPING IN ESSENTIAL AND HAZARDOUS FACILITIES

Critical piping is that which is required for life-safety systems, for continued operations after an earthquake, or for safety of the general public. All critical piping in essential and hazardous facilities will be designed using the seismic restraint provisions of Appendix F of UFC 3-310-04. Restraints may not be omitted from the following critical installations:

1. Gas or fuel piping
2. Compressed air piping
3. Acid waste piping
4. Medical gas piping
12.5.4. ALL OTHER PIPING

All other piping within the facility and not mentioned above, shall comply with Appendix F of UFC 3-310-04.

12.6. 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.

12.6.1. PIPE MATERIALS

Pipe materials for the domestic water system shall be specified as nonferrous.

12.6.2. 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.

12.6.3. 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.

12.6.4. 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.)

12.6.5. 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.

12.6.6. 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.

12.6.7. 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.

12.6.8. 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.

12.6.9. 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.

12.6.10. 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.
12.6.11. EMERGENCY SHOWER AND EYEWASH

Emergency showers and eyewash shall be provided where hazardous materials are stored or used or as required by the Customer 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.

12.6.12. 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 43°C (110°F) for distribution. Domestic hot water shall be stored at 60°C (140°F).

12.6.13. 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.

12.6.14. 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.

12.6.15. 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.

12.6.16. 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.
12.6.17. 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.
CHAPTER 13 – ELECTRICAL

13.1. 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.

13.1.1. 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 Japan 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 [AFJMAN 32-1083]
TM 5-811-3 Electrical Design: Lightning and Static Electricity Protection [AFM 88-9, Chap 3]
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
b. Communications Systems and Equipment
I3A Technical Criteria for Installation Information Infrastructure Architecture
c. Fire Protection.
See Chapter 11 - "FIRE PROTECTION" for criteria publications
d. 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
TI 810-90 Elevator Systems

AIR FORCE PUBLICATIONS

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]
b. 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, REFRIGIRATIOING, AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 189.1 Standard for the Design of High-Performance Green Buildings Except Low-Rise

ILLUMINATING SOCIETY OF NORTH AMERICA


INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS

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

INTERIM TECHNICAL GUIDANCE (ITG)

ITG 2013-01 Navy Interim Technical Guidance - Elevator Design

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 National Electrical Code
NFPA 70E (OSHA) Standard for Electrical Safety in the Workplace
NFPA 72 National 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
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 must provide equivalent or superior safety and/or reliability. If nongovernment facilities are involved, verify proposed arrangement with the applicable Code enforcing authority.

**13.1.2. 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 should 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.

**13.1.3. 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. JIS 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. JIS 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 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 must verify restriction on metric fixture layouts with manufacturers. Caution must 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. Local Japanese light fixtures shall be used to the maximum extent possible.

13.1.4. REHABILITATION (ADD/ALTER) WORK

- 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.

- 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 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.

- 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 must be disposed of in accordance with specific regulations (PCB transformers, ballasts, lamps employing mercury or radioactive elements, etc).

13.1.5. ENVIRONMENTAL CONSIDERATIONS

- 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.

- 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.

- 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.
- Frost Depth

Refer to UFC 3-301-01, Table E-1 for a comprehensive list of frost penetrations. These values should 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 Japan 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 must be placed below frost depth.

**13.1.6. SPACE CRITERIA**

- Electrical and Telecommunications Space Allowance

When a project is received, the electrical designer shall review the DD 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 2% of the gross building square footage. Shortages of space allowances shall immediately be reported to the Project Manager, so the customer 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 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.

- 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 must 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.

- Equipment Closet

In larger facilities closets shall be provided for stepdown 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.

160
- Clearances and Access

Ensure compliance with working space requirements of NEC Article 110, including entrance requirements for high ampacity equipment.

- 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.

13.1.7. DISABILITY ACCOMMODATIONS

All projects and designs will incorporate provisions of the Americans with Disabilities Act Accessibilities Guidelines (ADAAG) and the Uniform Federal Accessibility Standards (UFAS) unless excluded. Electrically the primary considerations are that switches must 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.

13.2. DESIGN SUBMITTAL REQUIREMENTS

This chapter entails descriptions of minimally accepted electrical and telecommunications submittal requirements for each phase of the design.

13.2.1. 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:

- 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 lights.")
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.

13.2.2. 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:

- DRAWINGS

GENERAL
1. Provide a legend and abbreviations sheet indicating symbols used in the drawings and their corresponding designation.
2. Typical details planned to be used in the project shall be provided for early evaluation.
3. A preliminary riser and/or one-line diagram shall be included.

EXTERIOR ELECTRICAL
1. Existing and new electrical primary and secondary lines both overhead and underground shall be properly identified.
2. Show removals and relocations, if any. If extensive, provide separate demolition/relocation drawing(s).
3. Indicate electrical characteristics of all items as much as possible; include voltage, phase, size, and kVA.
4. Show new routing of feeders, special grounding requirements and locations of new transformers, manholes and handholes.
5. Typical layout of exterior lighting system with the pole and fixture type indicated.
6. For extensive exterior electrical work, provide a site one-line diagram.

INTERIOR ELECTRICAL
1. 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.
2. Show the service and the main electrical service equipment and their ratings.
3. Show the location of all major pieces of electrical equipment such as panelboards, switchgear, substations, large motor driven items, shop machinery, kitchen equipment, etc.
4. 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.

5. Provide receptacle layout for several different areas to indicate project requirements.

**EXTERIOR TELECOMMUNICATIONS**

1. 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.

2. Any removals and relocations must be shown. If removals/relocations are extensive, demolition plan(s) are required as separate drawings.

**INTERIOR TELECOMMUNICATIONS**

1. Show on floor plans the location of all telecommunication equipment racks, panels, and possibly cable runway routing for early discipline conflict coordination.

2. Show the proposed riser diagrams for all systems.

3. It may be necessary for the designer to provide a recommended layout for telephone, data, CATV, and other telecommunication systems on floor plan at this stage.

**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 Unified Facilities Guide Specifications (UFGS).

**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.

13.2.3. INTERMEDIATE DESIGN

The Intermediate 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:

- DRAWINGS

GENERAL

1. 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.
2. Congested areas where there can be interference with various electrical systems, cable trays, piping, ducts, etc., shall be thoroughly detailed by expanded scale drawings.
3. 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.
4. Riser and/or one-line diagrams shall be essentially complete except for finalization of conduit and wire sizes.
5. Circuiting and routing shall be shown. Provide front elevation for free-standing equipment.
6. Include pertinent notes for clarification and/or addition of construction requirements.

EXTERIOR ELECTRICAL

1. All exterior electrical work shall be completely and accurately shown on the plans with corresponding details included in the detail sheets.
2. Show all exterior electrical connections required for exterior equipment.
3. Site lighting layout shall correspond to the calculated layout meeting the minimum UFC lighting level requirements.
4. Lightning protection and grounding plans and details shall be included.

INTERIOR ELECTRICAL

1. Power riser or one-line diagram shall be essentially complete except for finalization of conduit and wire sizes.
2. Panelboards, motor control centers, switchgear equipment and all utilization equipment shall be located with schedules and physical layout arrangement. Provide front elevation for free-standing equipment.
3. Lighting fixtures, lighting controls, receptacles, and mechanical connections shall be shown.
4. A completed lighting fixture schedule shall be included on the drawings.
5. Before submittal, drawings shall be thoroughly checked by the designer for discrepancies and conflicts, particularly as related between disciplines and various systems.

**EXTERIOR TELECOMMUNICATIONS**
1. 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.
2. Thoroughly check for discrepancies and conflicts, particularly between disciplines.

**INTERIOR TELECOMMUNICATIONS**
1. Provide riser diagrams for intrusion detection system, public address system, telephone system, etc. Risers shall show the location of the various components and interconnections with other systems.
2. Show location of all devices and equipment for electronic systems on the floor plans. Location of all devices shall conform to NFPA 72 and UFC-3-600-01 and ADA/ABA.
3. Show cable runway and protective distribution system (PDS) routing.
4. Provide details of telephone outlets, telephone backboard arrangement, and other items required by criteria or comment.

**SPECIFICATIONS**

**SPECIFICATIONS**
1. Read thoroughly and comply with the instructions in front of each set of guide specifications, including notes to specification writer.
2. Cross out not applicable index items, publications, paragraphs, phrases, words, and sentences. Fill in blanks as applicable.
3. Add publication references, paragraphs, phrases, words, and sentences for items not adequately covered by specifications.
4. Do not specify proprietary items unless approved.
5. Ascertain that major or special types of equipment are available commercially in the local project area.
6. For a design whose demand load is 500 kVA and above, or 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.
7. 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 must have prior approval.
- 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.

13.2.4. 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:

- DRAWINGS

GENERAL
1. All details for final package shall be on the drawings (pole details, fixture details, etc.).
2. Complete all circuiting.
3. Complete all schedules including panel schedules.
4. Thoroughly check the drawings for discrepancies, for compatibility between drawings and specifications, and for compatibility between disciplines.

- SPECIFICATIONS

SPECIFICATIONS
Final specifications shall incorporate all previous comments and provide all information previously required by early percentages.

- 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.
13.2.5. 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.

13.3. 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 Japan District for approval.

13.3.1. LIFE CYCLE COST ANALYSIS (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 Japan. 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.

13.3.2. 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.

13.3.3. 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.
13.3.4. 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 must 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 must 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.

- 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.

- 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).

- EMERGENCY LIGHTING

Emergency lighting illumination shall meet NFPA 101.

- 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 for regularly spaces only. Method of calculation can either be the (1) Spatial Daylight Autonomy method or the (2) Illuminance Calculations as described under LEED, Daylight credit.

- 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 ASHRAE 189.1 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.

13.3.5. 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.

13.3.6. VOLTAGE DROP

Calculations must 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 must be sufficient to encompass the application range of the project.

- PRIMARY – OVER 600 VOLTS

Distribution system design for voltages over 600 volts shall be based on a maximum of 2% voltage drop.

- 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.

13.3.7. 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 must 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 must 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.

- BASIC REQUIREMENT

Maximum theoretical fault current levels based on infinite bus conditions must 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 Japan 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.

- EXTENT OF ANALYSIS

1. 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.
2. 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.
3. 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.
4. Intermediate Fault-Levels. Unless other direction has been given, the type and extent of analysis and documentation in the 14,000 to 50,000 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.

- 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.
13.3.8. 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.

13.3.9. PROTECTIVE COORDINATION ANALYSIS

The proposed electrical distribution design must 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 must 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.)

13.3.10. 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.

13.4. EXTERIOR ELECTRICAL DESIGN

13.4.1. EXTERIOR SYSTEM VOLTAGE SELECTION – MEDIUM VOLTAGE

- Medium Voltage Distribution
Typical medium voltage distribution in mainland Japan is 6.6 kV and 3.3 kV for older projects. Specify 6.6 kV rated cables and related accessories (except surge arresters which should 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 Okinawa is 15 kV rated system for 13.8 kV distribution.

Contract drawing designation for transformers typically omit the delta symbol, but the “Y” must be retained in all cases.

- Low Voltage Distribution

  - Phase Configuration

(Three-Phase vs. Single-Phase) Three-phase power shall be standard practice. Single-phase 120/240 volt service should be limited to housing and similar low demand applications unless specifically directed otherwise. If demand would exceed 150A in a single-phase configuration, consider three-phase or a combined three-phase/single-phase arrangement.

  - Voltage Configuration

The preferred configuration is the 480Y/277- volt system due to cost effectiveness, reliability, and performance - reduced line losses, more efficient use of energy, and reduced fault currents. (See paragraph "ENERGY CONSERVATION".) Dry type transformers should be employed as required to support 208-, 120-, 240-, 120/240 volt loads. (Use of delta-wye step-down transformers will also provide some isolation and reduce power quality problems due to harmonics, spikes, noise, etc. generated elsewhere in the distribution system.) The 208Y/120V system could be considered for applications with relatively low fault currents (i.e., 10,000A infinite bus for a 150 kVA transformer at 2% impedance or 75 kVA at 4%), those having predominantly incandescent lighting and other 120V loads, or that would involve revisions to existing 208V facilities. Use of an ungrounded secondary system should be limited to applications where it is essential that service to critical operations or processes not be interrupted.

Type USE is the preferred cable type for secondary distribution whether in conduit or direct buried.

13.4.2. UNDERGROUND CONSTRUCTION

- 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 in manholes, handholes, pull boxes (primary junction boxes), or above grade equipment assemblies. Underground lines shall be routed to avoid crossing under paved surfaces, buildings, or other structures whenever possible.

- 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.

- **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.

- **Conductor Sizing**

Conductor size shall be #1 AWG minimum for 6.6 kV class service (For either wye or delta system), #6 AWG minimum for 5 kV class grounded or ungrounded neutral service. For Okinawa, 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. JIS equivalent conductor sizing shall be specified for all projects (see attached “Wires, Cables and Conduits” Table).

**13.4.3. DUCT BANKS**

- **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.

- **Crossing Existing Paving**

If it is permissible to reroute traffic or suspend operations. The preferred approach would be to remove paving, install duct bank, and install new paving. In some situations, pavement cuts may be permitted. Requirements relative to maintaining or replacing paving must be verified with the Japan District Geotechnical Branch or Civil Engineering Section as applicable. (In most airfield applications interruption of operations for extended periods would not be feasible and would be very costly.) When paving or railroads are in place and cannot be disturbed, the options for conduit installation will include the following: drill or auger a carrier pipe under the paving for installation of nonmetallic or metallic conduit; alternately to push a metal pipe or conduit under the paving, or the use of directional boring. Directional boring has become the best method for smaller line installation and has become very accurate.

**13.4.4. MANHOLES, HANDHOLES, AND PULL BOXES**

- **Duct Interfacing**

Duct shall enter manholes perpendicular to the wall or within 30 degrees.
- Spacing

Manholes shall be spaced at intervals not exceeding 150 meters (or 500 feet) for straight runs. Recommended spacing should not exceed 90 meters (or 300 feet) with 45 degrees maximum bend, 60 meters (or 200 feet) for 90 degrees maximum, 45 meters (or 150 feet) for 135 degrees, 30 meters (or 100 feet) for 180 degrees. Vertical bends into equipment pads must be counted in determining the total bend. Provide an analysis with calculations and pulling criteria if these limits are exceeded.

13.4.5. 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 Japan District applications is to install direct burial cable in trenches at 750 mm (or 30 inches) minimum below grade, duct at 600 mm (or 24 inches), with 200 mm (or 8 inches) sand backfill above and below; if plowing is used, cable must be placed below frost depth.

13.4.6. 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 should also be used for secondary lines in congested areas with other utilities.

13.4.7. OVERHEAD / UNDERGROUND TRANSITIONS

Poles serving transformers with delta connected primaries must have gang-operated disconnect switch assemblies in lieu of single pole cutouts to avoid ferro-resonance damage.

13.4.8. COLOR CODING UNDERGROUND UTILITIES

Color coding of identification means (dyed concrete duct bank, warning tape, etc.) for underground utilities shall be consistent with American Public Works Association recommended color code: red - power, orange - communications, yellow - gas/oil, blue - water, green - sewer.

13.4.9. IDENTIFICATION OF EXISTING UTILITIES BY CUSTOMER

Locations, routings, and depths of underground utilities shall be identified in contract documents as completely and accurately as possible. Where the Customer has up-to-date records and qualified personnel, arrangements should be made to have locations flagged by stakes, paint, chalk lines, etc. prior to work in the specific area. Advance notice of the contractor's intent to work in a particular area should be given to the COR on site (stipulate in contract documents - 1 to 7 days is common, verify with Customer).
13.4.10. IDENTIFICATION OF EXISTING UTILITIES BY CONTRACTOR

If the Customer is unable to provide locations, the second best alternative, generally, is to direct the Contractor to perform this task. Lines should be located using suitable instruments such as magnetometers, metal detectors, signal tracers, etc. Coordination of procedures with the COR and Customer should be stipulated. The Contractor shall furnish as-built utility plans at contract completion. If the amount of existing utilities or new construction is extensive, a site work submittal showing existing conditions should be considered.

13.4.11. RELOCATION OF LINES

Relocation of underground power will normally be included in the contract scope. Relocation of communication lines, particularly those that serve security functions, will usually be relocated by the Customer. Procedures shall be verified with specific Customers.

13.4.12. PROTECTION OF EXISTING LINES

In some cases, interruption of an existing electrical or communication line will not be permitted. Excavation over the cable and in the immediate vicinity with heavy equipment should be restricted. The 6-inch segment immediately above the projected cable elevation shall be hand excavated. Protective barriers or covers shall be placed over cable before allowing vehicle traffic.

13.4.13. ROUTING UNDER PAVING OR RAILROAD TRACKS

All cable extending under paving, structures or railroad tracks must be installed in raceway (primary power in concrete-encased duct, secondary and communications may be in non-encased duct). Raceway shall extend 1.5m beyond the edge of paving or track. If cable is existing and can't be disturbed, provide protection during construction and install a split sleeve configuration around the cable for the permanent arrangement. Preferred installation under existing hard surfaced roads and airfield pavement is via cut and patch methods. (Coordinate requirements with Civil Engineering Section or Geotech Branch as applicable. Removal and replacement of an entire section of paving between joints is generally preferred.) If removal is not an option, use jacking or boring techniques to cross paving (See UFGS 33 71 02 for requirements). Rigid metal conduit may be substituted for the concrete-encased duct for jacking or boring. Installation under runways shall be in reinforced, concrete-encased duct. If jacking or boring under a runway is required, install a sleeve or casing around raceway. In new construction provide several spare sleeves at about 150 meter intervals.

13.4.14. UTILITY TUNNELS

If quantities and sizes of electrical and nonelectrical utilities are significant or would require frequent access, consider use of a common tunnel or trench configuration. Details of the tunnel and building interfaces shall be coordinated with the structural designer.

13.4.15. EXTERIOR TRANSFORMERS AND EQUIPMENT

- 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 must be suitable for wet location use. Switches shall be dead front vacuum type.

- Interior Applications – Indoor Medium Voltage Transformers

Medium voltage transformers installed indoors must be dry type, epoxy-encapsulated type, or be installed in fire resistive vaults with curved liquid containment structures. Installation must conform to provisions of NEC and UFC-3-600-01.

- Medium Voltage Transformers and Substations

In selecting transformers, the designer should 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. Except for Okinawa areas, transformer shall be Japanese cubicle type. For Okinawa areas, transformer shall be US pad mounted type transformer.

Ensure that the step down transformer KVA rating is consistent with the Japanese transformer standard KVA rating as the following:

*Table 25: Transformer Phase Voltage Requirements*

<table>
<thead>
<tr>
<th>PHASE</th>
<th>KVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>SINGLE PHASE</td>
<td>10, 20, 30, 50, 75, 100, 150, 200, 300, 500</td>
</tr>
<tr>
<td>THREE PHASE</td>
<td>10, 20, 30, 50, 75, 100, 150, 200, 300, 500, 750, 1000, 1500, 2000</td>
</tr>
</tbody>
</table>

- 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 format may be applied for sizes through 2500 kVA. For applications involving primary voltages over 6.6 kV, service to more than one building, or outdoor location of secondary and metering, the (fence-enclosed) load center configuration should be considered (see UFC 3-550-01). 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).

- Line Connections

The preferred arrangement for underground distribution transformers is the delta-grounded wye. When a delta primary connection is employed, ganged switching should be specified so that ferroresonance effects associated with single-pole switching or tripping on an ungrounded primary will not be a problem. Whenever a wye-wye connection is used, both neutrals are to be grounded; the primary to a relatively low impedance ground. The system neutral must be connected to the transformer neutral. Pad-mounted transformers should be of the five-legged core type to counteract the tendency to inductive heating in the housing of a wye-wye connected transformer. Use of an ungrounded wye-wye connection or a delta connected secondary must be approved by Japan District, Electrical Design Section in advance.

- Transformers – Design Procedures

Dry type transformers are less tolerant of overloads and phase imbalances than oil-filled transformers, therefore sizing procedures are not interchangeable. If the facility has a large quantity of nonlinear loads, the harmonics generated could affect the service transformer. The potential impact should be evaluated and the sizing procedures adjusted to the extent necessary to compensate. See paragraph "Transformer Configurations". Note that standard dry type transformer generally carry lower BIL ratings than oil-filled transformers. Equivalent ratings are available as additional cost options from most suppliers.

- 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 should 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
An 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.

- **Temperature Correction Factor**

Temperature correction factor shall be derived by estimating the time of year when the load will be the largest (the warmest or coldest month). Select the percent of correction factor for appropriate the geographic location.

- **Overload Factor**

Overload factor of 1.24 may be used (assuming maximum duration of 2 hours per 24 hour period).

- **Power Factor**

Power factor shall be a reasonable estimate.

Equation shall be:

\[ kVA = \frac{kW}{TF \times OF \times PF} \]

- **Kilo-volt-ampere Rating (kVA)**

KVA of the transformer selected shall be the standard commercial size, equal to or greater than the computed size.

- **Transformer Sizing – Dry Type**

It is preferred that dry type distribution transformers be sized for 80 to 100 percent maximum loading. A short term (2 hours maximum) overload factor of 1.10 could be used if the load is evenly balanced between phases and harmonic content in the neutral does not exceed 10 percent of rated line current.

- **Transformer Location**

Transformers of the mineral oil insulated or low flammability ("non-flammable", "less flammable liquid-filled") type shall be located not less than 7.5 meters (or 25 feet) from combustible walls or building openings. Where not feasible, use of fire-resistant barrier walls or window configurations per UFC 3-600-1, sec 6-27.2, or interior dry type transformers shall be
considered. 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.

- Locating Transformers within 7.5 meters (or 25 feet) of Non-combustible Buildings

Oil filled transformers may be located closer than 7.5 meters (or 25 feet) if the building construction is masonry or concrete and the following conditions are met: There are no window openings in first story walls within 3 meters (or 10 feet) horizontally, Windows within 3-7.5 meters (or 10-25 feet) horizontally and in second and third stories directly above are wired glass in steel sash or glass block, existing windows are filled in with brick or block, and transformers are protected with a permanently piped water spray system.

- Locating Transformers within 7.5 meters (or 25 feet) of Louvers

Oil filled transformers may be located closer than 7.5 meters (or 25 feet) to louvers if the building construction is masonry or concrete and the following conditions are met. The louver is located in a room that is constructed with a 1-hour fire rated wall such as a mechanical, electrical, or generator room. The louvers have a fire damper door with a fusible link, and if the louver is ducted to a HVAC unit, the unit shall be provided with a duct smoke detector.

- Locating Transformers within 7.5 meters (or 25 feet) of Metal Buildings

Oil filled transformers located near metal buildings must follow the criteria for buildings having walls other than masonry or concrete.

- Disposal of Existing Transformers

If an existing transformer is to be disposed of by the Contractor, include a statement indicating whether the transformer is PCB contaminated or not. If the status is not known, indicate that the transformer has not been checked for PCB contamination.

13.4.16. AUXILIARY POWER SUPPLIES

- 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).

- 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 Customer review and comment. In other projects investigation and coordination will be necessary.

- 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.)

- Medical Facility Application

Refer to IEEE 602 "Electric Power Systems in Health Care Facilities" (White Book) and UFC 4-510-01 hospitals.

- Uninterruptible and Grounding Design

- Application

UPS assemblies are reverse transfer, battery-inverter power supplies (continuously on-line, transfer action is to off-line (bypass mode) or shut down. Acceptable assemblies include the following three basic configurations: solid-state rectifier/charger input to solid-state filtered output and static-switch bypass version, a magnetic synthesizer (a 6 step transformer arrangement which electromagnetically regenerates the output wave), and hybrid motor-generator version supplied by a battery bank via rectifiers. Ferro-resonant types of solid-state inverters are to be avoided in computer applications. If a UPS is to serve nonlinear loads, it is essential that requirements be identified in the design documents.

- Sizing

Battery inverters supplying external emergency panels shall be sized on the basis of 100 percent connected load (including spare circuits if any) not demand load. No diversities may be applied.

- Service Connection
The system shall have normal AC power supplied from a fused switch connected to the supply side of the main service equipment (ahead of the mains). An overcurrent breaker, fuse, or relay sized to trip on continuous loading exceeding 97 (or 95) percent of rated inverter output shall be installed at the inverter or supply panel. If it is physically possible to insert a higher amperage device, include a label stating the maximum permissible size. The input side overcurrent device must be sized to accommodate the full load ampere (FLA) demand of the EPS under charging conditions. Charging current is commonly field settable at 115-125 percent of FLA; if input FLA is not available assume 125 percent of rated output FLA.

- Environmental Considerations

Ventilation shall be provided as necessary, to prevent the buildup of gases resulting from the charging of batteries. Temperature alarms are also recommended if environmental temperature would exceed rating maximums for extended periods. Solid state components are typically rated for a temperature range of 0° to 40°C (32-105°F). Derate unit design capacity 10 percent at 45°C, 18 percent at 50°C. Lead acid battery life is shortened drastically at temperatures above 30°C/77°F (50 percent life reduction for each 15°F increase). Nicad batteries are relatively unaffected up to 115°F. UPS components shall be located away from heat generating equipment and/or the space shall be ventilated or conditioned to maintain ambient temperature within a tolerable range.

13.4.17. SYSTEM PROTECTION – MEDIUM VOLTAGE

- 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.

- 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.

- 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.
13.4.18. SERVICE ENTRANCE FEEDER AND ENTRANCE EQUIPMENT

- 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.

- 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.

- 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.

- 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 customer-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 Customer. Comply with ASHRAE 189.1 submetering requirements as required by the customer.

- EMCS Provisions

Unless other direction is provided, furnish contacts for EMCS/UMCS interfaces. See UFGS 26 20 00.

13.4.19. 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.

13.4.20. CONDUCTOR AND CONDUIT TYPES

Coordinate with base electrical engineers on required conductor and conduit types specific to their installation.

Ensure that conductors and conduit sizes are specified in hard metric and with Japanese standard sizes.

If installation-specific requirements are not specified, apply the following or refer to UFC requirements as a minimum:

- Conductors
  1. For low voltage, 600 volts and below: EM-IE type with the appropriate rating
  2. For high voltage, 6.6 kV or higher: EM-CET type with the appropriate rating

- Conduits

<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior – Above Ceiling or concealed locations</td>
<td>Type E (EMTS) conduits</td>
</tr>
<tr>
<td>Interior and exposed</td>
<td>Type E (EMTS) conduits or Type G (thick wall/steel) conduits for wet/damp/hazardous areas</td>
</tr>
<tr>
<td>Exterior direct burial</td>
<td>Type FEP (corrugated plastic) conduits for non-paved areas or Type GLT (plastic coated rigid steel) conduits for under paved areas or Type HIVE (extra heavy wall rigid PVC) conduits under heavy traffic areas</td>
</tr>
</tbody>
</table>
13.5.  **INTERIOR ELECTRICAL DESIGN**

13.5.1.  **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 should be apportioned at one spare for every 4-6 active circuits however at least one spare circuit should be provided in each equipment assembly unless other direction is given.

13.5.2.  **SYSTEM PROTECTION – LOW VOLTAGE**

- **Low Voltage – Overvoltage Protection**

Molded-case circuit breakers should 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.

- **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.

- **Low Voltage – Circuit Breakers**

Molded-case circuit breakers should 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.

- **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.

- **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 must be maintained.

- **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 must be provided downstream in lieu of a shared neutral.

- **Arc 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 must be provided downstream in lieu of a shared neutral.

13.5.3. **HEAVY-DUTY (INSULATED-CASE CIRCUIT BREAKER) SWITCHBOARD**

Assemblies may require rear access.

13.5.4. **NORMAL-DUTY (INSULATED-CASE CIRCUIT BREAKER) SWITCHBOARD**

Rear access is not required.

13.5.5. **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.

- **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.).
- **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 must not exceed 80 percent of bus rating (see paragraph "Feeders and Branch Circuits"). Panel boards serving predominantly nonlinear loads should be supplied with a 200 percent neutral bar.

- **Overcurrent Calculations**

For panel boards with heavy motor loads, computations must 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.

- **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 should be routed to the nearest J-Box above the panelboard, if possible.

- **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.

### 13.5.6. INTERIOR TRANSFORMERS

- **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°C temperature rise. For higher elevation applications some capacity derating would be recommended.

- **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.

- **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).

- **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 premium grade unit with a 220°C insulation system and a 115°C maximum rise can support a 12-15 percent overload essentially continuously. 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.

- **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 should be exercised when using formulas to calculate theoretical K-factors, the need for units with ratings higher than K-13 is unlikely and should 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 should be installed as close as possible to the panels they feed.

- **Control Transformers**

Use of 120V control transformers with one fused leg and one grounded leg is recommended for all control circuits.

**13.5.7. FEEDERS AND BRANCH CIRCUITS**

- **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). JIS equivalent cable sizing shall be specified for all projects (see attached “Wires, Cables and Conduits” Table).

- **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.

- **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 must be treated as a current carrying conductor (see NEC Table). In data processing applications including personal computers, the neutral must 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.

- **Derating**

Ampacity of conductors is affected by two NEC derating factors. One is an adjustment factor that is applied when there are more than three current carrying conductors installed in a raceway. When nonlinear loads are served, the neutral must 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 26.0°C - 30.0°C (78.0°F - 86.0°F). 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.

- **Paralleled Runs**

Use of bus duct should be considered in lieu of parallel runs of cable when required ampacity is at or above 800A. Parallel runs of cable should be limited to 3 legs generally or 4 maximum. If these approaches are not practical, use of a higher distribution voltage should 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 must contain all circuit conductors (phase, neutral, and ground) in a common raceway to function properly and must be equal in length, size, configuration, materials, brand, etc. to ensure proportionate division of current. Equipment grounding conductors in each leg must 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.

- **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. JIS equivalent cable sizing shall be specified for all projects (see attached “Wires, Cables and Conduits” Table).

- **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 should 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, should be based on THW insulation (or type USE for underground feeders).

- **Conductor Identification**

See UFGS 26 20 00 specification and designer notes.

**13.5.8. 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. JIS equivalent conduit sizing shall be specified for all projects (see attached “Wires, Cables and Conduits” Table).

- **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.

- **Cable Tray**

 Verify that cable fill does not exceed NEC Table. Covered tray is usually required - verify for specific projects.

- **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).

- **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.

- **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 should be located at tentative locations of Customer 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. In small offices with carpet and low volume or lightweight traffic, a ribbon type undercarpet cable system could be considered. Cable should be 5-conductor (3-phase, 4-wire plus ground), Type FCC conforming to NEC.

- **Bus Duct and Cablebus**

When load demand reaches the 800-1000A range, feeder type bus duct should 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. Cablebus can also be considered. If parallel runs are involved each leg must be of equal length.

### 13.5.9. MOTORS

- **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 horsepowers 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 recircuit if necessary at no additional cost to the Government. (See Specifications.)"

- **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.

- **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.

- **High Efficiency and Premium Efficiency Motors**

High efficiency and premium efficiency motors shall be applied as indicated by UFGS 26 20 00.

- **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 should be allowed to provide combination starters at his option.

- **Motors and Applications**

A disconnecting means shall be provided for all motor operated equipment and fixed appliances. The disconnect must 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.

- **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.

- **Motor Controllers**

  - **Control Circuits**

    Control voltage shall be 120 volts. Circuits should 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 should 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 must 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.

  - **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.

- **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.

- **Miscellaneous Low Voltage Apparatus and equipment**

Circuit loading of fixed equipment shall not exceed 80% of the circuit capacity.

- **Heating Appliances**

Electric heating will be limited to supplemental uses unless specifically authorized.

- **Phase Converters**

Use of phase converters should 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.

- **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).

- **Disconnecting Provisions**

See UFGS 26 20 00. A disconnecting means shall be provided for all fixed appliances. The disconnect must be in view from the appliance location unless it is lockable. (Also see paragraph "Motors and Drives").

- **Elevators**

Coordinate with architectural and structural designers to determine what components will be furnished by the manufacturer in the elevator package and what must 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 should also check for special requirements in local codes (it is the policy to conform to state codes on Government property whenever feasible). (See UFGS 14 24 00.)

- 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.

13.5.10. SPECIAL APPLICATION – LOW VOLTAGE

- 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.

- 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 should 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 should 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 should be considered. Use of Line Drop Compensators (LDC), adjustable to line conditions, is recommended for applications with larger amperage feeders, runs exceeding 45 meters, or where load type and configurations could change. LDCs must 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.
13.5.11. ELECTRICAL SUPPORT FOR FIRE PROTECTION

- 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).

- 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, must conform to NFPA-20.

- Electronic Monitoring System

Coordinate requirements for monitoring fire alarm, smoke control, and other special systems with other designers as required.

- 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.

- 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).

13.6. LIGHTING DESIGN

The lighting system shall be designed to meet the lighting levels prescribed in the UFC and IES, considering customer 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.

13.6.1. CRITERIA

Lighting design shall generally be in accordance with the UFC and the "Lighting Handbook", published by the Illumination Engineering Society. The designer should take into consideration meeting proper uniformity levels per UFC, in addition to meeting the recommended illumination levels.

13.6.2. LUMINAIRE SELECTION

Lighting fixtures shall be locally manufactured in Japan to the maximum extent possible, with at least 3 local manufacturers to be listed for a given fixture type. 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.

13.6.3. 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 must conform to the requirements specified in UFGS 26 51 00. The use of incandescent lamps shall be limited to special applications only.

13.6.4. 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).

13.6.5. ENERGY EFFICIENT LIGHTING

- 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.

- Lamp Ballast Coordination

Energy saving lamps typically must be operated with compatible ballasts and within specified environmental conditions in order to assure proper performance. In some cases, the lamp and ballast must be of the same manufacturer for optimum performance. If energy efficient lamps are to be used, the existing ballast must 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.

- 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.

13.6.6. 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 must 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.

- 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 must be capable of supporting the load within 10 seconds of a loss of normal power. Central battery inverter systems (see Paragraph "Emergency Power System") should 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 must be provided to allow substitution of a temporary alternate source during a maintenance shutdown. Power must 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.

- Connections

The emergency or egress lighting system should 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) must 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 must 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.

- **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 must use the values from the manufacturer as much as possible.

- **Electronic Ballasts**

Use of electronic ballasts is encouraged for applications where high frequency interference would not be a concern. Design must also consider possible effects of input side harmonics generation. Use of electronic ballasts should be avoided in health care areas and electronics maintenance shops.

**13.6.7. RECOMMENDED CIRCUIT CONFIGURATIONS FOR LIGHTING**

- **Interior Applications**

Only line to neutral circuiting should be employed for interior lighting installations. Utilize higher line to neutral voltages in larger facilities to mitigate voltage drop.

- **Exterior Applications**

The supply circuit shall be multiple type for new facilities; series type circuits should 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.

**13.6.8. LIGHTING CONTROLS**

- **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.

- **Contactor**

Provide contactors to switch multiple or higher amperage circuits, for combined manual and automatic control, and for multi-function operating arrangements.

- **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.

13.6.9. SPECIFIC LIGHTING APPLICATIONS

- General Office Lighting

Target illumination level should 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.

- 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.

- Street Lighting

If power lines run parallel to a roadway, luminaires may be installed on the distribution poles.

- Parking Areas

Illumination shall be provided for all parking areas unless directed otherwise. Target level should be 0.2 foot-candles average (horizontal) except at handicapped spaces where 1-2 foot-candles is desirable.

- Security Lighting

Refer to project criteria package and to UFC 3-550-01. If contactors are used, specify the electrically operated, mechanically held type.

13.7. LIGHTNING PROTECTION AND GROUNDING DESIGN

13.7.1. 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)

- 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. In lieu of other direction, if the risk analysis result is a hazard index of 4 or higher a lightning protection system will be provided. 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.

- **Ammunition Plants**

Design shall comply with AMCR 385-100 Safety Manual as directed by the Customer.

- **Storage Tanks**

Tanks shall be grounded. They will not require air terminals if the wall thickness is more than 3/16-inch thick.

- **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 Customer.

- **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 should be laid out first and then the protected components positioned in parallel.

  - **Lightning Rods**

Lightning rods are recommended on poles or structures over 12 meters high to protect security lighting luminaires and obstruction lighting.

13.7.2. **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 Equipments and Facilities" and IEEE 1100 (Emerald Book) shall be utilized for reference and design criteria.

- **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.

- 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

1. 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.
2. If the transformer is grounded-wye grounded-wye, then the primary neutral and secondary neutral are to be tied together at the X0 terminal.
3. Frame of the transformer is to be grounded from the high voltage equipment pad and the low voltage equipment pad.
4. On a grounded-wye secondary, a ground strap is required from X0 to the frame, since UFGS 33 70
5. 02.00 10 requires X0 to be isolated from the frame.
6. 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.
7. Service from transformer to building should 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.
8. Install a counterpoise around concrete pads connected to 2 rods minimum (4 preferred, one at each corner).
9. 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.

- 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 must be interconnected below grade with
any electrodes of other systems located within 7.5 meters (interconnection is recommended within 30 meters).

- **Equipment Grounding**

  All electrical equipment shall be connected to an equipment grounding conductor sized per NEC Table. A separate cable must be provided if nonmetallic raceway is used and for receptacle circuits in EMT. Separate grounding conductors are also required for 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.

- **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.

- **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.

- **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 should be grounded at each pole, in addition to each transformer, and arrester. Shields of underground cable should 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.

- 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 must 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 must 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.

- **Ufer System**

In areas with dry soils of high resistivity values, traditional grounding methods are frequently inadequate. In the Ufer 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.

- **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:

1. 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.

2. 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) must be equal to the phase-to-phase voltage of the electrical circuit.

3. Ungrounded Applications – On systems where a grounded neutral is not present, the above mentioned guy insulators should be installed. If this is not possible, then the guy must be grounded and galvanized ground rods must be used.

- Underground Cable and Manholes

Ground the cable and hardware. See UFGS 33 71 02.
This page was intentionally left blank.
CHAPTER 14 –TELECOMMUNICATIONS

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.

14.1.1. 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 Japan 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 Japan District Electrical Section to see if it should be followed.

TELECOMMUNICATIONS INDUSTRY ASSOCIATION / ELECTRONIC INDUSTRIES ASSOCIATION (TIA / 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

In applications limited to installation of outlets, cable, and raceway, provision of grounding should be sufficient. Additional measures such as spark gap arresters or surge suppressor should be considered where an entire system is to be installed.
14.2. **DESIGN SUBMITTAL REQUIREMENTS**

See Chapter 13.2 “Design Submittal Requirements” under Electrical.

14.3. **COMMUNICATIONS – VOICE AND DATA**

**14.3.1. 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 Customer 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.

**14.3.2. 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.

**14.3.3. 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.

**14.3.4. OUTLETS**

Provide 8-pin USOC type RJ-45 jacks (verify with Customer).
14.3.5. 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.

14.3.6. 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 Customer has no objection.

14.3.7. DRAWINGS
Provide complete riser diagram for each system. Identify location of components by room number, building name or number, etc.

14.4. SPECIAL COMMUNICATIONS AND DATA SYSTEMS

14.4.1. 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 should be used for background music systems that require voice paging to override the music levels. The use of miniature relay s at zone volume controls to override volume control settings for paging should be avoided. In small systems employing relatively short runs of audio bus cable and low power requirements, a 25-volt distribution system should be used. Where long runs with high power requirements are levied on the distribution network, a 70-volt system should be used. The choice of all system components should be based on design calculations. These calculations should 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 must be coordinated with the telephone system and the user. The system must 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.

14.5. **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.

14.6. **SECURITY SYSTEMS**

14.6.1. **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 must 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).

14.6.2. **IDS SUPPORT**

In a majority of projects, raceway rough in is sufficient plus circuits for 120V power supply.

14.6.3. **ACCESS CONTROL**

Coordinate with architectural and civil designers as applicable. Generally, providing supply circuits and raceway rough in is sufficient for electrical support.
The video security system, where required, shall be integrated into the overall function of the facility. Placement of cameras must 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. A VCR shall be provided where required, to record unauthorized access (control by guard). A 120 volt single duplex receptacle (emergency power) shall be provided immediately adjacent to all CCTV camera locations.
This page was intentionally left blank.
CHAPTER 15 – SUSTAINABILITY

15.1. GENERAL

This section covers requirements for successful implementation of Sustainable Design and Development (SDD).

Sustainable Design and Development (SDD) 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.

15.2. DESIGN CRITERIA

The design publications listed below shall be used as sources of criteria for structural 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/reference/pa dod.php.

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:

5. Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings
6. Memorandum, DUSD (I&E), 10 November 2013, Subject: Department of Defense Sustainable Buildings Policy
7. HQ AFCESA/CEO ETL 08-13, Incorporating Sustainable Design and Development (SDD) and Facility Energy Attributes in the Air Force Construction Program
8. HQ USAF/A7C memo, *Air Force Sustainable Design and Development (SDD) Implementing Guidance*


http://www.wbdg.org/references/fhpsb.php


15.3. **SUSTAINABILITY IMPLEMENTATION**

Utilize the USGBC LEED for New Construction and Major Renovations rating system to incorporate, track, and document SDD in the project. Coordinate the implementation of the rating system by each discipline and verify its proper application throughout the project documents. Research and use local items that meet or provide similar performance to U.S. requirements in the LEED rating system. Pursue a minimum of 50 points in the LEED for New Construction and Major Renovations rating system.

15.3.1. **THIRD PARTY CERTIFICATION (TPC) PROJECT REGISTRATION**

The designer will register the project online with the Third Party Certification (TPC) rating system and provide the government with access. The designer shall utilize the online system to prepare all project documentation necessary for a design review. At each of the scheduled submittals, the designer shall provide hard copies of the latest TPC documentation to the Government. The Government will review and validate the documentation. At final submittal, the designer shall have completed the design documentation online and also provide all TPC documentation to the Government in a TPC Design Documentation notebook. The designer shall provide 3 copies of this notebook.

15.3.2. **ACCREDITED PROFESSIONAL AND COMMISSIONING AUTHORITIES**

Based on the required TPC an Accredited Professional (AP) in the given rating system is required on all projects for design and construction. That person/s 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. A separate TPC AP in the required project rating system shall also be involved through the construction phase as previously mentioned. A AP Commissioning authority (Cx) shall be established at the beginning of design and that person should be involved in the process through the facility pre-commissioning, commissioning plan, functional performance tests, and commissioning report. The person should attend all pre-charrettes etc. when enhanced commissioning, or when ASHRAE 189.1 Total Building Commissioning is
anticipated or included on the DD1391 (this shall include review of the entire design documentation).

15.3.3. DESIGN AND CONSTRUCTION SCHEDULES

TPC milestones shall be coordinated and indicated in the project design and construction schedules. Schedule and design approach to follow an Integrated Design Philosophy.

15.3.4. FEDERAL MANDATES

There are Federal Mandates in addition to TPC that must be met. Attaining a TPC rating does not necessarily mean federal mandates have been met. Verify that all current Federal and customer specific mandates and have been incorporated into the TPC Checklist and Construction Documents and included in the compliance documentation.

15.3.5. HIGH PERFORMANCE AND SUSTAINABLE BUILDING GUIDANCE (HPSB)

In addition to Federal Mandates verify that the project credits comply with latest version of HPSB, http://www.wbdg.org/pdfs/hpsb_guidance.pdf. It is currently a document that has consolidated the current federal mandates, criteria, and executive orders, along with additional items that can apply to The TPC rating system. Compliance with HPSB shall be documented utilizing the provided scorecard or scoresheet as indicated in UFC 1-200-02 Section 4-3.

15.4. DESIGN DOCUMENTATION SUBMITTAL REQUIREMENTS

15.4.1. USGBC LEED

Design documents shall contain all LEED documentation necessary to attain the proposed points / credits (with the exception of construction-related and post-occupancy credit documentation that will be performed by the construction contractor, the installation, and/or the user). Attainment of the points / credits will be validated by the Government based upon the use of local standards, materials, equipment, and construction methods that meet or provide similar benefits to the requirements of the LEED rating system. The Government will not seek GBCI certification.

15.4.2. 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 90.1-2007/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.
15.4.3. LIFE CYCLE COST ANALYSIS

Perform life-cycle cost analyses (LCCA) to validate SDD features during design development, and to demonstrate compliance with UFC 1-200-02, Subpart A and other federal mandates. The LCCA shall be done in accordance with UFC 1-200-02 and shall be prepared using the National Institute of Standards and Technology Handbook 135 and the Building Life Cycle Costing (BLCC) software program.

15.4.4. LIFE CYCLE COST ANALYSIS COMPLIANCE

(http://www.nist.gov/el/buildeconomic.cfm). Specifically, if an energy model analysis is required, then produce a LCCA to show compliance with the UFC 1-200-02, if life cycle cost effective. 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 and exceed 1% of the Programmed Amount in cost.

15.4.5. OWNERS PROJECT REQUIREMENTS (OPR)

Develop the Owner’s Project Requirements by using the LEED OPR Questionnaire template attached and customizing according to this project’s requirements prior to the project Charrette Conference, a sample OPR can be attained by request to the POJ SEPM. 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.

15.4.6. BASIS OF DESIGN (BoD)

The Basis of Design shall include a separate SDD narrative section detailing:

1. Project SDD intent and goals.
2. Applicable policies and regulations.
3. Description of specific SDD elements incorporated into the project by each discipline, how they contribute to the LEED score, and how they help to meet federal mandates such as EPAct 2005, EISA 2007, EO 13423, and EO 13514. Specifically, address how the design pursues a minimum 30% energy use reduction in accordance with EPAct 2005.
4. Analysis and clarification of any cost implications such as increases / savings over standard construction, and first-cost and life-cycle cost analyses.
5. Completed LEED for New Construction and Major Renovation checklist and summary, including assumptions.

15.4.7. OTHER DOCUMENTATION

1. Calculations, catalog cuts, and documentation to verify TPC checklist items.
2. Sample equipment and material catalog cuts to verify TPC checklist items.
3. Energy modeling analysis to verify EPAct 2005 and TPC EA Credit 1 compliance.
4. Life cycle cost analysis as applicable.
5. Meeting notes and correspondence to support SDD documentation.

7. Completed SDD Summary Fact Sheet to document SDD features in the project.

15.5. SUSTAINABILITY ADAPTATION FOR JAPAN

15.5.1. STANDARDS COMPARISON

Japan’s sustainability credential system is called CASBEE.

15.5.2. RECYCLED CONTENT REQUIREMENTS

Recycled content requirements should be in accordance with the Green Procurement Law (http://www.env.go.jp/en/laws/policy/green/) and the Construction Recycling Law (http://www.env.go.jp/en/laws/recycle/09.pdf). Recycled content requirements should be documented according to Section 01 33 29 LEED DOCUMENTATION for cumulative total recycled content requirements. Materials in this section may contain pre-consumer and post-industrial recycled content.

15.5.3. WATER CONSERVATION

When using American products, use American criteria for water conservation. If Japanese products are being used, Japanese criteria may be followed.

Below is a comparison of the Conservation Standards Comparison.

Table 26: Water Conservation Standards Comparison

<table>
<thead>
<tr>
<th>STANDARD</th>
<th>WATER CLOSET</th>
<th>URINAL</th>
<th>FAUCET</th>
<th>SHOWERHEAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHRAE</td>
<td>4.8L / flush</td>
<td>1.9L / flush</td>
<td>1.0L / min to 8.3L / min</td>
<td>7.6L / min</td>
</tr>
<tr>
<td>CASBEE</td>
<td>6L / use</td>
<td>4L / use</td>
<td>N / A</td>
<td>N / A</td>
</tr>
<tr>
<td>ECO MARK</td>
<td>6.5L / use</td>
<td>2.5L / use</td>
<td>N / A</td>
<td>N / A</td>
</tr>
</tbody>
</table>
This page was intentionally left blank.
CHAPTER 16 – CLIMATE DATA

16.1. GENERAL

This chapter will include the related climate data, climate zone information, along with related electrical, mechanical, civil and architectural associated climate information. Please see below for a consolidated list per each installation requirements.

16.2. CLIMATE ZONES

The climatic patterns of Japan have a wide range, from tropical to cold regions, below is a list of how each installations relates to the climate zones as classified by ASHRAE Standard 169-2013.

Figure 7: Japan Climate Zone Map, ASHRAE 169-2013
Table 27: Climate Zones for Installations in Japan

<table>
<thead>
<tr>
<th>INSTALLATION NAME</th>
<th>LOCATION</th>
<th>CLIMATE ZONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misawa</td>
<td>Aomori Prefecture</td>
<td>5A</td>
</tr>
<tr>
<td>Yokota AFB</td>
<td>Kanagawa Prefecture</td>
<td>4A</td>
</tr>
<tr>
<td>Camp Zama</td>
<td>Kanagawa Prefecture</td>
<td>4A</td>
</tr>
<tr>
<td>Camp Fuji</td>
<td>Shizuoka Prefecture</td>
<td>4A</td>
</tr>
<tr>
<td>Hardy Barracks</td>
<td>Tokyo Prefecture</td>
<td>3A</td>
</tr>
<tr>
<td>Yokohama North Dock Yokohama</td>
<td>Kanagawa Prefecture</td>
<td>3A</td>
</tr>
<tr>
<td>Sagami General Depot Sagamihara</td>
<td>Kanagawa Prefecture</td>
<td>3A</td>
</tr>
<tr>
<td>Sagamihara Housing Area Sagamihara</td>
<td>Kanagawa Prefecture</td>
<td>3A</td>
</tr>
<tr>
<td>Akizuki Ammunition Depot</td>
<td>Hiroshima Prefecture</td>
<td>2A</td>
</tr>
<tr>
<td>Hiro Ammunition Depot</td>
<td>Hiroshima Prefecture</td>
<td>2A</td>
</tr>
<tr>
<td>Kawakami Ammunition Dock</td>
<td>Hiroshima Prefecture</td>
<td>2A</td>
</tr>
<tr>
<td>Gesaji Communication Site</td>
<td>Okinawa Prefecture</td>
<td>2A</td>
</tr>
<tr>
<td>Army POL Depots</td>
<td>Okinawa Prefecture</td>
<td>2A</td>
</tr>
<tr>
<td>White Beach Area</td>
<td>Okinawa Prefecture</td>
<td>2A</td>
</tr>
<tr>
<td>Naha Port</td>
<td>Okinawa Prefecture</td>
<td>2A</td>
</tr>
<tr>
<td>Fort Buckner</td>
<td>Okinawa Prefecture</td>
<td>2A</td>
</tr>
<tr>
<td>Torii Station</td>
<td>Okinawa Prefecture</td>
<td>2A</td>
</tr>
<tr>
<td>Kadena AFB</td>
<td>Okinawa Prefecture</td>
<td>2A</td>
</tr>
</tbody>
</table>

16.3. **DRY BULB, WET BULB**

Below is a compilation of the dry bulb and wet bulb temperatures based on each location of Japan. Please note, that the discrepancies between the UFC and GOJ have been identified for situational awareness, it is recommended to use the latest GOJ information when providing calculations.
### Table 28: Dry Bulb Temperatures

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>UFC</th>
<th>GOJ (new)</th>
<th>GOJ (old)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Okinawa</td>
<td>91 (F) 32.8 (C)</td>
<td>90.7 (F) 32.6 (C)</td>
<td>89.8 (F) 32.1 (C)</td>
</tr>
<tr>
<td>Iwakuni</td>
<td>88 (F) 31.1 (C)</td>
<td>94.2 (F) 34.6 (C)</td>
<td>90.1 (F) 32.3 (C)</td>
</tr>
<tr>
<td>Yokosuka</td>
<td>86 (F) 30.0 (C)</td>
<td>94.3 (F) 34.6 (C)</td>
<td>90.1 (F) 32.3 (C)</td>
</tr>
<tr>
<td>Sasebo</td>
<td>91 (F) 32.8 (C)</td>
<td>92.5 (F) 33.6 (C)</td>
<td>92 (F) 33.3 (C)</td>
</tr>
<tr>
<td>Atsugi</td>
<td>88 (F) 31.1 (C)</td>
<td>94.3 (F) 34.6 (C)</td>
<td>90.1 (F) 32.3 (C)</td>
</tr>
<tr>
<td>Yokota</td>
<td>90 (F) 32.3 (C)</td>
<td>93.9 (F) 34.4 (C)</td>
<td>92 (F) 33.3 (C)</td>
</tr>
<tr>
<td>Misawa</td>
<td>82 (F) 27.8 (C)</td>
<td>88.7 (F) 31.5 (C)</td>
<td>88.2 (F) 31.2 (C)</td>
</tr>
</tbody>
</table>

### Table 29: Wet Bulb Temperature

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>UFC</th>
<th>GOJ (new)</th>
<th>GOJ (old)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Okinawa</td>
<td>80 (F) 26.7 (C)</td>
<td>82.8 (F) 27.9 (C)</td>
<td>81.7 (F) 27.6 (C)</td>
</tr>
<tr>
<td>Iwakuni</td>
<td>77 (F) 25 (C)</td>
<td>81.3 (F) 27.4 (C)</td>
<td>79.5 (F) 26.4 (C)</td>
</tr>
<tr>
<td>Yokosuka</td>
<td>78 (F) 25.6 (C)</td>
<td>81.3 (F) 27.4 (C)</td>
<td>80.4 (F) 26.9 (C)</td>
</tr>
<tr>
<td>Sasebo</td>
<td>78 (F) 25.6 (C)</td>
<td>81.7 (F) 27.6 (C)</td>
<td>81 (F) 27.2 (C)</td>
</tr>
<tr>
<td>Atsugi</td>
<td>76 (F) 24.4 (C)</td>
<td>81.3 (F) 27.4 (C)</td>
<td>79.5 (F) 26.4 (C)</td>
</tr>
<tr>
<td>Yokota</td>
<td>78 (F) 25.6 (C)</td>
<td>80.6 (F) 27 (C)</td>
<td>79.5 (F) 26.4 (C)</td>
</tr>
<tr>
<td>Misawa</td>
<td>73 (F) 22.8 (C)</td>
<td>77.7 (F) 25.4 (C)</td>
<td>77.7 (F) 25.4 (C)</td>
</tr>
</tbody>
</table>

### 16.4. RAINFALL DATA

The Air Force has published data regarding rainfall throughout Japan. Please reference the provided link for site specific information on their website; https://www.climate.af.mil/product_locator/?userinput=&product=ewd&country_cd=JA&latitude=&longitude=&distance=&sortBy=name&ascendingOrDescending=ASC

This data is missing the 100 year rainfall data. For this information, please see the enclosed excerpts from 東京都雨水貯留・浸透施設技術指針（資料編）published in 2009.
表2.1.2 確率降雨表
(東京管区気象台・東京観測所における観測記録をもとに「ガンベル法」により算出)

<table>
<thead>
<tr>
<th>確率線</th>
<th>最大10分</th>
<th>最大20分</th>
<th>最大30分</th>
<th>最大1時間</th>
<th>最大2時間</th>
<th>最大3時間</th>
<th>24時間最大降雨</th>
<th>日雨量</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>10.0</td>
<td>13.3</td>
<td>18.6</td>
<td>30.0</td>
<td>40.6</td>
<td>53.7</td>
<td>85.3</td>
<td>72.2</td>
</tr>
<tr>
<td>2</td>
<td>13.6</td>
<td>21.3</td>
<td>30.0</td>
<td>43.1</td>
<td>59.3</td>
<td>70.5</td>
<td>118.0</td>
<td>106.9</td>
</tr>
<tr>
<td>3</td>
<td>16.0</td>
<td>24.2</td>
<td>35.8</td>
<td>50.8</td>
<td>70.6</td>
<td>92.5</td>
<td>152.0</td>
<td>130.4</td>
</tr>
<tr>
<td>4</td>
<td>18.6</td>
<td>30.0</td>
<td>39.6</td>
<td>56.2</td>
<td>77.4</td>
<td>91.6</td>
<td>166.0</td>
<td>143.8</td>
</tr>
<tr>
<td>5</td>
<td>20.8</td>
<td>31.5</td>
<td>42.6</td>
<td>60.2</td>
<td>82.3</td>
<td>97.0</td>
<td>178.2</td>
<td>151.9</td>
</tr>
<tr>
<td>7.5</td>
<td>23.0</td>
<td>34.3</td>
<td>47.2</td>
<td>66.8</td>
<td>93.0</td>
<td>108.0</td>
<td>199.5</td>
<td>171.8</td>
</tr>
<tr>
<td>10</td>
<td>24.8</td>
<td>35.5</td>
<td>51.0</td>
<td>71.2</td>
<td>98.8</td>
<td>115.0</td>
<td>212.0</td>
<td>182.5</td>
</tr>
<tr>
<td>15</td>
<td>27.0</td>
<td>42.3</td>
<td>55.0</td>
<td>76.8</td>
<td>105.3</td>
<td>124.9</td>
<td>231.5</td>
<td>199.3</td>
</tr>
<tr>
<td>20</td>
<td>29.0</td>
<td>46.2</td>
<td>58.7</td>
<td>81.2</td>
<td>114.2</td>
<td>132.0</td>
<td>245.5</td>
<td>210.0</td>
</tr>
<tr>
<td>30</td>
<td>31.6</td>
<td>56.7</td>
<td>63.7</td>
<td>88.8</td>
<td>123.3</td>
<td>142.1</td>
<td>264.2</td>
<td>226.0</td>
</tr>
<tr>
<td>50</td>
<td>34.7</td>
<td>58.2</td>
<td>69.5</td>
<td>95.7</td>
<td>134.5</td>
<td>153.5</td>
<td>287.6</td>
<td>245.0</td>
</tr>
<tr>
<td>70</td>
<td>36.4</td>
<td>58.3</td>
<td>72.0</td>
<td>100.5</td>
<td>142.3</td>
<td>161.0</td>
<td>302.0</td>
<td>266.5</td>
</tr>
<tr>
<td>100</td>
<td>37.4</td>
<td>58.7</td>
<td>73.8</td>
<td>102.8</td>
<td>145.5</td>
<td>165.0</td>
<td>308.9</td>
<td>269.4</td>
</tr>
</tbody>
</table>

(資料)
1.2.3時間降雨量 昭和2年～昭和41年 各年最大値35個
24時間降雨量 明治23年～昭和41年 各年最大値77個
日降雨量 昭和2年～昭和41年 各年最大値35個

Figure 8: Yokota AFB Rainfall Data

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>RAINFALL FOR 1 HR</th>
<th>RAINFALL FOR 10 MINUTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
<td>YR</td>
</tr>
<tr>
<td>Wakkani</td>
<td>64.0</td>
<td>1938</td>
</tr>
<tr>
<td>Rumoi</td>
<td>57.5</td>
<td>1988</td>
</tr>
<tr>
<td>Asahikawa</td>
<td>57.3</td>
<td>1912</td>
</tr>
<tr>
<td>Abashiri</td>
<td>36.8</td>
<td>1925</td>
</tr>
<tr>
<td>Sapporo</td>
<td>50.2</td>
<td>1913</td>
</tr>
<tr>
<td>Obishiro</td>
<td>56.5</td>
<td>1975</td>
</tr>
<tr>
<td>Kushiro</td>
<td>55.9</td>
<td>1947</td>
</tr>
<tr>
<td>Nemuro</td>
<td>52.6</td>
<td>1955</td>
</tr>
<tr>
<td>Suttsu</td>
<td>57.5</td>
<td>1990</td>
</tr>
<tr>
<td>Urakawa</td>
<td>43.5</td>
<td>1958</td>
</tr>
<tr>
<td>Hakodate</td>
<td>63.2</td>
<td>1939</td>
</tr>
<tr>
<td>Aomori</td>
<td>67.5</td>
<td>2000</td>
</tr>
<tr>
<td>Akita</td>
<td>72.4</td>
<td>1964</td>
</tr>
<tr>
<td>Morioka</td>
<td>62.7</td>
<td>1938</td>
</tr>
<tr>
<td>Miyako</td>
<td>63.6</td>
<td>1959</td>
</tr>
<tr>
<td>Sakata</td>
<td>77.8</td>
<td>1949</td>
</tr>
<tr>
<td>Yamagata</td>
<td>74.5</td>
<td>1981</td>
</tr>
<tr>
<td>Sendai</td>
<td>94.3</td>
<td>1948</td>
</tr>
<tr>
<td>Fukushima</td>
<td>70.6</td>
<td>1966</td>
</tr>
<tr>
<td>Onahama</td>
<td>61.8</td>
<td>1963</td>
</tr>
<tr>
<td>Wajima</td>
<td>73.7</td>
<td>1936</td>
</tr>
<tr>
<td>Akawa</td>
<td>79.8</td>
<td>1961</td>
</tr>
<tr>
<td>Niigata</td>
<td>97.0</td>
<td>1998</td>
</tr>
<tr>
<td>Kanazawa</td>
<td>77.3</td>
<td>1950</td>
</tr>
<tr>
<td>Toyama</td>
<td>75.0</td>
<td>1970</td>
</tr>
<tr>
<td>Nagano</td>
<td>63.0</td>
<td>1933</td>
</tr>
<tr>
<td>Takada</td>
<td>64.1</td>
<td>1962</td>
</tr>
<tr>
<td>Utsunomiya</td>
<td>100.5</td>
<td>1957</td>
</tr>
<tr>
<td>Fukui</td>
<td>56.2</td>
<td>1953</td>
</tr>
<tr>
<td>Takayama</td>
<td>52.0</td>
<td>1940</td>
</tr>
<tr>
<td>Matsumoto</td>
<td>59.0</td>
<td>1981</td>
</tr>
<tr>
<td>Karuizawa</td>
<td>69.4</td>
<td>1960</td>
</tr>
<tr>
<td>Maebashi</td>
<td>114.5</td>
<td>1997</td>
</tr>
<tr>
<td>Kumagaya</td>
<td>88.5</td>
<td>1943</td>
</tr>
<tr>
<td>Mito</td>
<td>81.7</td>
<td>1947</td>
</tr>
<tr>
<td>Tsuruga</td>
<td>57.9</td>
<td>1956</td>
</tr>
<tr>
<td>Gifu</td>
<td>99.6</td>
<td>1914</td>
</tr>
<tr>
<td>Nagoya</td>
<td>97.0</td>
<td>2000</td>
</tr>
<tr>
<td>Iida</td>
<td>79.7</td>
<td>1960</td>
</tr>
<tr>
<td>Koufu</td>
<td>73.0</td>
<td>1978</td>
</tr>
</tbody>
</table>

*Note The Starting year statistics – from 2003: edited by National Astronomical Observatory, Chronological scientific tables, Maruzen*
<table>
<thead>
<tr>
<th>LOCATION</th>
<th>RAiNFALL FOR 1 HR</th>
<th>RAiNFALL FOR 10 MINUTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
<td>YR</td>
</tr>
<tr>
<td>Choshi</td>
<td>140.1</td>
<td>1947</td>
</tr>
<tr>
<td>Tsu</td>
<td>118.0</td>
<td>1999</td>
</tr>
<tr>
<td>Hamamatsu</td>
<td>87.5</td>
<td>1982</td>
</tr>
<tr>
<td>Shizuoka</td>
<td>113.0</td>
<td>2003</td>
</tr>
<tr>
<td>Tokyo</td>
<td>88.7</td>
<td>1939</td>
</tr>
<tr>
<td>Owase</td>
<td>139.0</td>
<td>1972</td>
</tr>
<tr>
<td>Yokohama</td>
<td>92.0</td>
<td>1998</td>
</tr>
<tr>
<td>Oshima</td>
<td>84.5</td>
<td>1993</td>
</tr>
<tr>
<td>Hachijojima</td>
<td>129.5</td>
<td>1999</td>
</tr>
<tr>
<td>Saigou</td>
<td>93.0</td>
<td>1988</td>
</tr>
<tr>
<td>Matsue</td>
<td>77.9</td>
<td>1944</td>
</tr>
<tr>
<td>Tottori</td>
<td>68.0</td>
<td>1981</td>
</tr>
<tr>
<td>Hamada</td>
<td>91.0</td>
<td>1983</td>
</tr>
<tr>
<td>Kyoto</td>
<td>88.0</td>
<td>1980</td>
</tr>
<tr>
<td>Hikone</td>
<td>63.5</td>
<td>2001</td>
</tr>
<tr>
<td>Shimonoseki</td>
<td>77.4</td>
<td>1953</td>
</tr>
<tr>
<td>Hiroshima</td>
<td>79.2</td>
<td>1926</td>
</tr>
<tr>
<td>Okayama</td>
<td>73.5</td>
<td>1997</td>
</tr>
<tr>
<td>Kobe</td>
<td>87.7</td>
<td>1939</td>
</tr>
<tr>
<td>Osaka</td>
<td>77.5</td>
<td>1979</td>
</tr>
<tr>
<td>Wakayama</td>
<td>99.0</td>
<td>1952</td>
</tr>
<tr>
<td>Shionomisaki</td>
<td>145.0</td>
<td>1972</td>
</tr>
<tr>
<td>Nara</td>
<td>79.0</td>
<td>2000</td>
</tr>
<tr>
<td>Izuahara</td>
<td>116.0</td>
<td>2003</td>
</tr>
<tr>
<td>Fukuoka</td>
<td>96.5</td>
<td>1997</td>
</tr>
<tr>
<td>Saga</td>
<td>101.5</td>
<td>1937</td>
</tr>
<tr>
<td>Oita</td>
<td>81.5</td>
<td>1993</td>
</tr>
<tr>
<td>Nagasaki</td>
<td>127.5</td>
<td>1982</td>
</tr>
<tr>
<td>Kumamoto</td>
<td>80.5</td>
<td>2003</td>
</tr>
<tr>
<td>Kagoshima</td>
<td>104.5</td>
<td>1995</td>
</tr>
<tr>
<td>Miyazaki</td>
<td>138.5</td>
<td>1995</td>
</tr>
<tr>
<td>Fukue</td>
<td>113.5</td>
<td>1967</td>
</tr>
<tr>
<td>Matsuyama</td>
<td>60.5</td>
<td>1992</td>
</tr>
<tr>
<td>Takamatsu</td>
<td>68.5</td>
<td>1998</td>
</tr>
<tr>
<td>Kochi</td>
<td>129.5</td>
<td>1998</td>
</tr>
<tr>
<td>Tokushima</td>
<td>86.9</td>
<td>1950</td>
</tr>
<tr>
<td>Shimizu</td>
<td>150.0</td>
<td>1944</td>
</tr>
<tr>
<td>Murotomisaki</td>
<td>123.8</td>
<td>1949</td>
</tr>
<tr>
<td>Naze</td>
<td>116.4</td>
<td>1949</td>
</tr>
<tr>
<td>Naha</td>
<td>110.5</td>
<td>1998</td>
</tr>
</tbody>
</table>

*Note The Starting year statistics – from 2003: edited by National Astronomical Observatory, Chronological scientific tables, Maruzen