Aircraft Hangars & Other Airfield Structures
Airfield Planning and Design Criteria Training

5/22/2020
Section 1a – Welcome and Course Purpose

Aircraft Hangars & Other Airfield Structures
Welcome

• Conference Space and Facility Orientation
• Course Materials
• Sign-In Sheet
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Introductions

Gene O. Brown, PE, LEED AP
Principal & Executive Vice President at FSB
Oklahoma City, OK
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Phone: 405.840.2931

• 22 Years Experience at FSB
  – Licensed Professional Engineer, Licensed Structural Engineer (OK) and a LEED Accredited Professional
  – Published in The Military Engineer, Architectural Record, Modern Steel Construction, and Civil Engineering Magazine
  – Professional Advisory Council at OSU School of Architecture
  – Firm has completed over $6B in design of Aviation Facilities
    • Aircraft Maintenance (Hangars), Squadron Operations/Mission Support, Air Mobility/Warehouses, Flight Simulators, etc.
Why is this topic important to you?

- Understand basic programming, planning, design and construction requirements of airfield facilities
- Benefit from the collective wisdom of NAVFAC & AE
- Share best practices and stories to cement key concepts
- Enjoyment of this exciting work may stem from your projects’ success
Learning Objectives

Navy Airfields
Understanding of the types of aviation facilities

Criteria
Exposure to related reference material (UFC & UFGS)

Planning
Gain insight into the aviation facility planning process

Design
Learn about the key design elements in aviation facilities

Best Practices
Benefit from past projects and lessons learned
Training Course Development

Develop Expert Planners And Designers

Aircraft Are High Value Assets

Platform Buildout

Aviation Facility Design Issues and Failures

Excessive Airfield Waivers
UFC & UFGS Covered in this Course

• **UFC 4-211-01** Aircraft Maintenance Hangars
  – Dated 13 April 2017 (w/ Change 2, May 2020)
  – w/ UFGS 08 34 16.10 Steel Sliding Hangar Doors (May 2017)
  – w/ UFGS 08 34 16.20 Vertical Lift Fabric Doors (May 2014)

• **UFC 4-211-02** Aircraft Corrosion Control & Paint Facilities
  – Dated 1 December 2012
  – w/ UFGS 08 34 16 Corrosion Control Hangar Doors (May 2017)

• **UFC 4-133-01** Air Traffic Control & Air Operations Facilities
  – Dated 19 April 2016 (w/ Change 2, 25 June 2019)
  – w/ UFGS 08 88 58 Air Traffic Control Tower Cab Glass (May 2014)

• **UFC 4-121-01N** Navy Engine Test Cells
  – 27 July 2006 (w/ Change 4, September 2008)
## Agenda / Course Schedule

### DAY 3

<table>
<thead>
<tr>
<th>Section</th>
<th>Time</th>
<th>Title</th>
<th>Content</th>
</tr>
</thead>
</table>
| 1       | 0800-0830| Welcome & Course Purpose – NAVFAC Perspective & Waivers | • Opening and Welcome  
• Agenda for the Day and List of UFCs Covered  
• Course Development & Goals  
• Criteria Program Overview  
• Criteria List  
• Waivers                                                                 |
| 2       | 0830-945 | Aircraft Maintenance Hangars (Planning)         | • UFC 4-211-01 (and UFC 2-000-05N)  
  o Applicability  
  o Planning and Layout                                                                 |
|         | 0945-1000| BREAK                                           |                                                                         |
| 3       | 1000-1200| Aircraft Maintenance Hangars (Design)           | • UFC 4-211-01 (continued)  
  o Design Requirements for Navy Hangars – with select comparisons to Air Force |
|         | LUNCH (1200-1300) |                                   |                                                                         |
| 3 (cont.)| 1300-1400| Aircraft Maintenance Hangar (Design) - Continued | • UFC 4-211-01 (continued)  
  o Design Requirements for Navy Hangars – with select comparisons to Air Force |
## Agenda / Course Schedule

<table>
<thead>
<tr>
<th>DAY 3</th>
<th>Time</th>
<th>Topic</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1400-1445</td>
<td>Aircraft Maintenance Hangar (Hangar Doors)</td>
<td>• UFC 4-211-01 (continued)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>o Hangar Door Selection and Requirements</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>o UFGS 08 34.16.20 Vertical Lift Fabric Doors</td>
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<tr>
<td></td>
<td>1445-1500</td>
<td>BREAK</td>
<td></td>
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<tr>
<td>5</td>
<td>1500-1525</td>
<td>Aircraft Corrosion Control and Paint Facilities</td>
<td>• UFC 4-211-02 and UFGS 08 34 16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>o Applicability</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>o Facility Function, Layout and Adjacencies</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>o System Function and Requirements</td>
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<td></td>
<td>o Best Practices</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>o UFGS 08 34.16 Corrosion Control Hangar Doors</td>
</tr>
<tr>
<td>6</td>
<td>1525-1550</td>
<td>Air Traffic Control and Air Operations Facilities</td>
<td>• UFC 4-133-01 and UFGS 08 88 58</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>o Applicability</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>o Planning and Layout</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>o Design Requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>o Best Practices</td>
</tr>
<tr>
<td>7</td>
<td>1550-1615</td>
<td>Navy Engine Test Cells</td>
<td>• UFC 4-212-01N</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>o Types of Test Cells</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>o Standard Designs and Drawings</td>
</tr>
<tr>
<td>8</td>
<td>1615-1630</td>
<td>Questions &amp; Feedback</td>
<td>• Closing Thoughts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Final Questions</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>• Feedback Request</td>
</tr>
</tbody>
</table>
Overview - UFC Program Authority

1996
Legislation requires use of commercial Standards

1999
Engineering Senior Executive Panel (ESEP) established

2002
DUSD memo requires use of Unified Facilities Criteria (UFC)

2003
MOA between ESEP and the National Institute of Building Sciences (NIBS)

- Consensus Building Codes – IBC, IMC, ASHRAE, NFPA
- Standardize & Unify Service (DoD) Criteria
- Coordinating Panel (CP) for management oversight
- Discipline Working Groups (DWG) for criteria development, coordination & review
- All new construction, repair & maintenance projects for all DoD facilities
- MIL-STD 3007 establishes UFC program/practices
- DoDD 4270.5 Military Construction
- Establishes Whole Building Design Guide (WBDG) as primary distribution source of military facility standards
Criteria Development

• Industry Consensus Codes and Standards
  – I-Codes, NFPA, ASHRAE, NEC, etc.
    • Use without modifications to the greatest extent possible
    • Minimize government unique criteria

• Government (DoD) Criteria
  – Unified Facilities Criteria ~200 active UFCs & FCs
    • 28 Core UFC documents
  – Unified Facilities Guide Specifications ~ 800+ active UFGSs
    • Validate/justify that industry criteria is not adequate
    • Unify to the greatest extent possible
    • Be concise/definitive & applicable for all AQ strategies

• DoD Unified Facilities Criteria – Funding
  – Yearly Funding ~ 1/3 Requirement
  – Resources (FTE) ~ ½ Requirement
Criteria Development & Change Process – UFC and UFGS

<table>
<thead>
<tr>
<th>INPUTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technical Proponent/Facility User/Maintainer</strong></td>
</tr>
<tr>
<td>- Criteria Change Request (CCR)</td>
</tr>
<tr>
<td>- New/Changed Requirement</td>
</tr>
<tr>
<td><strong>Planning</strong></td>
</tr>
<tr>
<td>- Functional Requirements Document</td>
</tr>
<tr>
<td>- Legislation/Policy</td>
</tr>
<tr>
<td>- Executive Orders</td>
</tr>
<tr>
<td>- New technology</td>
</tr>
<tr>
<td><strong>OSD/Service HQ’s</strong></td>
</tr>
<tr>
<td>- Non-Unified</td>
</tr>
<tr>
<td>- Fiscal Year Defense Plan</td>
</tr>
<tr>
<td><strong>Specialty Centers</strong></td>
</tr>
<tr>
<td>- Lessons Learned</td>
</tr>
<tr>
<td>- Out-dated Criteria</td>
</tr>
<tr>
<td>- Industry standards change</td>
</tr>
<tr>
<td><strong>AE Consultant</strong></td>
</tr>
<tr>
<td>- Evaluate Input</td>
</tr>
<tr>
<td>- Request in CMS</td>
</tr>
<tr>
<td><strong>Discipline Working Group</strong></td>
</tr>
<tr>
<td>- Coordinate &amp; Change Criteria</td>
</tr>
<tr>
<td>- Prioritize Criteria</td>
</tr>
<tr>
<td>- Strategic Workshop</td>
</tr>
</tbody>
</table>

**CP**

**ESEP**

**Approvals**

- Develop/Revise/Review Criteria
- Review/Sign/Publish UFC

**Minor change**

**Revision/New**
Whole Building Design Guide (WBDG)

• Whole Building Design Guide
  – http://www.wbdg.org/

• UFC and UFGS listing

• Non-government Standards Access
  – IHS

• Numerous “other” documents
  – ECBs
  – ITGs
UFC 4-211-01 Aircraft Maintenance Hangars, With Change 1

Date: 04-13-2017
Change / Revision Date: 11-01-2017
Series: 4 - MULTI-DISCIPLINARY AND FACILITY-SPECIFIC DESIGN
4-200: MAINTENANCE AND PRODUCTION FACILITIES

Status: Active
Regulatory:

View/Download: PDF
Related Materials:
FY19-01 Navy and Marine Corps Aircraft Preconditioned Air (PCA) System Design
Criteria Change Request: CCR

Superseded Version(s):
UFC 4-211-01 Aircraft Maintenance Hangars (04-13-2017)
UFC 4-211-01N Aircraft Maintenance Hangars: Type I, Type II and Type III, with Change 3 (10-25-2004)
UFC 4-211-01N Aircraft Maintenance Hangars: Type I, Type II and Type III, with Change 2 (10-25-2004)
UFC 4-211-01N Aircraft Maintenance Hangars: Type I, Type II and Type III, with Change 1 (10-25-2004)
UFC 4-211-01N Aircraft Maintenance Hangars: Type I, Type II and Type III (10-25-2004)
FY10-01 Maintenance Hangar Design and Planning Guidance for F35B or C; Supplement to UFC 4-211-01N (01-12-2010)
Section 1b – NAVFAC UFC
Criteria Exemptions

Aircraft Hangars & Other Airfield Structures

5/22/2020
Criteria Overview

Planning Criteria
- Driven by UFC 2-000-05N
- Need Site Approval before design
- Site Approval may require CI exemption
- Site Approval may require other authority waivers
- AM has no defined waiver process

Design Criteria
- Driven by Mil-Std 3007F
- Driven by UFC 1-200-01 (Core UFCs)
- Driven by Facility-Type UFC (Airfield, Hangars, etc.)
- Exemptions require Chief Engineer Approval
UFC Exemption Mil-Std 3007 Process Input

NAVFAC Mil-Std 3007G UFC Waiver Process

Supply documentation
Follow detailed process

Alternatives Evaluated
Provide Documentation
Follow Process
Cost not the reason
Seek help
• Design Chain
• Planning/Design Criteria Mgrs

Base CO Concurrence
Acknowledges Risk
Safety Risk Mitigations

NAVFAC Support
Criteria Managers
• (AM/CI)
PWD
FEC Chief Engr
PAC/LANT Chief Engr

User Support
Mission Impact
NAVAIR
USMC
• MCI Region?
• MCI HQ?
• Aviation?
Other User?
Other Authorities?

NAVFAC CHIEF ENGINEER DECISION
• Waiver and Exemption Requirements – Definitions.
  • A waiver provides authority to deviate from a UFC requirement for no more than twelve months (can be/has been longer).
  • An exemption provides authority to deviate from a UFC requirement indefinitely.

“In general, the signature authority for the service or agency in publishing the document (ESEP representative) is the same authority that may waive, exempt, or deviate from the requirements in that document.”

• Navy activities and Navy projects will use the [waiver and exemption] process contained in APPENDIX A.
Example Facility UFC Exemptions
“Inside Hangar”

- Request to eliminate AFFF fire protection system due to lack of fueled aircraft mission
  – APPROVED because of mission requirements (UAV, Depot Hangar, etc.)

- Request to eliminate catwalk system for vertical lift fabric door system due to cost
  – DENIED due to maintenance/inspection rqmts.

- Request to not enclose rolling steel door pockets
  – DENIED due to corrosion/maintenance rqmts.

- Request to lower capacity or eliminate bridge crane clearances and capacity from Standard Type II due to existing facility constraints
  – APPROVED due to re-purposing of existing facility and user mitigations

- Request to reduce aircraft safety clearances due to existing facility constraints
  – APPROVED due to re-purposing of existing facility and user mitigations

- Request to vary from F-35 Cooling Air System ITG 19-01
  – DENIED to safety/dependability concerns
Example NAVAIR Airfield Safety Waivers

- General siting issues of hangar structure itself
- Roof mounted antennae obstruction
- Late request to add AFFF fire protection room on apron side of hangar causing obstruction
- Hangar expansion/addition towards apron causing encroachment into airfield clearances

5/22/2020
Section 2a – UFC 4-211-01
Introduction

Aircraft Hangars & Other Airfield Structures
• Chapters:
  1. Introduction
  2. Planning and Layout
  3. General Hgr Requirements
  4. Emerging Aircraft
  5. Air Force Specific Criteria
  6. Army Specific Criteria
  7. Navy Specific Criteria

• Appendices
Applicability – General (Chapter 1)

• The information in this UFC applies to the design of all new construction projects, to include additions, alterations, and renovation projects within the United States and its territories and possessions and outside of the United States and its territories and possessions.
• Tri-Service
• Maintain Several Standard Hangar Types
  – Hangar bay size
  – Similar aircraft / function
  – Support future mission/airframe changes

• Improve Future Flexibility through
  – Standard hangar bay sizes and slab design loading
  – Maximizing door sizes, bridge crane capacities
  – Eliminating fixed obstructions and hangar bay features which impact revised aircraft layouts.
  – Avoidance of non-standard, single purpose hangars
Applicability – Navy (Chapter 7)

• Navy Standard Hangar Types I, II, III & IV
• Modified Navy Hangar Types
  – Example: Standard Hangar with identified Variation(s)
• Custom Hangar Types
  – Example: Depot Hangar
• Renovations
  – Endeavor to meet all standard hangar type req’ts
  – Shall meet all life safety criteria and clearances
  – Identify intent of renovation scope on DD1391
Users and Scope of this UFC

• This UFC is intended:
  – As a source of basic architectural and engineering information for all individuals involved in the planning, design and construction of Aircraft Maintenance Hangars

• Scope:
  – Air Force, Army, Navy, Marine Corps and Reserves
  – Fixed wing, rotary wing, hybrid, UAS/RPA
Types of Hangars Covered

Types of Hangars:

- (Organizational) Maintenance
- Fuel-Cell Maintenance
- Depot
- Transient
- Special Operations
- Research
- Prototype

Refer to UFC 4-211-02 for Corrosion Control Hangars
Other Hangar Requirements

• UFC 1-200-01
  – 1- Policy, Procedures & Guidance
  – 2- Master Planning
  – 3- Discipline Specific Criteria
  – 4- Multi-Discipline & Facility Specific Design

• Functional Requirements (Maintenance/Depot/etc.)

• Validated Aircraft Requirements (FRD)
Hangars vs. Hangers
Section 2b – UFC 4-211-01
Planning

Aircraft Hangars & Other Airfield Structures
Planning and Layout

• Site: Comply with 3-260-01

• Solar Glare Hazard Analysis required for Photovoltaic or Glass-Enclosed Solar
Hangar Site Considerations:

Then ask yourself:
1. Did we choose the best site?
2. Future development or other?
3. Did we capture all of the site costs in the DD1391?
Airfield, Airspace and FAA Considerations

- Existing Control Tower Sight Lines
- Taxiway & Runway Clearances
- Apron Standoff
- Relationship to Airspace (Part 77 Study)
- Filing of FAA 7460 During Design
  - Specs to require contractor file during construction
Airfield, Airspace and FAA Considerations

UFC 4-211-01 – Ch. 2
Airfield Security Considerations

- Airfields are Level Two Restricted Areas
- Planners/Designers must work with the ATO, ISO and ASO to determine the project security requirements

- Airfield Enclaves (may have)
  - Intrusion Detection
  - Video Assessment Systems
  - Automated Access Control
    - Pedestrian Turnstiles
    - Vehicle Gates
Hangar Design Philosophy (Navy)

• Navy and USMC utilize standard hangar types
  – Type I, II, III & IV
  – Design to minimum safety clearances in Table 2-1

• Navy aircraft are grouped by size and function to establish a common hangar size.
  – This approach allows for some flexibility should there be a change in mission, aircraft layout, or introduction of new airframes during the lifespan of the hangar.

  – Contrast to Air Force: Hangars are typically designed around a fixed aircraft arrangement with safety/maintenance clearances
• Three distinct areas in a hangar

Organizational Hangar (OH) CCN 21105

Shop and Maintenance (01 level) CCN 21106

Operations, Training & Administration (02 level) CCN 21107

The levels are designations derived from shipboard levels and are not specific to the hangar design.
Planning and Layout

• Hangar (Building) consists of the following:
  – Aircraft Maintenance Bay
  – Maintenance Shops
  – Maintenance Administration
  – Storage (Supplies, Parts, Tools, etc.)
  – Support (Personnel and Building)
  – Secure Spaces
  – Operational Administration
Hangar Space (Navy)

- Table 7-3 lists area, space name, description & include reference to Functional Data Sheets

### Table 7-3: Hangar Space Table

<table>
<thead>
<tr>
<th>Airframe</th>
<th>Space Category</th>
<th>Space Grouping</th>
<th>Space Name</th>
<th>Space Description</th>
<th>Refer to Functional Data Sheet (Reference Table Number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>OH</td>
<td>OH</td>
<td>Hangar Bay (OH)</td>
<td>Maintenance Hangar area</td>
<td>Refer to Table 7-4: Hangar Bay</td>
</tr>
<tr>
<td>General</td>
<td>Shop</td>
<td>O1</td>
<td>Air Frames (Shop)</td>
<td>Maintains Air Frames.</td>
<td>Refer to Table 7-5: Air Frames</td>
</tr>
<tr>
<td>General</td>
<td>Shop</td>
<td>O1</td>
<td>Aviation Ordnance (Shop)</td>
<td>Maintains aircraft weapons systems including weapons cleaning and storage.</td>
<td>Refer to Table 7-6: Aviation Ordnance</td>
</tr>
</tbody>
</table>
### Functional Data Sheets

- **Tables 7-4 through 7-21**

#### Table 7-4: Hangar Bay (OH)

<table>
<thead>
<tr>
<th>Description / Usage</th>
<th>Maintenance area for airframes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Ceiling Height</td>
<td>Refer to mandatory height requirements based on hangar type.</td>
</tr>
<tr>
<td>Finishes</td>
<td></td>
</tr>
<tr>
<td>Walls</td>
<td>Painted walls between O1/O2 and hangar bay.</td>
</tr>
<tr>
<td>Floors</td>
<td>Fuel Resistive Resinous Flooring, 5-Coat System. Incorporate floor markings if required.</td>
</tr>
<tr>
<td>Ceiling</td>
<td>Exposed construction.</td>
</tr>
<tr>
<td>Interior Construction /</td>
<td>Incorporate an approved Avian Intrusion Prevention System in the hangar bay.</td>
</tr>
<tr>
<td>Built-in Equipment</td>
<td></td>
</tr>
<tr>
<td>Furniture, Fixtures &amp; Equipment (FF&amp;E)</td>
<td>Storage cabinets</td>
</tr>
<tr>
<td>Plumbing</td>
<td>Emergency Shower and Eyewash stations per Chapter 3. Compressed air drops on walls - Compressed air source of 125 psi with a constant flow rate of 20 cfm. Each service point with the following: One (1) 38 mm (1/2 in.) needle valve shutoff, One (1) pneumatic tool filter, One (1) 861.8 kPa (125.0 psi) pressure regulator, One (1) pneumatic tool lubricator, Two (2) pneumatic tool quick-connectors, One (1) wall-mounted hose rack. Coordinate with users on number of compressed air drops required and requirements for hose reels for water or air.</td>
</tr>
<tr>
<td>HVAC</td>
<td>Provide per Chapter 3. Specialized exhaust system(s) required. Exhaust directly outdoors through roof. Thermostatic control switch activated by hangar door shutter heating if OA temp is above 40°F. May require air conditioned hangar bay for certain aircraft in warmer climates. May require overhead radiant heating. May require hangar door track heating system in colder climates.</td>
</tr>
<tr>
<td>Fire Protection</td>
<td>Provide per Chapter 3 and Chapter 7.</td>
</tr>
<tr>
<td>Power</td>
<td>Provide per Chapter 3 and Chapter 7.</td>
</tr>
</tbody>
</table>
# Standard Hangar Types

<table>
<thead>
<tr>
<th>Aircraft Type</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smaller, Carrier Type Aircraft: Rotary (MH-60) &amp; Fighters (F-35)</td>
<td>Larger Aircraft: CH-53, MV-22 &amp; C-130</td>
<td>Primarily land based patrol aircraft (P-8A) &amp; large transport</td>
<td>Largest UAS: MQ-4C Triton</td>
<td></td>
</tr>
<tr>
<td>Notes: 01/02 spaces are configured for a typical strike fighter squadron</td>
<td>Primarily utilized by the USMC</td>
<td>UAS other than Triton: consider a non-standard hangar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridge Crane</td>
<td>1 per module</td>
<td>1 per module</td>
<td>not authorized</td>
<td>as req’d</td>
</tr>
</tbody>
</table>
# Hangar Types – Table 7-1

<table>
<thead>
<tr>
<th>Hangar Type</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>TYPE IV</th>
<th>SEE NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F-35C</td>
<td>F-35B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WIDTH</td>
<td>212'</td>
<td>262.5'</td>
<td>325'</td>
<td>165'</td>
<td>161'</td>
</tr>
<tr>
<td></td>
<td>64.01 M</td>
<td>80.01 M</td>
<td>99.1 M</td>
<td>50.3 M</td>
<td>49.07 M</td>
</tr>
<tr>
<td>DEPTH</td>
<td>95'</td>
<td>119'</td>
<td>165'</td>
<td>141'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>28.96 M</td>
<td>36.3 M</td>
<td>50.3 M</td>
<td>42.98 M</td>
<td></td>
</tr>
<tr>
<td>CLEAR HEIGHT</td>
<td>32.5'</td>
<td>44'</td>
<td>50'</td>
<td>32.5'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9.91 M</td>
<td>13.41 M</td>
<td>15.24 M</td>
<td>9.91 M</td>
<td></td>
</tr>
<tr>
<td>BRIDGE CRANE CAPACITY</td>
<td>5-TON</td>
<td>7 TON</td>
<td>NONE</td>
<td>5-TON</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.5 METRIC TON</td>
<td>6.5 METRIC TON</td>
<td></td>
<td>4.5 METRIC TON</td>
<td></td>
</tr>
<tr>
<td>HOOK HEIGHT</td>
<td>29.5'</td>
<td>39'</td>
<td>29.5'</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.99 M</td>
<td>11.9 M</td>
<td>8.99 M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOOR WIDTH (MIN)</td>
<td>209'</td>
<td>259.5'</td>
<td>322'</td>
<td>162'</td>
<td>158'</td>
</tr>
<tr>
<td></td>
<td>63.7 M</td>
<td>79.1 M</td>
<td>98.15 M</td>
<td>49.38 M</td>
<td>48.16 M</td>
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<tr>
<td>DOOR HEIGHT</td>
<td>25'</td>
<td>44'</td>
<td>50'</td>
<td>25'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.62 M</td>
<td>13.41 M</td>
<td>15.24 M</td>
<td>7.62 M</td>
<td></td>
</tr>
</tbody>
</table>

*DIMENSIONS ARE FOR A SINGLE HANGAR BAY MODULE BASED ON TABLE 2-1 CLEARANCES. SEE UFC 2-000-05N FOR WIDER INCREMENTS*
Hangar Size Standards

• UFC 4-211-01 hangar sizes are pass-through from UFC 2-000-05N which governs hangar module sizing
  – Asset Management (AM) maintains this document

• UFC 4-211-01 Table 7-1: Standard Hangar Bay Module Dimensions and Crane Capacities*
  indicates to see UFC 2-000-05N for wider increments
  – Net area of the hangar bay is defined in the module layout and is considered a fixed area – do not modify
Standard Hangar BFR

• BFR factors for hangar
  – Primary Assigned Aircraft (PAA)
  – Hangaring ratio, Table 21105-2
  – Aircraft dimensions
  – Type of hangar

• Gather data input
• Calculate the required hangar width
• Determine the number of standard module required
• Calculate the gross square footage
1. Gather data inputs
   - Squadron Service: Navy
   - Number of PAA: 14 aircraft
   - Aircraft Variance: F-35C aircraft
   - F-35C wings spread = 43 feet
   - F-35C wings folded = 31 feet
   - Hangar Ratio: 1/3

2. Calculate the required hangar width (RHW)
   - \( N = \text{Rounding of PAA} \times \text{Hangar Ratio} \)
   - (no PMI space required)
   - \( = 14 \times 1/3 \)
   - \( = 4.66 \)
   - \( = 5 \) Rounded from 4.66
   - \( \text{RHW} = N \times WF + (N-1) \times D + 2 \times SC \) (assuming no additional PMI bay required)
   - \( = 5 \times 31' + (5-1) \times 7.5' + 2 \times 7.5' \)
   - \( = 200' \)

3. Determine the number of standard modules required
   - Partial modules = \( \text{RHW} \div \text{Standard Module Width} \)
   - \( = 200'/212' \)
   - \( = 0.94 \)
   - Number of standard modules required = 1.0 (after normalization)

4. Calculate the GSF required
   - \( \text{NSF} = 1.0 \times 20,140 \text{ sf} \)
   - \( = 20,140 \text{ sf} \)
   - \( \text{GSF} = 1.12 \times \text{NSF} \)
   - \( = 1.12 \times 20,240 \text{ sf} \)
   - \( = 22,557 \text{ sf} \)

   01 Space requirement: 19,658 gsf (Table 21105-1a)
   02 Space requirement: 13,181 gsf (Table 21105-1a)
Common Hangar Planning Issues

• Which Hangar Type to Use
• Low net-to-gross factors
  – Note recent UFC 2-000-05N change for Type I hangars: from 1.05 to 1.12 for OH Bay
• Calculation mistakes (differ by Hangar Type)
• Unit costs utilized are too low
• Inadequate POV parking
• Supporting facilities, utilities and site costs
Potential Hangar Cost Impacts

• Sensitive Compartmented Information Facility (SCIF) relies upon a 6 sided approach to:
  – Resist forced or covert entry of perimeter
  – Visual evidence of perimeter penetration
  – Prevent acoustic eavesdropping
  – Countermeasures for electronic emanations - TEMPEST (when required)
Potential Hangar Cost Impacts

• SCIF/SAPF Require (early in project):
  – Construction Security Plan (CSP) to capture the scope and cost associated with security.
  – Fixed Facility Checklist (FFC)
  – TEMPEST Addendum to the FFC to incorporate TEMPEST Countermeasures

• Site Security Manager (SSM) is responsible for assembling and submitting documents for Accrediting Official (AO) review and approval.
  – NAVFAC provides input to these documents
Potential Hangar Cost Impacts

• **UFC 4-010-01** Minimum Antiterrorism Standards for Buildings
  – Glazing and Doors
  – Structural Isolation
  – Equipment Bracing
Potential Hangar Cost Impacts

• **UFC 4-010-06** Cybersecurity of Facility-Related Control Systems
  – Potentially impacts any item with an IP address
  – Naval Facilities Engineering Command, Command Information Office (CIO)

• **DD1391** Primary Facility Costs, Block 9
  – When <$10M Facility Cost, use $100k
  – When >$10M and <$50M, use 1% of Cost
  – When >$50M Facility Cost, use $500K
Minimum Aircraft Maint. Bay Clearances

• Horizontal Obstructions
  – Any fixed obstruction on the perimeter including structure, bollards, mechanical equipment, ductwork, plumbing/piping, electrical equipment or any other permanent physical item.

• Vertical Obstructions
  – Any obstruction overhead including structure, draft curtains, mechanical equipment, ductwork, plumbing/piping, electrical equipment, lighting, heaters, fire protection, crane bridges/rails, etc. Note: Crane hoists/hooks are excluded if moveable.
Minimum Aircraft Maint. Bay Clearances

Figure 2-1: Minimum Aircraft Maintenance Bay Clearances

- VERTICAL PLANE AT NEAREST FIXED OBSTRUCTION ALONG BACK WALL
- INSIDE FACE OF HANGAR DOOR
- VERTICAL PLANE AT NEAREST FIXED OBSTRUCTION ALONG SIDE WALL
- WHEN AIRCRAFT IS PASSING THROUGH THE HANGAR DOOR
Minimum Aircraft Maint. Bay Clearances

Figure 2-2: Alternate Corner Configuration

- ALTERNATE CORNER CONFIGURATION ACCEPTABLE AT END BAY ONLY
- TYPICAL 90 DEGREE CORNER
- CONFIRM OPERATIONAL CLEARANCE REQUIREMENTS IF INTRODUCING A FIXED OBSTRUCTION IN SHADED AREA
Minimum Aircraft Maint. Bay Clearances

Figure 2-3: Vertical Hangar Clearances

Figure 2-4: Vertical Hangar Clearances with Sloped Roofs
Minimum Aircraft Maint. Bay Clearances
# Minimum Aircraft Maint. Bay Clearances

## Table 2-1: Minimum Aircraft Maintenance Bay Clearances

<table>
<thead>
<tr>
<th>FIGURE 2.1 AND 2.2</th>
<th>SEE CLEARANCES A THROUGH H ON FIGURES 2-1 THROUGH 2-4</th>
<th>AIR FORCE AND ARMY</th>
<th>NAVY - NOTE 10</th>
<th>NOTES:</th>
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<tbody>
<tr>
<td></td>
<td>AIRCRAFT TO NEAREST FIXED OBSTRUCTION ALONG BACK WALL</td>
<td>WINGSSPAN &lt; 100’ 30.48M</td>
<td>HANGAR TYPE I</td>
<td>1, 2, 3</td>
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<td>A</td>
<td>10'-0&quot;</td>
<td>15'-0&quot;</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
</tr>
<tr>
<td></td>
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<td>3.05M</td>
<td>3.05M</td>
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<td>AIRCRAFT TO INSIDE FACE OF HANGAR DOOR</td>
<td>WINGSSPAN &gt; 100’ 30.48M</td>
<td>HANGAR TYPE II</td>
<td>1, 2, 4</td>
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<td>B</td>
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<td>10'-0&quot;</td>
<td>7'-8&quot;</td>
<td>10'-0&quot;</td>
</tr>
<tr>
<td></td>
<td>3.05M</td>
<td>3.05M</td>
<td>2.29M</td>
<td>3.05M</td>
</tr>
<tr>
<td></td>
<td>AIRCRAFT TO NEAREST FIXED OBSTRUCTION ALONG SIDE WALL</td>
<td></td>
<td>HANGAR TYPE III</td>
<td>1, 2, 3</td>
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<td>C</td>
<td>10'-0&quot;</td>
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<td>7'-8&quot;</td>
<td>10'-0&quot;</td>
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<td>3.05M</td>
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<td>AIRCRAFT TO ADJACENT AIRCRAFT</td>
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<td>HANGAR TYPE IV</td>
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<td>7'-8&quot;</td>
<td>10'-0&quot;</td>
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<tr>
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<td>4.57M</td>
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<td>AIRCRAFT TO HANGAR DOOR JAMB</td>
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<td>NAVY - NOTE 10</td>
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<td>E</td>
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<td>AIRCRAFT TO NEAREST FIXED OR MOBILE OVERHEAD OBSTRUCTION</td>
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</tr>
<tr>
<td>F</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
<td>5'-0&quot;</td>
<td>5'-0&quot;</td>
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<tr>
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<td>3.05M</td>
<td>3.05M</td>
<td>1.52M</td>
<td>1.52M</td>
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<tr>
<td></td>
<td>AIRCRAFT TO UNDERSIDE OF DOOR HEAD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>7'-0&quot;</td>
<td>7'-0&quot;</td>
<td>5'-0&quot;</td>
<td>5'-0&quot;</td>
</tr>
<tr>
<td></td>
<td>2.13M</td>
<td>2.13M</td>
<td>1.52M</td>
<td>1.52M</td>
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<td></td>
<td>HOOK HEIGHT (SADDLE OF HOOK)</td>
<td>Army: Per Std Design</td>
<td></td>
<td>1, 7, 9</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td>Air Force: Per FRD</td>
<td>Refer to Table 7-1</td>
<td></td>
</tr>
</tbody>
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Break
Section 3 – UFC 4-211-01
General Requirements & Navy Specific Criteria

Aircraft Hangars & Other Airfield Structures
Associated Site Design References

• Airfield Siting: UFC 3-260-01 & UFC 2-000-05N
• Soil & Groundwater: UFC 3-220-01
• Vehicular & Pedestrian: UFC 3-250-01FA
• Airfield Pavement: UFC 3-260-02
• Airfield Markings: UFC 3-535-01
Site & Building Potential Movement

• Vertical:
  – Are both supported in upper layers of soil?
  – Is the building supported by deep foundations?
  – Is special detailing required to accommodate differential movement?

• Consider the same for utility entrances and sidewalks.
Site & Building Potential Movement

• Horizontal:
  – What is the potential for temperature effects on the airfield pavement?
  – How much might it expand?
  – What is the appropriate joint size and type between the pavement and the building
• Building: UFC 1-200-01
• Life Safety / Fire Prot. order of precedence:
  – UFC 4-211-01 then
  – UFC 3-600-01 and then
  – NFPA 409 (only where referenced)
• Group I, II & III Hangars (NFPA) use Non-Combustible Type I or Type II (IBC)
• Group IV Hangars (NFPA) use membrane requirements in NFPA 409
Internal Fire Rated Separations

• Comply with UL or FM – or –
  – Calculate per NRTL or IBC

• Provide **1-hour fire barrier** between Hangar Bay & Support Areas (OH – 01/02)

• Provide **2-hour fire barrier** between separate fire areas (IF required in this UFC)

• Protect openings (windows/doors) per NFPA 101

• Protect duct penetrations per UFC 3-600-01
Internal Fire Rated Separations

FIRE AREA

SUPPORT AREA

AIRCRAFT MAINTENANCE BAY(S)

PROVIDE A 2-HOUR FIRE BARRIER WHERE MORE THAN ONE FIRE AREA IS PROVIDED

SUPPORT AREA

AIRCRAFT MAINTENANCE BAY(S)
Internal Fire Rated Separations

UNRATED CEILING (UNLESS REQUIRED ELSEWHERE)

MINIMUM 10 FT (3 M) OF MASONRY OR CONCRETE CONSTRUCTION AS REQUIRED UNDER AIRCRAFT MAINTENANCE BAY FINISHES

UNRATED EXTERIOR SURFACE (UNLESS REQUIRED ELSEWHERE)

PROVIDE 1-HOUR OR 2-HOUR FIRE BARRIER TO EXTERIOR WALL AS REQUIRED

SECTION A-A SUPPORT AREAS ATTACHED TO AIRCRAFT MAINTENANCE BAY
SCIF/SAPF Acoustically Rated Separations

- Perimeter shall meet Sound Group 3, unless additional protection is required for amplified sound
  - Sound Group 3 – (STC of 45) or better. Loud speech can be faintly heard but not understood. Normal speech is unintelligible.
  - Sound Group 4 – (STC of 50) or better. Very loud sounds, such as loud singing, brass musical instruments or a radio at full volume, can be heard only faintly or not at all.
SCIF Acoustically Rated Separations

• ICD 705 contains specific perimeter wall construction details for Sound Group 3 and 4

• When detailing the perimeter pay attention to:
  – Corners, Base and Top of wall details
  – Detailing of flush mounted (or recessed) devices such as switches, outlets, thermostats, etc.
  – **Detailing of penetrations** such as doors, windows and utility entrances – all of which have special requirements.
• Allowable Fire Area Unlimited in Hangar Bay
  – Allowable Building Area Limited to IBC

• Allowable Building Height Unlimited
  – Allowable Stories Limited to IBC

• Provide Building Clear Space and Fire Separation around the facility per NFPA 409
Hangar Bay Egress per NFPA 101, except:

- Perimeter door maximum spacing of 150 feet.
  - Travel distance begins at the hangar bay exit
- If hangar bay doors exceed 110 ft. exits are not required in the doors to meet the maximum distance.
  - Provide exits within 20 ft. of each end of the hangar bay door
- Personnel access doors may be provided through the hangar bay door; but are not exits for egress.
Hangar Bay Egress per NFPA 101, except:
Draft Curtains
Exterior Envelope – Air Barrier

- Materials per Installation Standards & Contextual Surroundings
- Exterior Envelope per ASHRAE 90.1 and UFC 3-101-01

Air Barrier Detailed, Constructed, Inspected and Tested

Air Barrier Detailed, Constructed & Inspected but exempt from Testing
Hangar Bay Perimeter Walls

- Masonry or concrete 10 ft. (min) both interior and exterior face of perimeter hangar walls.
Exterior Windows and Glazed Doors

• Inhabited portions of bldg per UFC 4-010-01

• In walls exposed to the hangar bay shall also be per UFC 4-010-01 for the same blast effects as the most severely loaded exterior glazing system

Note: UFC 4-010-01 (Dec 2018) no longer requires site specific blast design as a requirement.
Roof System per UFC 3-110-03, except

- No aggregate or vegetative roofs (FOD)
- Slope roof away from hangar doors and apron
- Slope roof away from airfield (unless taken below grade to stormwater drain system)

- Provide fall prevention or fall protection from interior roof access to all roof top equipment.
Interior Finishes

- Interior Finishes, Doors, Hardware, Durability, Signage and Elevators

- The following photos are illustrative examples of the above requirements in various spaces.
Example 02 Finishes
Example 02 Finishes
Example Personnel Support Spaces
Example 01 Finishes
Example 01 Finishes
Example OH Finishes
Example OH Floor Finishes

- Fuel Resistive Epoxy Floor
- Sealed Concrete
- Dry Shake Floor
- Hardener
Protective Coatings (Floor)

- **Provide 3-coat fuel resistive resinous flooring**
  - Light maintenance shops and associated corridors

- **Provide 5-coat fuel resistive resinous flooring**
  - Aircraft maintenance bay
  - Heavy maintenance shops and associated corridors
## Protective Coatings (Floor)

<table>
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<th>Layer</th>
<th>3-Coat JFR Epoxy</th>
<th>5-Coat JFR Epoxy</th>
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</thead>
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<tr>
<td>Urethane Top Coat #2</td>
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<td>X</td>
</tr>
<tr>
<td>Urethane Top Coat #1</td>
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<td>X</td>
</tr>
<tr>
<td>Grout Coat</td>
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<td>X</td>
</tr>
<tr>
<td>Epoxy Mortar</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Primer</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Concrete Slab (Stable)</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
Hangar Floor Striping

- Safety eyewash/shower 2’ clearance (green)
- Fire Extinguishers (if provided 2’ clearance (red)
- Safety Lane 5’ wide (yellow)
- Aircraft safety perimeter line at clearances per Table 2-1
- Grounding receptacle per UFC 3-575-01, Figure 2-3
- Aircraft position centerline & nose gear stop, Coordinate with users
- Safety Lane 5’ w/ 6” diagonal stripes at risk locations (yellow)
Protective Coatings (UFGS 09 97 13.27)

- Shop coat exposed **exterior** ferrous metal primary and secondary steel framing

- Shop coat exposed **interior** ferrous metal primary and secondary steel framing inside Aircraft Maintenance Bays

- Shop coat **all** exposed and non-exposed ferrous metal of hangar doors
Protective Coatings (UFGS 09 97 13.27)

• Exterior (primary and secondary), Interior Hangar Bay (primary and secondary), and Hangar Door Steel
Protective Coatings (UFGS 09 90 00)

• Use applicable Paint Tables in UFGS 09 90 00:
  – Coat all other exposed exterior ferrous metal
  – Coat all other exposed interior ferrous metal
  – Coat all other non-exposed interior ferrous metal at a minimum with a primer coat
  – Coat other interior substrates such as gypsum board, concrete, masonry and wood
Structural Design

• **Building:** UFC 1-200-01 and UFC 3-301-01

• **Risk Category III** unless the AHJ approves a different Risk Category based on the following:

  • Category II: Aircraft which are not "high value equipment"
  • Category IV: Aircraft with a "mission critical" function

<table>
<thead>
<tr>
<th>Category</th>
<th>Seismic</th>
<th>Snow</th>
<th>Ice</th>
<th>Wind*</th>
</tr>
</thead>
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<td>II</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>118 MPH (1.0)</td>
</tr>
<tr>
<td>III</td>
<td>1.25</td>
<td>1.10</td>
<td>1.25</td>
<td>128 MPH (1.18)</td>
</tr>
<tr>
<td>IV</td>
<td>1.50</td>
<td>1.20</td>
<td>1.25</td>
<td>131 MPH** (1.23)</td>
</tr>
</tbody>
</table>

* Example wind speeds (and factors) shown per UFC 3-301-01: Naval Station Norfolk

** Wind-borne debris region within 1 mile of coastal mean high water line
Hangar Bay (Slabs on Grade)

- Lateral forces may not be resisted by Slabs
  - Tie beams independent of slabs, if required

- Slabs shall be designed for anticipated loads
  - Offices: 5” minimum on grade
  - Shops: 6” minimum on grade
  - Hangar Bay: 8” minimum on grade

- Uniform slab thickness due to flexible aircraft parking required in Navy Hangars

- Hangar Bay sloped toward trench drains / flightline - 0.5% (1/16”/ft) to 1.5% (3/16”/ft)
Hangar Bay (Slabs on Grade)

- Thickness designed unreinforced per UFC 3-260-02 (F’r 550 - 650 psi @ 90 days)
  - Loads per this UFC
  - Navy Hangars: 0.05% reinforcing steel OC, EW
  - Joints per Table 3-1
  - Dowel per Table 3-2
  - Details per Figures 3-4 through 3-8

![Figure 3-4: Typical Aircraft Maintenance Bay Slab on Ground Cross-Section](image-url)
Hangar Bay (Floor Slabs)

• Slab Design Loads vary by Hangar Type I - IV
  – Type I Hangar uses Type B traffic area with the following minimum traffic mix:
    • F-35C Aircraft (70,400 lbs) - 40,000 passes
    • ATLAS forklift (10,000 lbs - loaded carriage) - 10,000 passes
    • P-15 Crash/Fire Truck (130,860 lbs) - 1,200 passes
    • Transport Truck M1088 w/ M871A3 Trailer (80,000 lbs) - 1,000 passes
  – Refer to UFC for Type II, III and IV design loads
  – Don’t forget to check your FRD for add’l loading
Hangar Bay (Floor Slabs)

• Other Slab Design Considerations
  – Trenches
  – Grounding Points
  – Utility Pits (if permitted)
Hangar Bay Trench Drains

• Provide where and as required by Chapter 7
  – Slope drainage trench inverts at a minimum 0.5% towards and empty into the hangar bay door trench. Provide drainage from the door rails.
  – Capture inadvertent oily wastewater contaminants from the hangar bay trench system, as directed by the department overseeing environmental policy for the installation; this may include an oil/water separator.
Hangar Bay Trench Covers

• Ductile iron or galvanized steel

• Manufactured to withstand:
  – minimum proof-load from all vehicle wheel (and jacking) loads anticipated to be supported by the slab.
Hangar Bay Trench Size

- Size to remove and convey fire suppression system discharge to the system discharge devices (including sprinkler system & hose stream)
- Size to convey compressed air and water service lines to support other operational functions of the maintenance hangar
- To allow for sufficient space for maintenance in the trench, consider:
  - Volume of piping within the trenches and turning radius of the fittings in the design
  - Ability to remove/repair one utility without other utilities
Hangar Bay Trench Layout

Figure 7-2: Drive-Through Hangar

- 90 degree nozzle at corner
- 180 degree nozzle at perimeter
- 360° NOZZLE
- 22.5' to 27.5'
- 3.0'
- ≤ 50.0'

Table 2-1

Do Not Do This – See Hangar Doors
Figure 7-3: Pull-In Hangar

- 90 degree nozzle at corner
- 360° nozzle
- 180° nozzle at perimeter
- 22.5' to 27.5'
- ≤ 50.0'

Do Not Do This – See Hangar Doors

Table 2-1
Substructure (Foundations)

• Spread Footings
  – In-Situ Soils
  – Or with site improvement

• Deep Foundations
  – Drilled Piers
  – Auger Cast Piles
  – Driven Piles (Steel, Precast, etc.)

• Proprietary Solutions
  – Caution with pricing & loss of control
Soil Matrix Modifications

• Consider engineered options to permit shallow foundations:
  – Preloading of Site
  – Stone Columns (RAP)
  – Grout Injection
  – Rigid Inclusions
  – Wet Soil Mixing
Superstructure

• **Typically Structural Steel** with Hangar Bays isolated from Admin/Shops

• **Hangar Door Selection will impact Superstructure**
  
  – **Strength** (to resist all imposed environmental and operational requirements)
  
  – **Serviceability** (to limit deflection/drift to work human factors, structural compatibility, etc.)
Superstructure Framing Options

- Pre-Engineered Metal Building System (PEMB)
- Parallel Truss System
- Header Truss System
- Super (or Box) Truss System
- Cantilever System
Superstructure Framing Options

- Pre-Engineered Metal Building System (PEMB)
Superstructure Framing Options

- Parallel Truss System
Superstructure Framing Options

• Header Truss System
Superstructure Framing Options

• Header Truss System
Superstructure Framing Options

- Super (Box) Truss System
Superstructure Framing Options

• Cantilever Truss System

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Superstructure Framing Options

• Cantilever Truss System
Superstructure – Structural Isolation

• UFC 4-010-01 (Antiterrorism) Standard 7
  – Requires structural isolation between low occupancy portions of inhabited buildings
    • or verification through analysis that collapse of low occupancy portions of buildings will not result in collapse of any portion of inhabited portions

• Also makes sense from a relative building movement perspective (flexible high bay vs. rigid two story 01/02 space)
UFC Crane Guidance

• Table 7-1: Minimum capacity & hook height
• Under running girder electric cranes w/ under running trolley hoist
• Use patented track systems designed by the crane manufacturer.
• Provide loaded hook coverage within 12 ft. of walls and within 15 ft. of hangar doors (and other cranes)
• Crane operating envelope, including clearances, will not have interferences with the electrical, HVAC, or similar equipment
Navy Crane Center (NCC)

• Navy Crane Instruction 11450.2
• NCC Consultation for >40 ft. bridge spans
• NCC Procurement in (NEC 513) Hazard Zones

• NAVFAC Criteria working with NCC to:
  – Develop standard UFGS for bridge cranes
  – Develop provisions for bridges, hooks & pendants
  – Eliminate need for NCC consultation if above is met
  – Publish a revised NCC Instruction 11450.2
Overhead Crane (hung from structure)
Overhead Equipment (Telescoping Lifts)
Mobile Crane (floor supported equipment)
Fall Prevention and Fall Protection

• Fall Prevention: Design to eliminate fall hazards

• Fall Protection: provide system for all roof-mounted lighting, equipment and platforms from the interior roof access

• Fall Protection: provide as required for aircraft maintenance (guidance in FRD)
Fall Protection – Rigid Rail Systems

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Plain Track
PT Series

PT Series and R Series
are available in stainless steel.

R Series

Dual Trussed Track
DST Series

Triple Trussed Track
TST Series
Fall Protection – Flexible Life Line System
Fall Protection - Mobile Stand
Mechanical Design

• Building: UFC 1-200-01
• HVAC: UFC 3-401-01
• Sustainability: UFC 1-200-02

• Admin/Office/Shop: 78°F Cooling / 68°F Heating
• Hangar Bay: n/a Cooling* / 55°F Heating

* Air Conditioning is permitted only when required by the FRD.
Aircraft Maintenance Bay Heating

- Overhead Radiant
- In-Floor Radiant Heating
- Forced-Air Heat
Low Intensity Radiant Heat

• Automatically shut off system if the outside air temperature is above 40°F and a hangar door is open
  – If the outside air temperature is below 40°F operate the system regardless of hangar door position

* Watch for required clearance to combustible materials
In-Floor Radiant Heat

• May be LCCE in colder climates
• Optionally used across the whole hangar bay or just the hangar door threshold
• Watch for coordination with floor slab design (thickness, reinforcing, jointing and placement sequencing)
Aircraft Bay Heating Ventilation

- Typically provided by dedicated outdoor air system (DOAS)
- High-volume, low speed (HVLS) fans are permitted for human comfort & destratification
Mechanical Design

• Provide dedicated units for the Communications Room and Secure Office.

• Provide heating only with a unit heater for the stairs when the climate makes it necessary.
Where is Exhaust Required?

- Aircraft Maintenance Bays
- Repair and Maintenance Areas
- Avionics/Electrical Repair
- Parts Washers
- Rest Rooms
- Printer/Copier Rooms
- Specialized or Localized
  - Battery maintenance shop
Fuel Cell Evacuation / Exhaust

• NAVAIR 01-1A-35 permits fuel cell evacuation in an enclosed maintenance area provided:
  – The exhaust outlet is vented to the outdoors and
  – The vapors cannot reenter the enclosed maintenance area.

• No specialized exhaust required except as identified elsewhere in UFC 4-211-01.
– Not permitted for stationary applications in occupied facilities
– Requirements for portable lithium batteries used in military mission systems that are stored or charged inside facilities
– Requires storage & charging enclosures designed specifically for the battery type
• Exemptions for UL-listed COTS batteries, less than 21 volts & 100 watt-hours
• Emergency exhaust at 12 ACH for closets and cubbies, normal exhaust at 6 ACH
• VOC sensor for early detection and charger shutdown
• Manual charger shutdown switch
• Hazmat signage per NFPA 704
• Locate charging stations away from egress pathways and personnel areas
• Open side of charging station cannot open towards other charging cubbies or flammables
• No fire dampers in exhaust duct
  – Provide continuous fire-rated duct wrap for the entire length of battery room exhaust duct if the duct must be routed through rated partitions.
• Battery room cooling independent from the building HVAC system. Capable of 65 °F
• Sprinkler in each closet and over each cubby
UFC 3-520-05 Stationary & Mission Batteries

• UFC 3-520-05
  – Concept plan for battery charging and storage
Lithium Battery Safety

• Establish safety guidelines
  – Selection
  – Design
  – Testing
  – Evaluation
  – Use
  – Packaging
  – Storage
  – Transportation
  – Disposal

• Applies to all Navy Facilities
Emergency Shower/Eye Wash Wash Stations

• Provide:
  – Hangar bay
  – Pneudraulics repair
  – Shop areas where chemicals, oils, solvents or debris can be sprayed or blown into eyes, or spilled on clothing.

• Supply tepid water to these stations.

• Floor drains may be provided at these stations, but are not required.
Wall Hydrants & Hose Bibbs - Exterior

• Provide:
  – Exterior walls with a max spacing of 100 ft.
  – Freeze-proof exterior yard hydrant in mechanical yards containing chillers, condensers, condensing unit, and cooling towers
  – Provide at roof mounted PV and Solar Heating

• All hydrants and hose bibbs shall have a vacuum breaker to prevent back flow
Wall Hydrants & Hose Bibbs - Interior

• **Provide**
  
  – Hose bibbs on all interior (perimeter) walls of hangar maintenance bay
    
    • Spacing not specified, consider matching the exterior maximum spacing of 100 ft.
  
  – In all mechanical rooms

• **All hydrants and hose bibbs shall have a vacuum breaker to prevent back flow**
Domestic Water Heating System

• Size system with storage and recovery for delivery of hot water to every fixture (diversity factor of one for showers)

• Instantaneous water heaters are permissible for remote fixtures

• Provide floor drains near ice machines, in rooms with HVAC condensate, showers, restrooms and mechanical rooms

• Evaluate cost effectiveness of solar domestic hot water per UFC 1-200-02
• Provide floor drains in the hangar bay spaces or shops/storage rooms that are tied to the station industrial sewer with outlet to an oil/water separator tied to a collection system that will capture and hold these materials for proper disposal.

• Coordinate with the Installation
  – For Air Force: Do not install floor drains or trench drains in the hangar bay except where explicitly indicated in Chapter 5.
Lunch Break
Compressed Air – Shops

• Provide wall-mounted compressed air drops, with lubricator on every wall at 25 ft spacing
• Include a refrigerated air dryer in the compressed air systems

– For Navy: Refer to Chapter 7 Data Sheets
Compressed Air (125 psig) Required For:

- Air Frames
- Aviation Ordnance
- Avionics
- Corrosion Control
- Detachment
- Flight Gear/Paraloft
- Flight Line
- Night Vision Goggles
- Phase Crew
- Power Plant
- Seat Shop
- Tool Room
- Division Office
- Maintenance Control
- Seat and Canopy Maintenance
Compressed Air – Hangar Bay

- Provide compressed air drops, with lubricator, along back and side walls at spacing of every 50 ft.
- Include a refrigerated air dryer in the compressed air systems.
Compressed Air – Hangar Bay

• Size air compressor system to accommodate all identified loads, such as:
  – all tool loads
  – fuel cell evacuation equipment
  – air pressure cabin leakage tester (APCLT)
  – fuel vacuum.
F35 Compressed Air Requirements

- Required for high-volume equipment in hangar
  - Air pressure cabin leakage tester (APCLT), fuel cell evacuation (FCE) equipment, fuel vacuum
    - APCLT - 100 cfm @ 100 psig
    - FCE – 100 cfm @ 80 psig
    - Fuel Vacuum – 45 cfm @ 80 psig
F35 Compressed Air Requirements

• Required for high-volume equipment in hangar:
  – Need one high capacity compressed air drop (100 cfm @125 psig) with lubricator, shutoff valve, filter, & pressure regulator for every two aircraft bays

• UFC will be updated with loads and HC drop requirements

• Currently no information in FRD or UFC on APCLT and FCE loads – tech manuals only

• CA sizing spreadsheet with all known requirements available for use by designers
### F35 Maintenance Hangar Compressed Air Sizing

<table>
<thead>
<tr>
<th>Location</th>
<th>Item</th>
<th>Number</th>
<th>Flow Usage @ 80 psig (CFM)</th>
<th>Pressure @ 80 psig (PSIG)</th>
<th>Flow Usage @ 125 psig (CFM)</th>
<th>Usage Factor (Diversity)</th>
<th>Design Flow</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hangar Bay</td>
<td>APLCT</td>
<td>1</td>
<td>100</td>
<td>100</td>
<td>82</td>
<td>100%</td>
<td><strong>82.1</strong></td>
<td>Sized to support one APLCT and one FCE simultaneously. Flow based lesser of F35 APLCT (J41004, Tester, Pressure, Cabin Leakage) and Portable compressor (J00075, Portable Compressor, RCU).</td>
</tr>
<tr>
<td>Hangar Bay</td>
<td>FCE</td>
<td>1</td>
<td>100</td>
<td>80</td>
<td>68</td>
<td>100%</td>
<td><strong>67.8</strong></td>
<td>Size system to support fuel cell evacuation equipment per UFC 4-211-01, para 3-5.8.1. Flow based on F35 fuel cell evacuation equipment (J46006 Ventilating System, Fuel Tank Repair).</td>
</tr>
<tr>
<td>Hangar Bay</td>
<td>Vacuum</td>
<td>1</td>
<td>45</td>
<td>80</td>
<td>31</td>
<td>100%</td>
<td><strong>30.5</strong></td>
<td>Sized based on F35 twin venturi vacuum equipment (J46028, Extractor, Residual Fuel). Assume operation of vacuum and fuel cell evac equipment is not concurrent.</td>
</tr>
<tr>
<td>Hangar Bay</td>
<td>CA Drop</td>
<td>24</td>
<td>20</td>
<td>100</td>
<td>16</td>
<td>25%</td>
<td><strong>98.5</strong></td>
<td>Provide every 50 ft with lubricator per UFC 4-211-01, para 3-5.8.1 and Table 7-19. Each service point with the following: One (1) 38 mm (1/2 in.) needle valve shutoff, One (1) pneumatic tool filter, One (1) 861.8 kPa (125.0 psi) pressure regulator, One (1) pneumatic tool lubricator, Two (2) pneumatic tool quick connectors, One (1) wall-mounted hose rack</td>
</tr>
<tr>
<td>Hangar Bay</td>
<td>CA Drop</td>
<td>-</td>
<td>100</td>
<td>100</td>
<td>82</td>
<td>25%</td>
<td>-</td>
<td>Provide one high capacity compressed air drop with lubricator for every two aircraft bays. Each high capacity drop must have shutoff valve, filter, and pressure regulator.</td>
</tr>
<tr>
<td>Air Frames</td>
<td>CA Drop</td>
<td>4</td>
<td>40</td>
<td>100</td>
<td>33</td>
<td>25%</td>
<td><strong>32.8</strong></td>
<td>UFC 4-211-01 Table 7-6</td>
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<tr>
<td>Aviation Ordinance</td>
<td>CA Drop</td>
<td>2</td>
<td>34</td>
<td>90</td>
<td>25</td>
<td>25%</td>
<td><strong>12.7</strong></td>
<td>UFC 4-211-01 Table 7-6, FRD MGP Area specifies 34 cfm at 90 psig</td>
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<td>Avionics</td>
<td>CA Drop</td>
<td>4</td>
<td>20</td>
<td>100</td>
<td>16</td>
<td>25%</td>
<td><strong>16.4</strong></td>
<td>UFC 4-211-01 Table 7-7</td>
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<tr>
<td>Corrosion Control</td>
<td>CA Drop</td>
<td>4</td>
<td>20</td>
<td>100</td>
<td>16</td>
<td>25%</td>
<td><strong>16.4</strong></td>
<td>UFC 4-211-01 Table 7-8</td>
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<td>Detachment</td>
<td>CA Drop</td>
<td>2</td>
<td>20</td>
<td>100</td>
<td>16</td>
<td>25%</td>
<td><strong>8.2</strong></td>
<td>UFC 4-211-01 Table 7-9</td>
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<td>Flight Gear/Paralot</td>
<td>CA Drop</td>
<td>2</td>
<td>20</td>
<td>100</td>
<td>16</td>
<td>25%</td>
<td><strong>8.2</strong></td>
<td>UFC 4-211-01 Table 7-10</td>
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<td>Flight Line</td>
<td>CA Drop</td>
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<td>20</td>
<td>100</td>
<td>16</td>
<td>25%</td>
<td><strong>16.4</strong></td>
<td>UFC 4-211-01 Table 7-11</td>
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<td>Night Vision</td>
<td>Goggles</td>
<td>2</td>
<td>20</td>
<td>100</td>
<td>16</td>
<td>25%</td>
<td><strong>8.2</strong></td>
<td>UFC 4-211-01 Table 7-12</td>
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<td>Phase Crew</td>
<td>CA Drop</td>
<td>2</td>
<td>20</td>
<td>100</td>
<td>16</td>
<td>25%</td>
<td><strong>8.2</strong></td>
<td>UFC 4-211-01 Table 7-13</td>
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<td>Power Plant</td>
<td>CA Drop</td>
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<td>20</td>
<td>100</td>
<td>16</td>
<td>25%</td>
<td><strong>16.4</strong></td>
<td>UFC 4-211-01 Table 7-14</td>
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<td>Seat Shop</td>
<td>CA Drop</td>
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<td><strong>8.2</strong></td>
<td>UFC 4-211-01 Table 7-15</td>
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<td>Tool Room</td>
<td>CA Drop</td>
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<td>20</td>
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<td>16</td>
<td>25%</td>
<td><strong>16.4</strong></td>
<td>UFC 4-211-01 Table 7-16</td>
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<td>Maintenance Control</td>
<td>CA Drop</td>
<td>2</td>
<td>20</td>
<td>100</td>
<td>16</td>
<td>25%</td>
<td><strong>8.2</strong></td>
<td>UFC 4-211-01 Table 7-17</td>
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<td>Maintenance Control</td>
<td>2</td>
<td>20</td>
<td>100</td>
<td>16</td>
<td>25%</td>
<td><strong>16.4</strong></td>
<td>Not required by UFC 4-211-01</td>
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<td>Seat and Canopy Maintenance</td>
<td>4</td>
<td>20</td>
<td>100</td>
<td>16</td>
<td>25%</td>
<td><strong>16.4</strong></td>
<td>UFC 4-211-01 Table 7-20</td>
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<td>GSE Support</td>
<td>4</td>
<td>20</td>
<td>100</td>
<td>16</td>
<td>25%</td>
<td><strong>16.4</strong></td>
<td>Not required by UFC 4-211-01</td>
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<td>CA Drop Count</td>
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<td>Safety Factor</td>
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<td>10%</td>
<td>50</td>
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<td></td>
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<td>547</td>
<td></td>
</tr>
</tbody>
</table>

**CA sizing spreadsheet with all known requirements available for use by designers**
Preconditioned Air (PCA)

- Provide PCA as required by the Aircraft FRD
- Comply with this UFC & UFGS 23 75 15
F-35 Preconditioned Air Systems (PCA)

• Facilities Requirements Document (FRD) directs specific cooling air requirement for maintenance operations
  – 46.6 lb/min (~450 cfm)
  – 35-55°F, 0-55 grains of moisture (86% Rel. Hum.)
  – 5.25 psig (-0.25/+0.50 psig)
  – 0.02 grams of dust with a maximum particle size of 50 microns per pound
F-35 Preconditioned Air Systems (PCA)

• Every air station reports major issues with PCA systems – multiple causes of failure

• Lessons learned previously included in an ITG have now been included in the recently released UFC 4-211-01 Change 2
F-35 Preconditioned Air Systems (PCA)

• One PCA unit to one aircraft - no manifolding
• No valves in duct
• No underground ductwork or utility pits
• Locate units outside – no screen walls
• Size for worst-case enthalpy, not dry bulb
• Welded SS piping, gasketed in hazardous locations within 18” of hangar floor
F-35 Preconditioned Air Systems (PCA)

- Route duct in (AFFF) trench
- No more than 5 °F temperature rise
- No more than 30 minutes to cool down
- Low pressure purge mode
- No built-up controls – start, stop, purge
- Testing requirements – factory, functional, and endurance/season of max cooling
F-35 Preconditioned Air Systems (PCA)

- Supplier must have at least three previous successful PCA system installations
- System Supplier Involvement - present during all field testing activities and coordinates installation, testing, and training

- There are many required submittals, QC and testing requirements associated with this system (refer to UFGS 23 75 15).
F-35 Preconditioned Air Systems (PCA)

- Locate units away from sound sensitive spaces such as conference and classrooms
- Enforce quality control and testing requirements – expensive test bullet and multiple testing trips
- Train maintenance personnel and/or securing OEM maintenance contracts
Fire Protection Design

- Building and Systems: This UFC and UFC 3-600-01 and then NFPA where explicitly noted
- Classify all hangars as Group I in accordance with NFPA 409 (Chapter 7).
Fire Hydrants

- Supply from the domestic water service, where it can be supported.
  - Locate hydrants protecting the building at a maximum interval of 300 ft.
  - If hangar bay door opening exceeds 300 ft., place a hydrant at each end of the opening.
  - Locate a hydrant w/in 100 ft. of each corner of bldg.
  - Locate hydrants in apron w/in 10 ft.0 m) of the bldg.
  - Install low profile, conventional hydrants, no higher than 2.5 ft. where within 25 ft. of airfield pavement.
Fire Water Supply

• Shall meet the total flow and duration demands of the following:
  – Fire water suppression systems located in support areas outside the hangar bay
  – The hangar bay ceiling sprinkler system and foam/water fire suppression system for 45 minutes (min.)
  – Outside hose stream allowance if supplied from the same fire water supply
  – Any other suppression system(s) within the hangar
  – Any domestic and industrial demands if required
Fire Water Supply

• If Fire Water demand is not met:
  – Single Hangar: Provide Pump(s) as needed
  – Two or more Hangars: Provide pumps of equal capacity meeting the total fire water demand of the most demanding hangar, and a redundant pump meeting the size of the largest pump.
  – Provide electric or diesel pumps per UFC 3-600-01
  – Provide a pressure maintenance (jockey) pump
Fire Protection Design

• Provide a wet pipe sprinkler system at the roof/ceiling in the Hangar Bay
  – Some instances may require Dry Pipe or Preaction

• Navy: Provide a low level Aqueous Film-Forming Foam (AFFF) trench nozzle system
  – Looking for a system to replace AFFF

• Air Force: provide an overhead High-Expansion (HEF, Hi-Ex) foam system
• NDAA 2020 prohibits the purchase of AFFF concentrate after 1 October 2023 and prohibits its use after 1 October 2024

• AFFF contains perfluoroalkyl and polyfluoroalkyl substances commonly identified as PFAS that are persistent in the environment.

• Currently, there is no acceptable replacement foam for AFFF.
Interim Technical Guidance 2020-01

• If past 35% design (design-bid-build), continue with AFFF system
• If Design-Build contract is awarded, continue with AFFF system

• If DB-RFP development, or less than 35% design, provide “water only” system in the same AFFF infrastructure (including containment, etc.)
Aqueous Film-Forming Foam - Navy

• Project criteria:
  – Trench drains w/ Grate Nozzles® discharging AFFF
  – Optical flame detection (3IR) to activate AFFF (two detectors to activate)
  – Discharge of AFFF goes to containment system
  – Wet pipe (water) sprinklers overhead
  – Fire alarm throughout

• Major Issue:
  – Containment and disposal of AFFF
  – NDAA 2020 Chemical Prohibition
Aqueous Film-Forming Foam - Navy

• No Moving Parts
Aqueous Film-Forming Foam - Navy
Test Video
(MV-22 Miramar)
• AFFF Containment
  – AFFF runoff routed to an underground containment system via the trenches
  – Diverter valve system to direct AFFF to containment
  – Containment capacity for 15 mins of discharge (without trench or piping capacity included)
  – Provide containment system monitoring
Aqueous Film-Forming Foam - Navy

• Recent criteria changes
  – MIL-SPEC AFFF formulation change from C8 to C6
  – Fiberglass double-walled AFFF containment tank

• NDAA 2020 phase out of PFOS/PFOA

• Now Evaluating:
  – Variety of other foams & formulations
  – Non-chemical systems such as an aluminum flooring with integral drainage system
High Expansion Foam – Air Force

• High Expansion Foam System (HEF or Hi-Ex) in the Hangar Bays
  – HEF Flow Control Valves with On/Off Capability
  – Inductor Type Foam Proportioners, Atmospheric Tank
  – HEF Discharge via Trench Drains to Containment
High Expansion Foam System – Air Force

- Foam Controls: Proprietary Foam Control Panel and Flame Detection
- Triple IR Flame Detectors - Crosszoned
- First Detector – Prealarm
- Second detector in Same Hangar Bay, Activates HEF Zone
- OR -
- Foam Manual Pull – Activates HEF Zone Per Hangar Bay – located at Hangar Exits, dual action stations w/ clear covers & sirens
- Abort Switch at Foam Pulls to Prevent or Stop Foam Flow, Even After System Activation (must press and hold)
- Blue Beacons Signal Foam Discharge
High Expansion Foam Test – Air Force

Test Video
(F35 Luke AFB)
Hazardous Locations

• The hangar bay and adjacent spaces are hazardous locations (per NFPA 70)
• Defined by NEC Article 513

• Class I Division 1
• Class I Division 2
EXHIBIT 511.2 Seals not required for conduits that pass unbroken through the Class I location.
Hazardous Locations

- Classify adjacent spaces that are not suitably cutoff as Class I Division 2 up to 18 inches above the floor.
Hangar Bay Door Power

• Provide power to keep doors energized when the main hangar power disconnect switches are shut off.
  • Separate, dedicated power supply from the facility transformer, or
  • Power ahead of the main service disconnecting means

• Key-operated or other access-controlled switch on the exterior of facility to open hangar doors in an emergency.

• Portable generator connection on the exterior of facility with a manual transfer switch for hangar doors.
Aircraft Power

- Aircraft have specific power requirements, including unique voltages, frequencies, capacities and locations. Provide per FRD requirements.

Note: permanently mounted or pop-up pedestals are not permitted and Navy does not permit a centralized 400Hz system servicing more than two aircraft.
Aerospace Ground Equipment Power

• Provide electrical power receptacles to support portable AGE equipment
  – Equipment receptacles shall not provide three phase power until the interlocking pins have been correctly mated, utilizing a control interlock circuit.
Power Separation in 01 & 02 Spaces

- Supply loads located in the 01 space from panel boards located in the 01 space
- Supply loads located in the 02 space from panel boards located in the 02 space
Grounding and Bonding

• In accordance with UFC 3-575-01.
  – Coordinate the requirement for ordnance grounding with the users supported. Areas of consideration may include, but is not limited to, the following:
    • Seat maintenance for seats with explosives
    • Canopy maintenance for canopies w/ explosives
    • Seat storage for seats with explosives
    • Canopy storage for canopies with explosives
    • Canopy shop and storage areas
    • Armament Room

• Lightning Protection per UFC 3-575-01
Lighting and Controls

• Comply with UFC 3-530-01
  – Apron lighting may be facility mounted
  – Aviation obstruction lighting
    • Also provide in accordance with NAVAIR 51-50AAA-2
    • Provide LED obstruction lights where permitted
Communication Infrastructure

- In accordance with UFC 3-580-01
- User based, as required:
  - GPS, SIPRNet, CENTRIXS, JWICS, LMS, IMIS, ULLS-A
  - Wireless Access Point (WAP)
  - Classified Systems
  - Naval Aviation Logistics Command Management Information System (NALCOMIS)
  - Triton Communication Systems
  - 3M Communications (Maintenance and Material Management)
  - (F-35 Hangars) ALIS is required with a SAPF area
Communication Design

• Public Address (PA) integrated with Mass Notification System (MNS) per UFC 4-021-01
• Cable Television (CATV) Systems
• Audio Visual System (A/V)
• Closed Circuit Television System (CCTV)
• Radio and Satellite Systems
• Electronic Security Systems (ESS)
  o ACS – access control system
  o IDS – intrusion detection system
Hangar Doors

• How do you choose which hangar door system is right for your project?
  – Horizontal Steel Sliding Doors
  – Vertical Lift Fabric Doors
  – Swinging Hangar Doors (small hangars)
  – (Other Options are Obsolete)
Horizontal Steel Sliding Doors

Video
GRU Hangar
Horizontal Steel Sliding Doors

• Design Considerations
  – More durable, less maintenance
  – More secure
  – More manufacturers
  – Higher insulation (R-Value)
  – Heavier foundation/rails
  – May be pushed open w/ tug

  – Poor seals (air infiltration)
  – Requires more floor space (door pockets)
Horizontal Steel Sliding Doors

• Backup Power Operations
  – Provide power ahead of the main hangar power disconnect
  – Portable generator connection on the exterior of facility with a manual transfer switch for hangar doors
  – Manual Operation (release brakes/motor and push open with a tug)
Hangar Doors & Pockets

Remember Figure 7-2 & 7-3? Do Not Do This!

Do This!
Vertical Lift Fabric Doors

Video
VLFD
Vertical Lift Fabric Doors

• Design Considerations
  – Low air infiltration (superior seals)
  – Requires less floor space
  – No door pockets or blocking of bays
  – Flexibility in door heights, shapes, & configurations

  – More moving pieces / maintenance
  – Coordination of superstructure
  – Fewer manufacturers
  – Lower R-value (insulation)
Vertical Lift Fabric Doors

• Backup Power Operations
  – Provide power ahead of the main hangar power disconnect
  – Portable generator connection on the exterior of facility with a manual transfer switch for hangar doors
  – Manual Operation (manually turn each device on each leaf to raise doors/mullions)
Figure 2-6: Space Requirements for Sliding Steel Hangar Doors

- Count the area inside the exterior face of the door as 100% Square Footage (SF).
- Do not count the area under roof and outside the exterior face of the door.
- Count the area inside the exterior face of a door pocket as 100% SF.
Figure 2-5: Space Requirements for Vertical Lift Fabric Doors

- Count the area inside the exterior face of the door as 100% square feet.
- Do not count the area under roof and outside the exterior face of the door.
Hangar Doors – Supplemental Guidance

• Hangar Doors
  – Vertical Lift Fabric Hangar Doors (VLFD) Prohibited
    • In DoD windborne debris regions
      – Where Risk Category III wind speed exceeds 130 mph within 1 mile of coast
      – Where Risk Category III wind speed exceeds 140 mph
  – Challenge – above prohibition includes:
    • MCAS Cherry Point & New River
    • MCB Camp Lejeune
    • MCAS Beaufort
    • Etc. (see wind tables)
Hangar Doors

• Design the width of the opening to not be less than 3ft. less than the width of the aircraft maintenance bay

• The vast majority of door requirements are already included in the specifications
  – Performance Spec with Editor Decisions

• Door components and details to be covered in applicable Specification Section
UFGS – Hangar Doors

- UFGS 08 34 16.10 Steel Sliding Hangar Doors
- UFGS 08 34 16.20 Vertical Lift Fabric Doors
UFGS – Hangar Doors

• Review of UFGS Organization
  – Part 1 General
    • References, Submittals, Design Requirements and QA
  – Part 2 Products
    • Components, Finishes, Fabrication and Operation
  – Part 3 Execution
    • Erection and QC
• Part 1 Notes to Editor/Designer:
  – Reminder of the required Hangar Paint System
  – List of information to be included in the drawings

• Submittals Include:
  – Professional Sealing Req’ts (delegated design)

• Design Requirements:
  – Wind and Seismic Loads
  – Permissible Deflections

• Quality Assurance (QA):
  – 5 yrs proven experience by Manufacturer / Installer
  – 3 yr Warranty
Steel Sliding – Part 2 Components

• Part 2 Notes to Editor/Designer:
  – Rail alignment and construction tolerances
  – Supplier of Exterior and Interior metal panels

• Component Requirements:
  – Bottom and Top Door Guide Requirements
  – Personnel Doors
  – Weather Stripping
  – Door Type/Configuration Selections
  – Door Controls / Limit Switches /Safety Edges
  – Warning Devices and Emergency Operation
  – Electrification
Steel Sliding – Door Configurations

- Individually Operated Leaves
- Anchored Group

- One-way
- Biparting
- Floating
Steel Sliding – Door Configurations

• Aperture vs. Tail Slot
Steel Sliding – Bottom Door Guide
Steel Sliding – Drive Operation

Video
Drive Operation
Steel Sliding – Weather Stripping
Steel Sliding – Safety Edges
Steel Sliding – Top Door Guide
Steel Sliding – Part 3 Erection Requirements

• Part 3 Execution Requirements
• Field Quality Control and Testing

• Pro Tip: Add Training Requirement
  – For safety, normal operation, emergency operation and basic maintenance
  – Require video taping of the training session
  – Coordinate with UFGS 01 78 23 (O&M Data)
Part 1 Notes to Editor/Designer:
- Provide alternate means of door operation
- List of information to be included in the drawings

Submittals Include:
- Professional Sealing Req’ts (delegated design)

Design Requirements:
- Wind and Seismic Loads
- Minimum Door (& mullion) Speed (or Time)

Quality Assurance (QA):
- 5 yrs proven experience by Manufacturer / Installer
- 3 yr Warranty / 10 yrs Fabric / Emergency Plan
• Part 2 Component Requirements:
  – Fabric Type and Color
  – Operation and Safety
  – Motors, Controls, Limit Switches and Alarms
  – VLFD Components
VLFD – Door Configurations (by Aircraft)
VLFD – Door Configurations (by Site)
VLFD – Translucent & Vision Panels
VLFD – Energy Benefits
VLFD – Operation

[Image of airfield facilities and control panel]

[Caption: VLFD – Operation]

[Image of control panel with buttons and screen]

[Image of airfield and control room]

[Caption: VLFD – Operation]
VLFD – Bottom of Door Mullion
VLFD – Top of Door (above catwalk)
VLFD – Top of Door (above catwalk)
VLFD – Part 3 Erection Requirements

• Part 3 Execution Requirements
• Acceptance Testing & Report
• Personnel Training – 8 hours
  – Door operation, troubleshooting and repair
• Extra Materials / Door Patch Kit

• Pro Tip: Require Training to be videotaped
  – Coordinate with UFGS 01 78 23 (O&M Data)
Section 5a – UFC 4-211-02
Aircraft Corrosion Control & Paint Facilities

Aircraft Hangars & Other Airfield Structures

3/1/2020
Aircraft Corrosion Control & Paint Facilities

• Chapters:
  1. Introduction
  2. Planning and Layout
  3. General Design Requirements
  4. Media Blast Hangar Design Criteria
  5. Chemical Depaint Design Criteria
  6. Aircraft Wash Racks
  7. Specific Design Criteria

• Appendices
Applicability

–This UFC provides planning and design criteria applicable to new construction as well as sustainment, restoration and modernization projects on all Department of Defense (DoD) facilities in the continental United States, (CONUS), and outside the continental United States (OCONUS).

–Tri-Service
Other Requirements and Revisions

• Must also Comply with:
  – UFC 1-200-01
  – Facility Requirements Docs (FRD)
  – Other Special Requirements

• Upcoming Revision
  – Update Requirements
  – Calibrate with recently updated UFC 4-211-01
Scope

• ACCPFs provide space, infrastructure and support facilities to conduct de-paint, paint, and corrosion control activities for DoD aircraft.
  – Depot Facilities
  – Corrosion Control Facilities
  – Wash Racks
• **Depot Level** – Complete Corrosion Control Activities on an Aircraft undergoing major maintenance

• **Corrosion Control Facility** – Minor Corrosion Control in support of an Active Squadron

• **Wash Racks** – Open or Covered paved area for manual washing of aircraft (located nearby)
FIGURE 1-1. ACCPF FACILITIES

- Aircraft Corrosion Control and Paint Facilities (ACCPF)
  - Corrosion Control Facility (CCF)
  - Depot Facilities (DF)
  - Washracks
    - Paint Finishing Facility
    - Depaint Finishing Facility
      - Chemical Paint Finish Removal
      - PMB Dry Media Paint Removal

May perform function
Complex and Unique Building Systems

- Health / Environmental
- Architectural Detailing
- Structural Detailing
- Mechanical HVAC Systems
- Equipment Systems
- Processes
Complex and Unique Building Systems
Bubble Diagrams

**FIGURE 2.3a. DF PAINT & CHEMICAL DEPAINT BUBBLE DIAGRAM**

**FIGURE 2.3b. DF DRY MEDIA DEPAINT BUBBLE DIAGRAM**
Space Programming and Study

• Refer to UFC 2-000-05N
  – CATCODE 21103
  – Space Programming
  – Minimum Clearances
  – Working Space
  – Ancillary Spaces

• Start with a Detailed Facility Study

• Health, Safety and the Environment
Corrosion Control Hangar Doors

- Specialized, insulated, swinging or sliding
- Designed to serve as insulated supply air plenums when closed
- Galvanized steel perforated plates are used with a means to balance air distribution to achieve evenly distributed laminar flow in the hangar bay.
- The hangar door acts as a plenum
Corrosion Control Hangar Doors
Interior Walls and Finishes
Plumbing Requirements
HVAC Requirements
Fire Protection & Life Safety

• Provide fire protection in accordance with UFC 3-600-01, Fire Protection Engineering for Facilities and the following documents:
  – Navy: UFC 4-211-01N, Aircraft Maintenance Hangars: Type I, Type II and Type III
  – NFPA 33, Standard for Spray Application Using Flammable or Combustible Materials

• Note: Foam Fire Protection is not required for hangars housing aircraft that are defueled and purged or have their fuel cells removed. The requirements in NFPA 409 for unfueled aircraft must be followed for these situations.
Electrical

- Equipment in the hangar bay must be waterproof or water protected
- Electrical installations shall meet hazardous classifications required by NFPA 70 and National Electrical Code (NEC)
- Provide grounding per UFC 3-575-01
- Provide lighting per UFC 3-530-01
Platforms and Fall Protection
Media Blast Hangar Design Criteria

• Dry Media Blasting (DMB) facility – removes coatings/corrosion in preparation for the application of corrosion treatment / surface coatings
  – Most common is: Plastic Media Blast (PMB) 12-16 mesh

• Process generates dust – the composition and toxicity of the dust is often a health or combustion hazard
  – Blast Cleaning Room vs. Blasting Cabinet
  – DMB is recovered (Pneumatically)
  – DMB is recycled (particles between 12 and 60 mesh)
Media Blast Hangar Design Criteria

• Due to dust generated by the DMB depaint process, the potential exists for an explosive atmosphere in the hangar bay. The hangar bay must be classified as a Class 2, Division 1 space per NFPA 70.

• Follow NFPA 409 for sprinkler system design – when aircraft are defueled and purged and a foam system is not required.
Media Blast Hangar Design Criteria

• IBC Classification is Factory and Industrial F-1
• A fully lined and sealed space
• Hard, light-colored, smooth surface
• Horizontal surfaces and ledges must be covered with a sloping surface such that the accumulation of dust is mitigated
• Provide Observation Windows and Access Doors into the bay for continuous observation
• Provide Ventilation for Control of Air Contaminants
• Provide Noise and Vibration Control
Wash Racks for DMB Operations

• Residual dust resulting from depainting by DMB must be completely removed

• Locate a Wash Rack as close as practical to the Dry Media Depaint Hangar and include this in the planning phase

• The DMB hangar itself must not be used for the aircraft wash process
Chemical Depaint Design Criteria

– Special attention must be given to the interior surfaces (floors, walls, ceilings, trenches, pits) that could come in contact with the paint removal solution due to the inherent corrosive properties of the chemicals.

– The chemical depaint solution is considered toxic and, with the removed paint hazardous waste, requires specific industrial waste treatment to maintain the mandated zero discharge or meet the input requirements of the Industrial Waste Treatment Plant serving the facility.
Chemical Depaint Design Criteria

• The hangar floor drainage system for a chemical depaint facility requires a trench and piping design of sufficient size and slope to carry all paint chips and residue to a collection/holding tank
  – Size the tank for a three month projection
  – Entire system (trench and tank) must be sized to facilitate manual cleanout and inspection on a regular basis.
  – The tank must be capable of being emptied of the paint residue manually or automatically.
Aircraft Wash Racks

• Paved areas or facilities provided at all aircraft base facilities for the purpose of cleaning aircraft in conjunction with periodic maintenance and corrosion control activities

• Design aircraft wash racks in accordance with UFC 3-260-01, Airfield and Heliport Planning and Design
### Functional Areas and Data Sheets

- **ACCPF Functional Program Areas:** Table 1-1
- **Function Data Sheets:** Tables 7-1 through 7-35

#### TABLE 7-14. PAINT BOOTH

<table>
<thead>
<tr>
<th>Description/Usage</th>
<th>Individual paint spray booth for small parts (may be located inside hangar bay or exterior to building). See UFC 3-410-04 Industrial Ventilation for specifications and facility requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling Ht.</td>
<td>Based on largest part anticipated, with sufficient clearances for movement of personnel and equipment</td>
</tr>
<tr>
<td>Windows/Doors</td>
<td>Supply plenum and/or paint filters in doors for cross-flow booth; size doors to accommodate movement of parts; heavy duty hollow metal personnel doors and frames with closers; insulated doors between conditioned and unconditioned spaces;</td>
</tr>
</tbody>
</table>
| Interior Construction/ Built-in Equipment | Walls. Factory finished metal panels  
Floor. Thin film coating or dry shake hardener is minimum requirement. Coating must provide smooth, easily cleanable surface that will not accumulate dust  
Base.  
Ceiling. Factory finished metal panels |
| Finishes          | Drains, if installed must be routed to IW systems for proper treatment. Emergency Shower & Eyewash, floor drains to IW system |
| Plumbing          | For Paint Booths exhausted to the exterior installed in interior spaces, replacement air must be supplied to the space to maintain an even static pressure. See UFC 3-410-04 |
Appendix B – Best Practices

• A Must Read Section
  – Design Guidance (25 Different Spaces)
  – Personnel Safety Issues
  – Maintenance Contracts
  – Lessons Learned (8 Topical Discussions)
Corrosion Control (Filter) Doors

• Part 1 Notes to Editor/Designer:
  – Unique in that they also serve as the Air Plenum
  – Reminder of the required Hangar Paint System
  – List of information to be included in the drawings

• Submittals Include:
  – Professional Sealing Req’ts (delegated design)

• Design Requirements:
  – Wind and Seismic Loads & Permissible Deflections

• Quality Assurance (QA):
  – 5 yrs proven experience by Manufacturer / Installer
  – 3 yr Warranty
Corrosion Control (Filter) Doors

• Part 2 Notes to Editor/Designer:
  – Rail alignment and construction tolerances
  – Supplier of Exterior and Interior metal panels

• Component Requirements:
  – Bottom and Top Door Guide Requirements
  – Emergency Personnel Doors
  – Filter Assembly & Differential Pressure
  – Door Drive Mechanism & Lock Pins
  – Electrical Equipment (Explosion Proof)
  – Warning Devices and Emergency Operation
  – Fabrication & Finishes
Corrosion Control (Filter) Doors
Corrosion Control (Filter) Doors
Corrosion Control (Filter) Doors
Corrosion Control (Filter) Doors
Corrosion Control (Filter) Doors

• Part 3 Execution Requirements
• Field Inspection and Tests
• Personnel Equipment Systems Orientation
  – 8 hours formal training on door operations

• Pro Tip: Require Training to be videotaped
  – Coordinate with UFGS 01 78 23 (O&M Data)
Section 6 – UFC 4-133-01
Air Traffic Control Facilities

Aircraft Hangars & Other Airfield Structures

3/1/2020
• Chapters:
  1. Introduction
  2. Planning and Layout
  3. General Requirements
  4. Special Design Requirements
  5. Functional Data Sheets

• Appendices
Purpose & Scope

• This UFC contains guidance for planners, engineers and architects

• Air Traffic Control (ACT) houses equipment and personnel for control of aircraft in the air and on the ground

• Radar Approach Control Facility (RACF)

• Air Operations Building (AOB)
Air Operations Facilities & Infrastructure
Planning & Coordination

• Size per UFC 2-000-05N and UFC 3-101-01

• Consult NIWC for required ATC equipment & siting

• The Control Cab is often prefabricated
Planning & Coordination

- Coordinate if FAA and ATC equipment will need to be relocated from existing facilities, or procured and installed in the new facility.

- Coordinate if existing ATC requires continuous operation.
Planning & Coordination

• An elevated structure with unobstructed line-of-sight of the entire airfield

   – Approach areas
   – Runways and Taxiways
   – Aircraft movement and Parking areas
Planning & Coordination

• Tower Location and Height
  – Entry Level, Intermediate Levels and the Control Cab
  – Set by the siting report (IAW 3-260-01) by Asset Management and NIWC
  – Signed off on by Base/Station Commanding Officer
Table 2-1 ATCT Cab Controller and Space Allowances

<table>
<thead>
<tr>
<th>ATCT Service Criteria</th>
<th>Typical ATC Controller Positions</th>
<th>Cab Area (SF)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Army</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Cab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 positions and 1 supervisor</td>
<td>4</td>
<td>600 Max NSF (^2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Based on AR 420-01 and TC 3-04.81</td>
</tr>
<tr>
<td><strong>Navy</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Small Cab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 positions and 1 supervisor</td>
<td>3</td>
<td>370 GSF (^3)</td>
</tr>
<tr>
<td>Standard Medium Activity Cab</td>
<td>4</td>
<td>500 GSF</td>
</tr>
<tr>
<td>3 positions and 1 supervisor</td>
<td></td>
<td>Based on NAVAIR 80-T-114</td>
</tr>
<tr>
<td>Standard Large Cab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 positions and 1 supervisor</td>
<td>5</td>
<td>620 GSF</td>
</tr>
<tr>
<td><strong>Air Force</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Cab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 positions and 2 supervisors (including SOF – Supervisor of Flying)</td>
<td>5</td>
<td>540 NSF + 64 NSF for each additional position</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Based on AFMAN 32-1084</td>
</tr>
</tbody>
</table>
### Table 2-2 ATCT Functional Program Areas

<table>
<thead>
<tr>
<th>Functional Program Area</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Entrance Lobby/Vestibule (Table 5-1.1)</td>
<td>Main entrance to the ATCT. Include vestibule in cold weather climates.</td>
</tr>
<tr>
<td>Elevator and Elevator Lobby (Table 5-1.2)</td>
<td>One (1) elevator must be provided to service the ATCT. Elevator service is not required to serve the Control Cab and the floor immediately below the Control Cab. However, if a hydraulic elevator is used, the elevator can serve all floors including the one immediately below the Control Cab.</td>
</tr>
<tr>
<td>Elevator Machine Room (Table 5-1.3)</td>
<td>A room housing elevator machine equipment.</td>
</tr>
<tr>
<td>Tower Shaft Mechanical Room (Table 5-1.4)</td>
<td>A room housing mechanical equipment servicing the Tower Segment with a lockable door.</td>
</tr>
</tbody>
</table>
Planning & Coordination – Figure 2-1
Planning & Coordination – Figure 2-3

- Building Restriction Line
  - 7:1 Transitional Surface or
  - 150 FT Inner Horizontal Surface

- Air Terminal / Antenna Height
- Tower Height
- OSHA Compliant Industrial Guardrail
- Recessed Window Shade
- Unobstructed Vertical View Angle
  (Actual Angle Shall Be Determined During Planning/Design Phase)
- Eye Level
  (See Figures 4.2 & 4.3)
- Unobstructed Vertical View Angle
- OSHA Compliant Industrial Guardrail
- Exterior Catwalk

- Roof Hatch and Ladder
- Cab Console
- Raised Access Flooring
Planning & Coordination – Figure 2-4 – 2-7
Chapter 3 contains the General Architectural and Engineering requirements

- Critical spaces include the Control Cab, Communications Equipment Room, RACF Operations/IFR Room, UPS/Battery Room and all ATC Electronic Equipment Rooms
- All mechanical equipment and electrical power provided to ATC and Air Operations Facilities is considered “Essential”, requiring back-up HVAC and an Emergency Generator.
Special Design Requirements

• Risk Category III or IV? (Table 2-2)
• AT Progressive Collapse? Or less than 11 occupants?
• Accessibility for the Disabled (not req’d to cab or level immediately below the cab)
• Control Cab
  – Raised access flooring with static dissipation
  – Sound dampening surfaces where possible
  – Non-reflective surfaces (dark acoustical ceiling tile)
Special Design Requirements – Windows

• All sides of the Control Cab
• Minimize depths of frames, sills and ledges
  – Set sills and consoles at the same height
  – Sills must be capable of supporting 250# for personnel to stand upon while cleaning
  – Sills covered with durable, non-reflective mat’l
• Minimize size and intermediate mullions (dark, non-reflective)
• Operable window shades required
Special Design Requirements – Cab Glass

- **Low-iron glass** (no tint or heat strengthened)
- **Low-E coated glass** may be used
- **Double pane** (laminated or insulated)
- **Slope outward 15 degrees from vertical at top**
- **Frame bonded to the glass** (airtight, water proof and vapor proof)
- **Allow light gun red, white & green light** to pass
- **Designed for Wind, Seismic and AT loads**
Special Design Requirements - Lighting

- Compatible with night vision goggles
- Focused Lighting
  - Illuminate controller positions without shadows or reflections and with individual intensity control
- Non-Focused Lighting
  - General use lighting with intensity control (cover)
- Lighting for other spaces, exterior lighting, FAA obstruction lighting and signal light guns
Special Design Requirements

• Refer to Chapter 4 for additional detailed specific requirements for:
  – Access, catwalks, stairs, elevators
  – Utility chases, pathways
  – Alarms, Safety, security
  – Architectural and Engineering requirements
### Functional Data Sheets

#### Table 5-1.1 ATCT – Main Entrance Lobby/Vestibule

<table>
<thead>
<tr>
<th>Description / Usage</th>
<th>Main entrance to ATCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling Height</td>
<td>8'-0&quot; minimum</td>
</tr>
<tr>
<td>Windows</td>
<td>Not required</td>
</tr>
<tr>
<td>Doors</td>
<td>Minimum 42&quot; W x 96&quot; H opening – provide vestibule in cold weather areas</td>
</tr>
<tr>
<td>Interior Construction / Built-In Equipment</td>
<td>Building directory and bulletin board</td>
</tr>
<tr>
<td>Finishes</td>
<td></td>
</tr>
<tr>
<td>Walls</td>
<td>Plaster or GWB - painted</td>
</tr>
<tr>
<td>Floor</td>
<td>Hard surface (terrazzo, VCT, etc.)</td>
</tr>
<tr>
<td>Base</td>
<td>Terrazzo, rubber or vinyl</td>
</tr>
<tr>
<td>Ceiling</td>
<td>Acoustical ceiling tile or painted GWB</td>
</tr>
<tr>
<td>Plumbing</td>
<td></td>
</tr>
<tr>
<td>HVAC</td>
<td>Heating and Cooling (heating only in vestibule)</td>
</tr>
<tr>
<td>Fire Protection and Life Safety</td>
<td>Wet-pipe, automatic fire suppression sprinkler system</td>
</tr>
<tr>
<td>Power</td>
<td>Standard power for office-type areas</td>
</tr>
</tbody>
</table>
Appendix B – Best Practices

• During the planning/DD 1391 development process, the planner should contact appropriate local personnel to discuss and finalize specific space requirements.

• For the ATCT, the circulation factor is greater than normal due to limited building footprint.

• After site selection and issuance of siting report, with tower height, the planner can determine the number of floors and area in the ATCT.
Appendix B – Best Practices

- Minimize AT/FP requirements, if possible
- Plan cable tray layout, routing and distance
- Duct banks require both fiber and copper, make sure there is adequate future duct bank
- Review section on “Work Not Included in Construction Contract”
Part 1 Notes to Editor/Designer:
- List of information to be included in the drawings

Submittals Include:
- Professional Sealing Req’ts (delegated design)

Design Requirements:
- Wind and Blast Pressures (as applicable)
  - Basic (ASTM E1886)
  - Enhanced (ASTM E1996)
- Quality Assurance (QA):
  - 5 years experience by Manufacturer / Installer
  - 10 year Warranty
Part 2 Notes to Editor/Designer:
- Must set requirements for Delegated Design
- Component Requirements:
  - Glass Materials
  - Tower Cab Glass Assemblies
  - Setting and Sealing Materials
  - Fabrication

Part 3 Execution Requirements
- Preparation, Glass Setting, Cleaning, Protection
- Maintenance Manuals
UFC 4-212-01N Navy Engine Test Cells

• Chapters:
  1. Introduction
  2. T-10 Standard
  3. Aircraft Acoustical Enclosure
  4. Outdoor Unabated Power Check Facility
  5. Jet Test Cell Tie Down Testing Requirements
  6. Inspection, Test Procedures...

• Appendices
• Drawings are considered non-deviational.
  – Specialized knowledge and expertise are required to design, inspect and accept jet engine test cell facilities
  – The mission of aircraft engine test facilities dictates that senior level Command personnel review and approve technical matters related to jet engine test cell construction
NAVFAC Standard Jet Engine Test Cell

- Test Cell Enclosure (Run Room & Air Intake)
- Exhaust Stack
- Control Room
- Fuel Source
- Air Start
- Augmentor
NAVFAC Standard Jet Engine Test Cell
NAVFAC Standard Jet Engine Test Cell
NAV FAC Standard Jet Engine Test Cell
NAVFAC Standard Jet Engine Test Cell
NAVFAC Standard Jet Engine Test Cell
NAVFAC Standard Jet Engine Test Cell
T-10 Standard Jet Engine Test Cell

• List of NAVFAC Standard Drawings are included in Paragraph 2-4
• List of NAVFAC Standard Specs are included in Paragraph 2-5
Aircraft Acoustical Enclosure

• List of NAVFAC Standard Drawings are included in Paragraph 3-4
  – List of NAVFAC Standard Specs are included in Paragraph 3-5
Aircraft Acoustical Enclosure
Outdoor Unabated Power Check Facility

–List of NAVFAC Standard Drawings are included in Paragraph 4-4
This chapter provides basic criteria and information for the testing of Navy/Marine Corps aircraft and engine restraints used in Jet Engine Test Cells, Unabated Power Check Facilities, and Aircraft Acoustical Enclosures.
• INSPECTION, TEST PROCEDURES AND RECOMMENDED PROOF TEST ASSEMBLY
  – The purpose of the proof load test system is to permit an initial and subsequent structural integrity test of T-56 tie-down fittings.
Appendix B – T-10 Utilities

• The buildings are extensions of the aircraft. Building instrumentation and controls must run the engine the same way the aircraft does.
• The building utility systems must be pure so as not to contaminate the engine.
• The fuel system is calibrated so as to provide the exact flow rate the operator calls for.
• All logic within the controls must be field verified by the commissioning process.
Appendix B – T-10 Safety

• The doors are interlocked to prevent someone from entering run room during engine testing.

• The Run Room wall panels are protected by amour plate that protects personnel and equipment (against engine rupture failure and engine disintegration during blade out from a catastrophic engine failure).

• All fasteners are captivated to prevent accidental loss and F.O.D. potential.
Appendix B – T-10 Temperature

- Design entire building for expansion and contraction due to temperature differential caused by engine testing.
- Building temperatures in the Run Room can reach temperatures up to 200 degrees F.
- Design augmenter for 500 degree F temperature change.
- It is essential for Augmenter centerline & the engine restraint system centerline to coincide to prevent uneven heat distribution of the augmenter.
Appendix B – T-10 Fire Protection

• The fire detection/suppression system is critical to the safety of personnel & equipment.

• Fire suppression system is interlocked with fuel system to provide for a controlled engine shut down.

• Small engine fires are extinguished by the fire suppression spurt system.

• Water deluge is activated in the event the spurt system fails to extinguish the fire.
Appendix B – T-10 Air Flow

• Test Cell Enclosure is designed for 4” of water cell depression; inlet velocity should be less than 50 feet per second

• Test Cell has a standard airflow configuration enabling the engine to be tested within 3% of gold plate data for standard day & temperature

• Noise Criteria: not to exceed 85 decibels at 250 feet
Section 8 – Closing
Thoughts, Questions & Feedback

Aircraft Hangars & Other Airfield Structures

2/18/2020
Closing Thoughts

• Hangar Size Standards

  – Concern raised that some auditors reference UFC 4-211-01 regarding hangar sizes. They should be alerted to that this is only pass-through information.
  – Asset Management (AM) manages hangar module sizes in UFC 2-000-05N which is the controlling document for hangar size.
  – UFC 4-211-01 Table 7-1: Standard Hangar Bay Module Dimensions and Crane Capacities* indicates to see AM UFC for wider increments.
Closing Thoughts

• UFC and FRD Requirements Hierarchy
  – Generally the order of design requirements starts with UFC 1-200-01 which references “core UFCs” then you would go to a “facility-type” UFC like Hangar UFC 4-211-01, and finally a platform requirements document like the FRD. The contract RFP needs to call these documents out.

• Don’t deviate from design. Get Designer of Record approval on changes.

• Enforce certifications involving design in spec
Closing Thoughts

• Always validate that you are using current requirements by downloading from WBDG.org.

• Look for Interim Technical Guidance Documents.

• Check with criteria managers.

• If you have a SCIF/SAPF: assign a Site Security Manager during the planning phase and ensure their involvement throughout the project.