AIRCRAFT HANGARS AND OTHER AIRFIELD STRUCTURES

Aircraft Facilities Planning and Design Criteria Training

Fall 2023

NAVFAC
AIRFIELD FACILITIES PLANNING AND DESIGN CRITERIA TRAINING

COURSE SCHEDULE

DAY 3 (7 FEB 24)			
AIRCRAFT HANGARS AND OTHER AIRFIELD STRUCTURES			
Section	**Time**	**Title**	**Content**
	0830-0845	Doors Open	• Setup
1a	0845-0915 (0:30)	Welcome, Schedule Review, Course Logistics	• Introduction • Facilities • Syllabus / Agenda
1b	0915-1045 (1:30)	Aircraft Maintenance Hangars (Planning)	• UFC 4-211-01 (and UFC 2-000-05N) ○ Applicability ○ Planning and Layout
	1045-1100	BREAK	
2	1100-1200 (1:00)	Aircraft Maintenance Hangars (Design)	• UFC 4-211-01 ○ Design Requirements for Navy Hangars – with select comparisons to Air Force
	1200-1300	**LUNCH**	
2 (cont)	1330-1430 (1:00)	Aircraft Maintenance Hangars (Design)	• UFC 4-211-01 ○ Design Requirements for Navy Hangars – with select comparisons to Air Force
	1430-1445	BREAK	
2 (cont)	1445-1545 (1:00)	Aircraft Maintenance Hangars (Design)	• UFC 4-211-01 ○ Design Requirements for Navy Hangars – with select comparisons to Air Force
	1545	**End of Day 3**	

NAVFAC
AIRFIELD FACILITIES PLANNING AND DESIGN CRITERIA TRAINING

COURSE SCHEDULE

DAY 4 (8 FEB 24)			
AIRCRAFT HANGARS AND OTHER AIRFIELD STRUCTURES			
Section	**Time**	**Title**	**Content**
	0830-0845	Doors Open	• Setup
2 (cont)	0845-0945 (1:00)	Aircraft Maintenance Hangars (Design)	• UFC 4-211-01 ○ Design Requirements for Navy Hangars – with select comparisons to Air Force
3	0945-1045 (1:00)	Aircraft Maintenance Hangar (Hangar Doors)	• UFC 4-211-01 (continued) ○ Hangar Door Selection, Requirements ○ UFGS 08 34 16.10 Steel Sliding Hangar Doors ○ UFGS 08 34.16.20 Vertical Lift Fabric Doors
	1045-1100	BREAK	
4	1100-1130 (0:30)	Aircraft Corrosion Control and Paint Facilities	• UFC 4-211-02 and UFGS 08 34 16 ○ Applicability ○ Facility Function, Layout and Adjacencies ○ System Function and Requirements ○ Best Practices ○ UFGS 08 34.16 Corrosion Control Hangar Doors
6 (out of order)	1130-1200 (0:30)	Air Traffic Control and Air Operations Facilities	• UFC 4-133-01 and UFGS 08 88 58 ○ Applicability ○ Planning and Layout ○ Design Requirements ○ Best Practices
	LUNCH (1200-1300)		
5	1300-1345 (0:45)	Aircraft Protective Equipment	• UFGS 13 31 33 Frame Supported Membrane Structures For Protection Of Aircraft
7	1345-1415 (0:30)	Navy Engine Test Cells	• UFC 4-212-01N ○ Types of Test Cells ○ Standard Designs and Drawings
	1415-1430	BREAK	
8	1430-1530 (1:00)	Key Take-Aways, Lessons Learned, Closing Thoughts, Questions & Feedback	• Hangar Maintenance / Service Contracts • Waivers and Exemptions • Closing Thoughts • Final Questions • Feedback Request


NAVFAC
Naval Facilities Engineering Command
Aircraft Hangars & Other Airfield Structures
Airfield Planning and Design Criteria Training
9/19/2023

This class would not have happened without the effort of George to obtain funding and contracts. George has provided great oversight and involvement in this process and worked with CMT/FSB to develop the course material based upon the criteria and the collective wisdom of all parties. So my sincere gratitude for their contributions to the success of this program.

- George – overall manager for airfield criteria documents

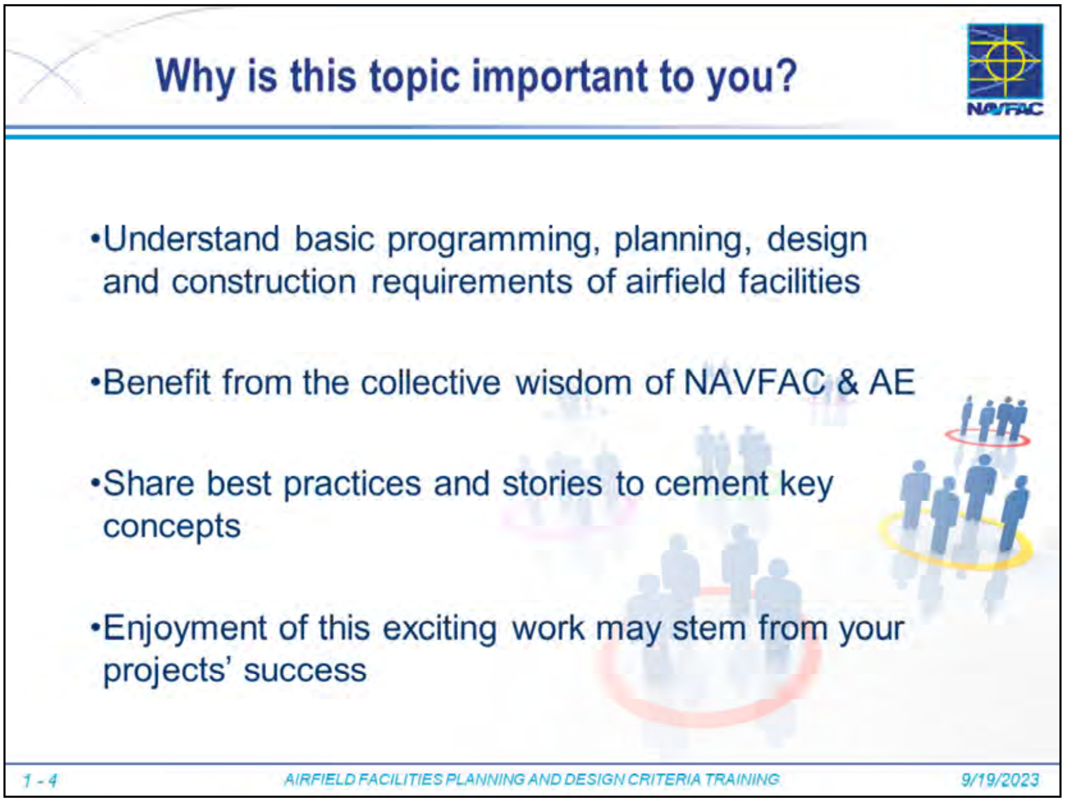
Introductions

Gene O. Brown, PE, LEED AP

President and CEO at FSB Architects and Engineers
Oklahoma City, OK
Email: gbrown@fsb-ae.com
Phone: 405.840.2931

Define Design Deliver

- **25+ Years Experience**
  - **Licensed Professional Engineer (20 States), Licensed Structural Engineer (OK) and a LEED® AP**
  - **Published in The Military Engineer, Architectural Record, Modern Steel Construction, and Civil Engineering Magazine; a Speaker at SAME and serve on a State Board of Engineering**
  - **Professional Advisory Council at OSU School of Architecture**
  - **Firm has completed over $7B in design of Aviation Facilities**
    - Aircraft Maintenance (Hangars), Squadron Operations/Mission Support, Air Mobility/Warehouses, Flight Simulators, etc.



<u>As a DoD employee with potential for doing airfield work:</u>

Essential for you to know about the basic programming, planning, design and construction requirements of various airfield facilities

Benefit from the collective wisdom of NAVFAC & AE as we share best practices and stories of lessons learned from past projects to help cement these concepts

Project success and your enjoyment of this exciting work will stem from your exposure to these project requirements

Learning Objectives

Navy Airfields
Understanding of the types of aviation facilities

Criteria
Exposure to related reference material (UFC & UFGS)

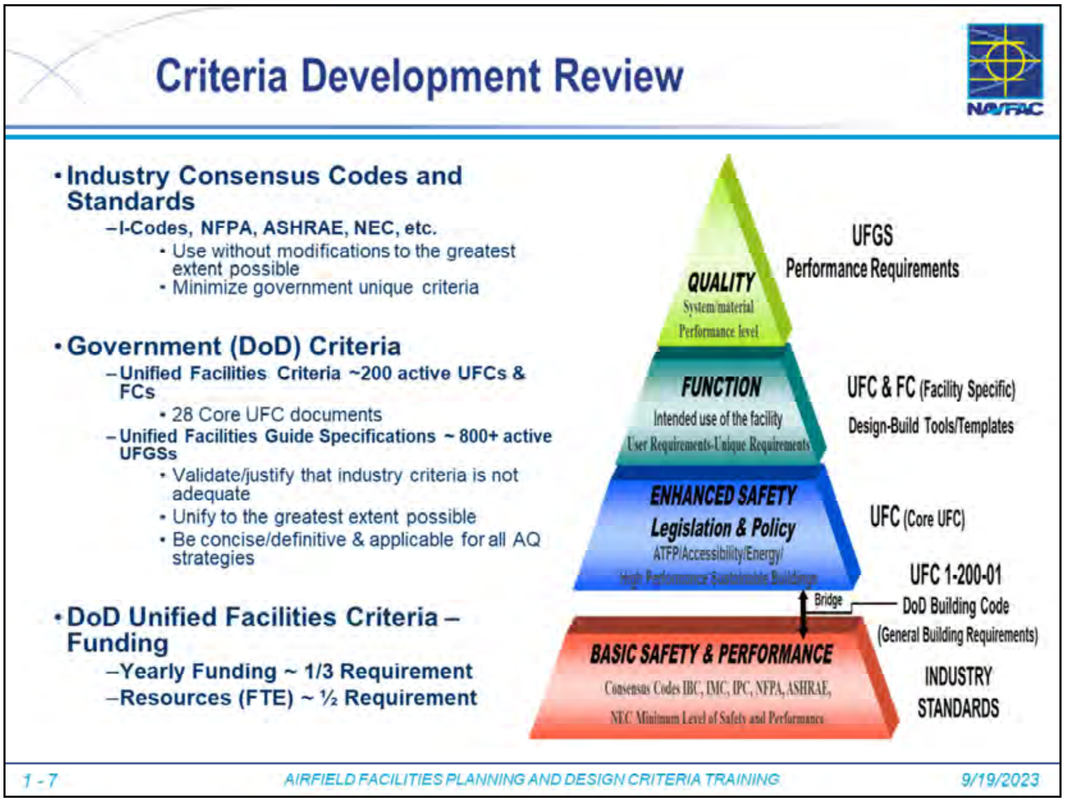
Planning
Gain insight into the aviation facility planning process

Design
Learn about the key design elements in aviation facilities

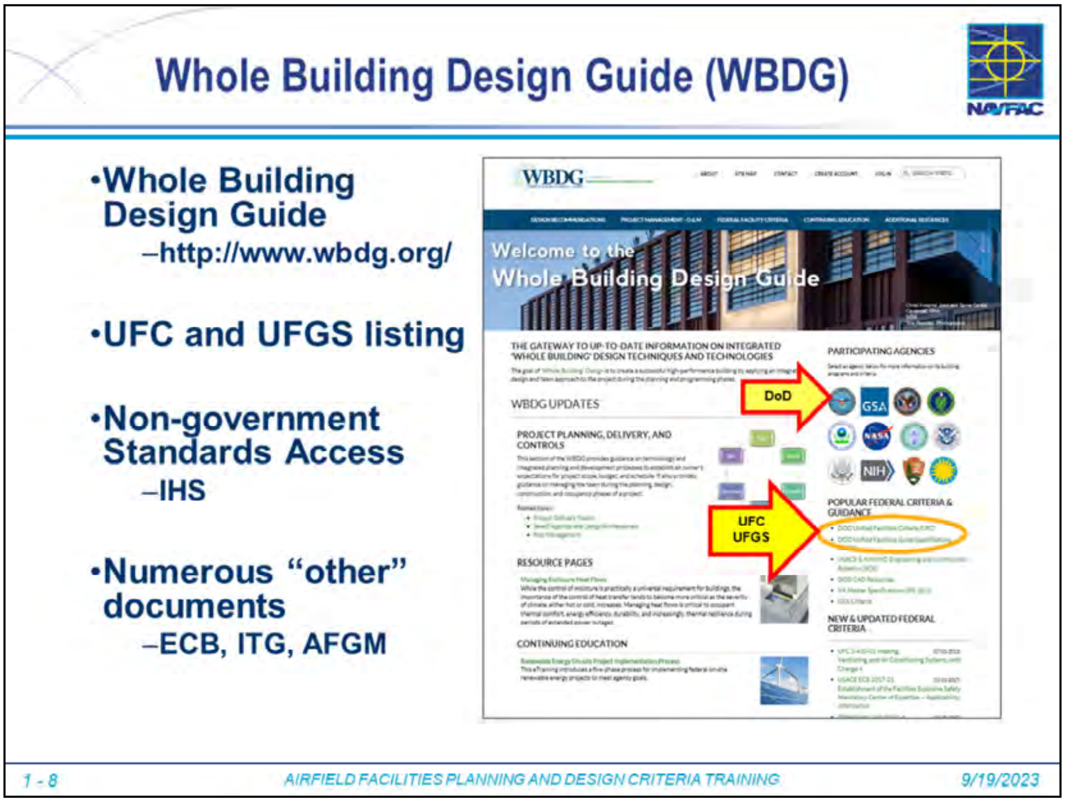
Best Practices
Benefit from past projects and lessons learned

NAVFAC invested in developing this course for the following reasons:

- Develop expert planners and designers
    - NAVFAC needs to be best at military aviation facilities
    - If we are not…who is?
- Aircraft are High Value Assets
    - Maintenance and mission training, Strategic importance and Evolving fast and proliferating
- Platform Build Out (still time to improve)
    - F-35 Program is 40%
    - And P-8, Triton, CV-22 and MQ-25
- Aviation Facility Design Issues and Failures
    - F-35 cooling air system (abandoned & ITG 19-01)
    - Pavement failures (F-35, P-8)
- Excessive Airfield Waivers from Poor Planning
    - Lack of awareness on basic clearances
    - Avoidable waivers cause project delays, costs, etc.
    - Make NAVFAC look incompetent in applying its own criteria.
    - Waivers mean accepting added risk.



1. Graphic shows how criteria is layered
2. Starts w/ Industry standards and layers government policy, then facility-type lessons learned.

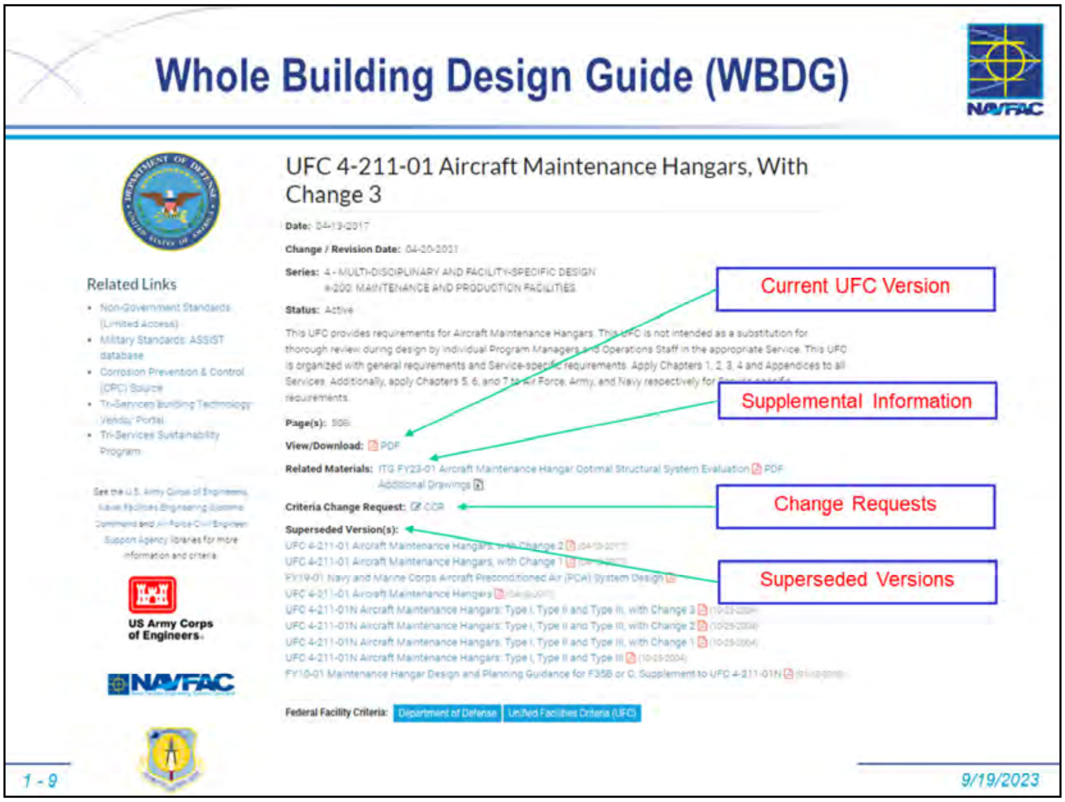


All criteria and CCRs reside on WBDG

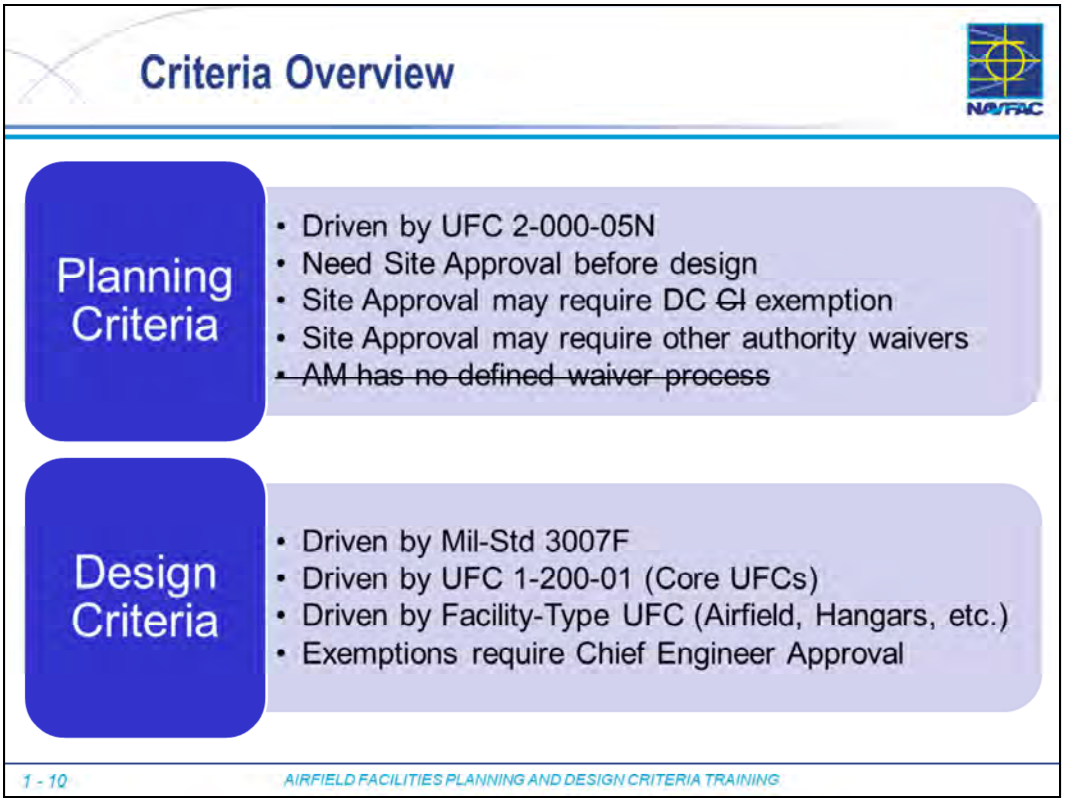
Navy issues interim technical guidance (ITG)

Army issues engineering construction bulletins (ECB)

Air Force issues guidance memorandums (AFGM)

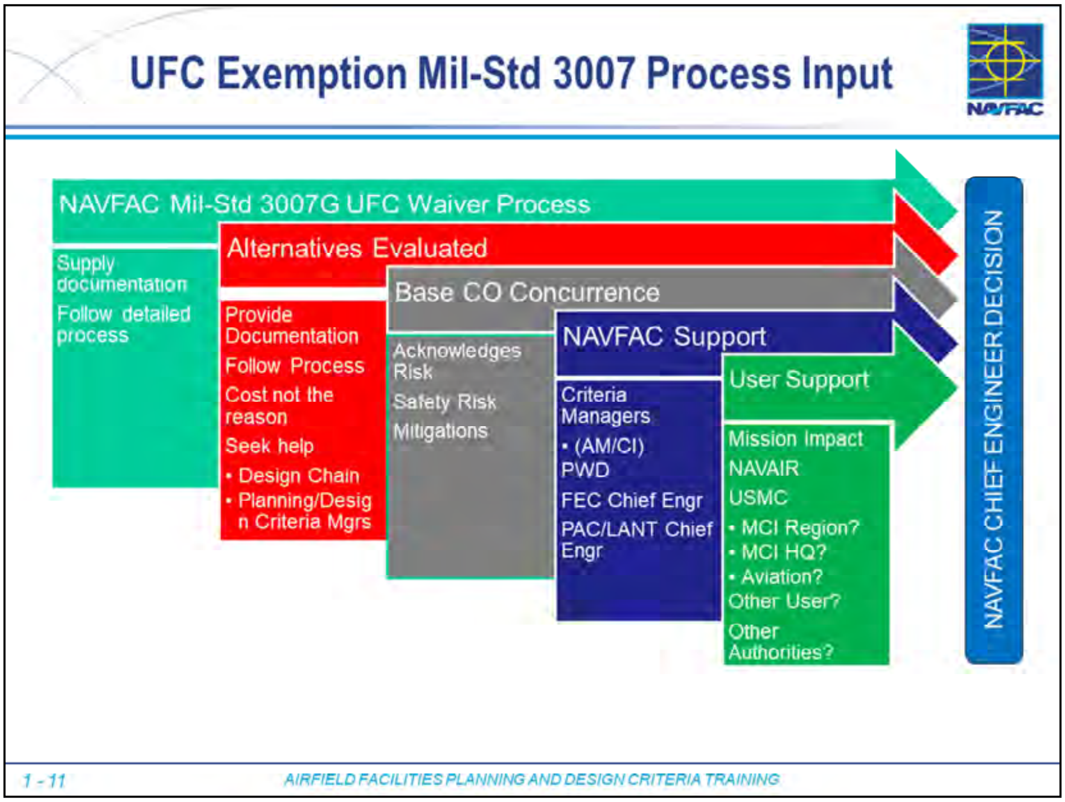


- Key information about a UFC is listed on each UFC home page
  - Current Version date and link to pdf
  - Related Materials like Interim Technical Guidance
  - Change Request Button link to CCR Form
  - Superseded Versions

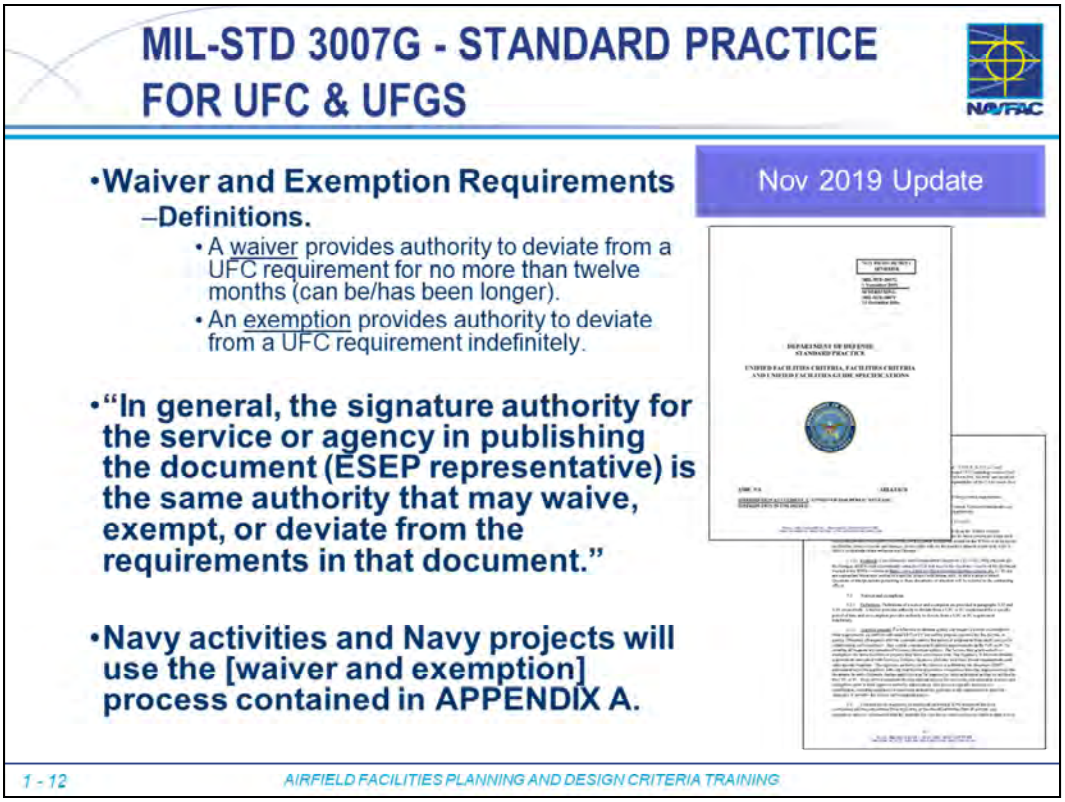


Two major types of criteria for compliance

- Planning
- Design
- For hangar design, likely would be dealing with Design Criteria waiver.
- (siting waiver covered in other class)



- The UFC Exemption shows parallel input required. (Does not require NAVAIR ASW unless siting is issue. See airfield class for processes.)
- Design UFC Exemption issues:
  - Not Common
  - Structural, Mechanical, Electrical, Fire protection Issues.
  - UFC Hangar Type Variation (May require Planning, Design, and Customer support)
    - Cannot provide bridge crane
    - Cannot provide fire protection (facility doesn’t have fueled aircraft)
    - Issues regarding hangar door constraints (opening size)

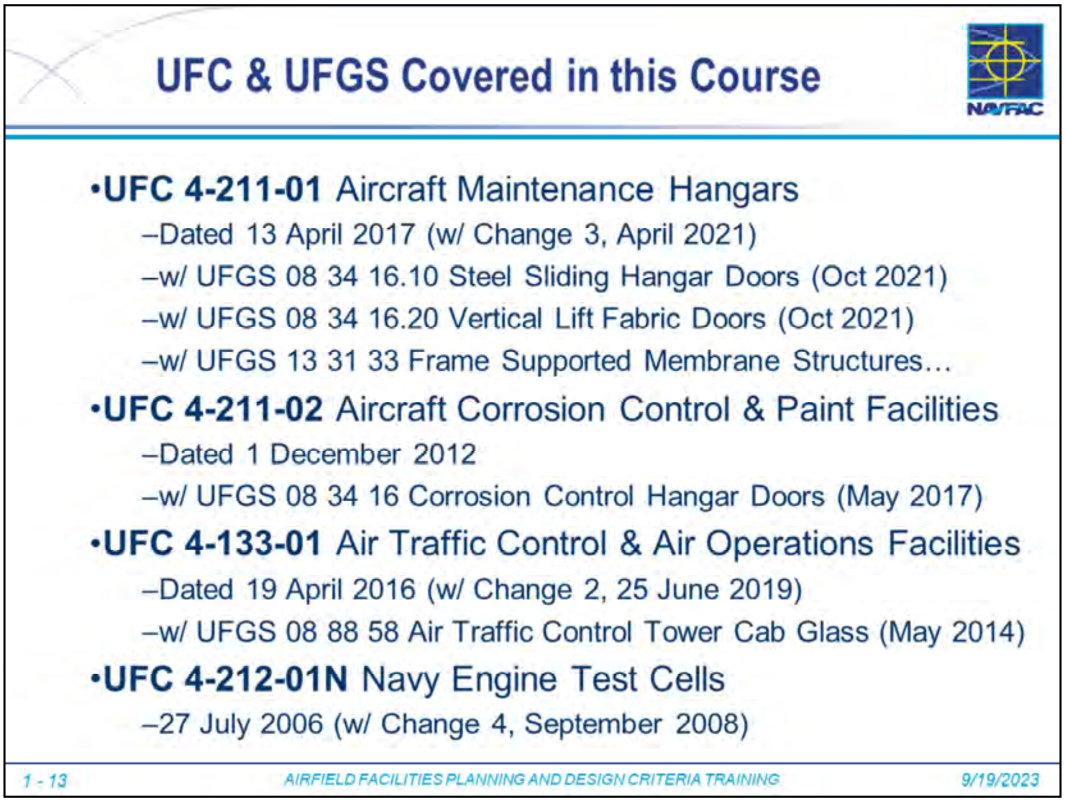


- MIL-STD 3007F Defines the Waiver and Exemption Process for UFC & UFGS
- Gives criteria exemption waiver authority to NAVFAC Chief Engineer
- MIL-STD 3007F was updated/re-published in Nov 2019.

- Although there is a defined process for exemptions and waivers, the main point is to do the thorough planning early to avoid the need for exemptions and waivers.

- If a waiver or exemption is unavoidable, then one package following MIL-STD 3007 and UFC process should be developed during the Site Approval Process and coordination started.

- NAVFAC won't approve an exemption until NAVAIR makes a decision on the need and approval of an Airfield Safety Waiver.



The above documents are all available at www.wbdg.org.

Naval Facilities Engineering Command

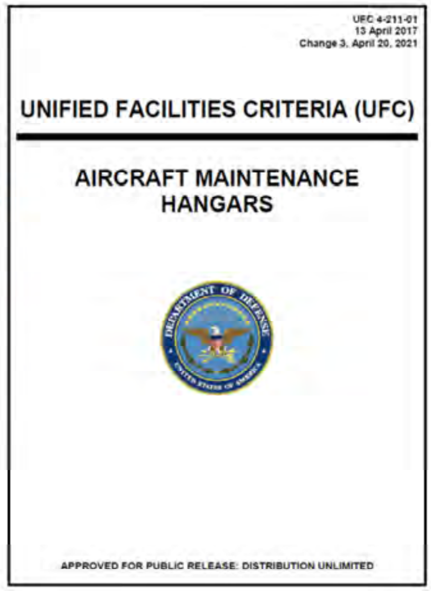
Section 1a – UFC 4-211-01 Introduction

Aircraft Hangars & Other Airfield Structures

9/19/2023

UFC 4-211-01 Aircraft Maintenance Hangars

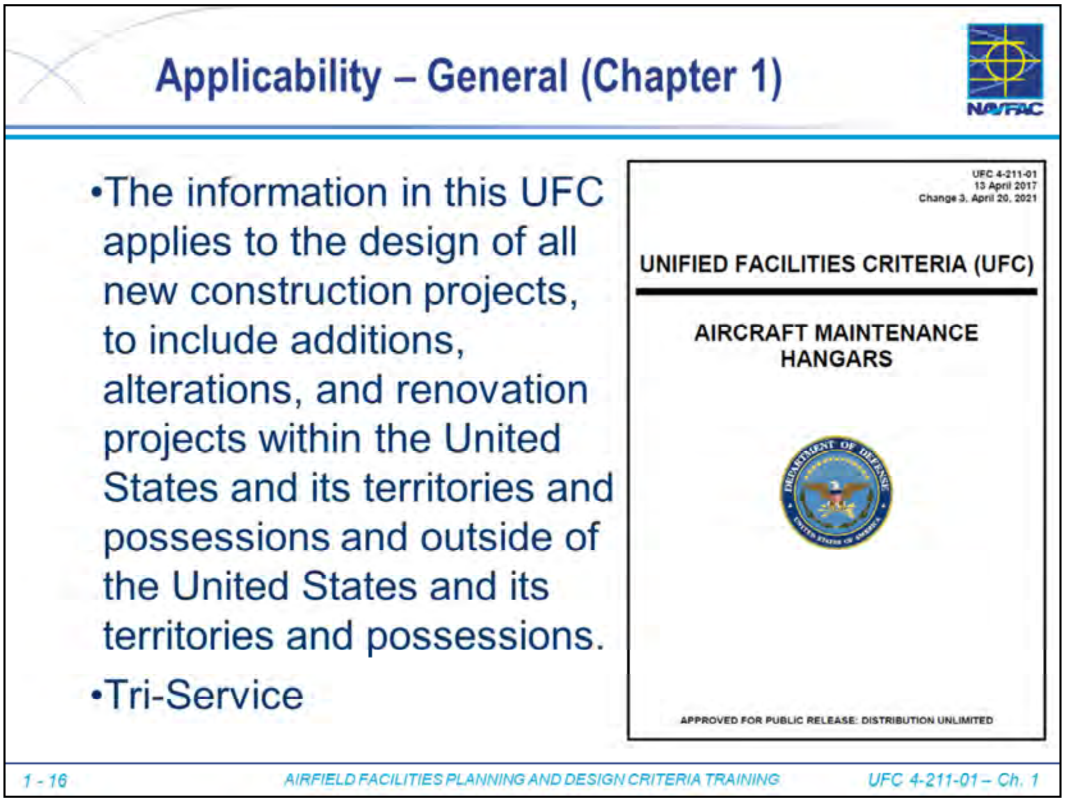
- **Chapters:**
  1. Introduction
  2. Planning and Layout
  3. General Hgr Requirements
  4. Aircraft Specific Req's
  5. Air Force Specific Criteria
  6. Army Specific Criteria
  7. Navy Specific Criteria
- **Appendices**


UFC 4-211-01
13 April 2017
Change 3, April 20, 2021

UNIFIED FACILITIES CRITERIA (UFC)

AIRCRAFT MAINTENANCE HANGARS

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

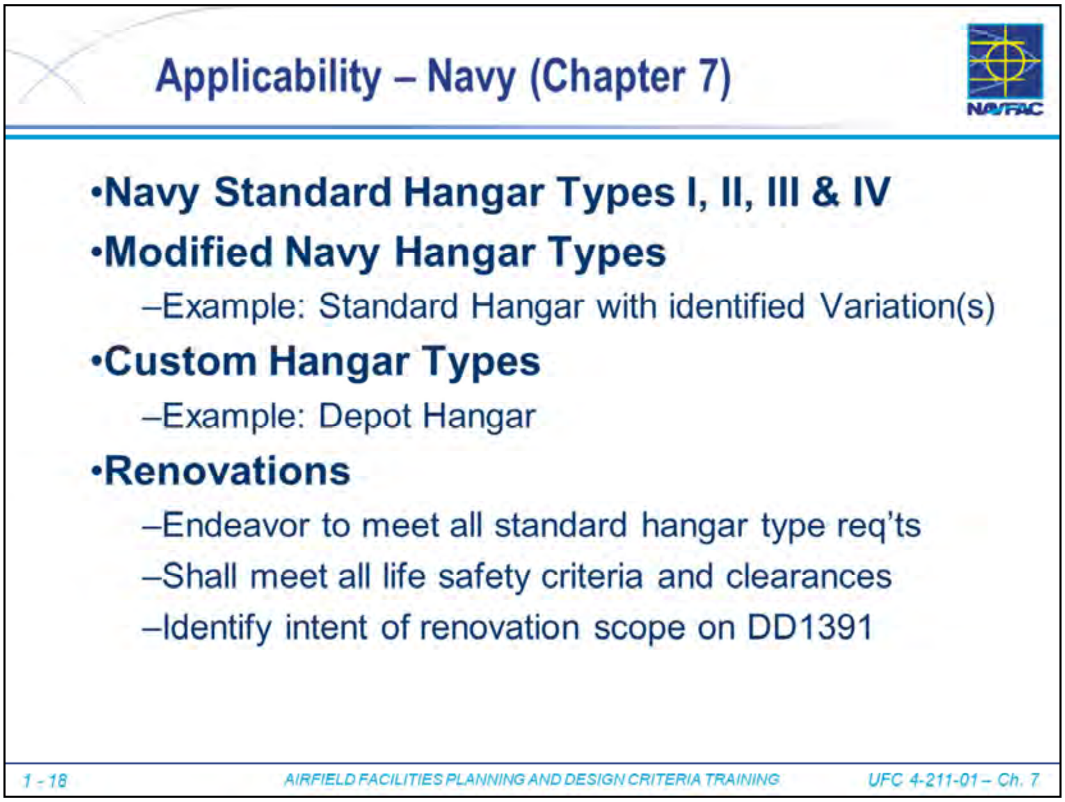


This document applies to all aircraft hangars.

Exemptions to certain requirements may be submitted for consideration where supported and warranted by the mission requirements. See Mil-STD 3007G.

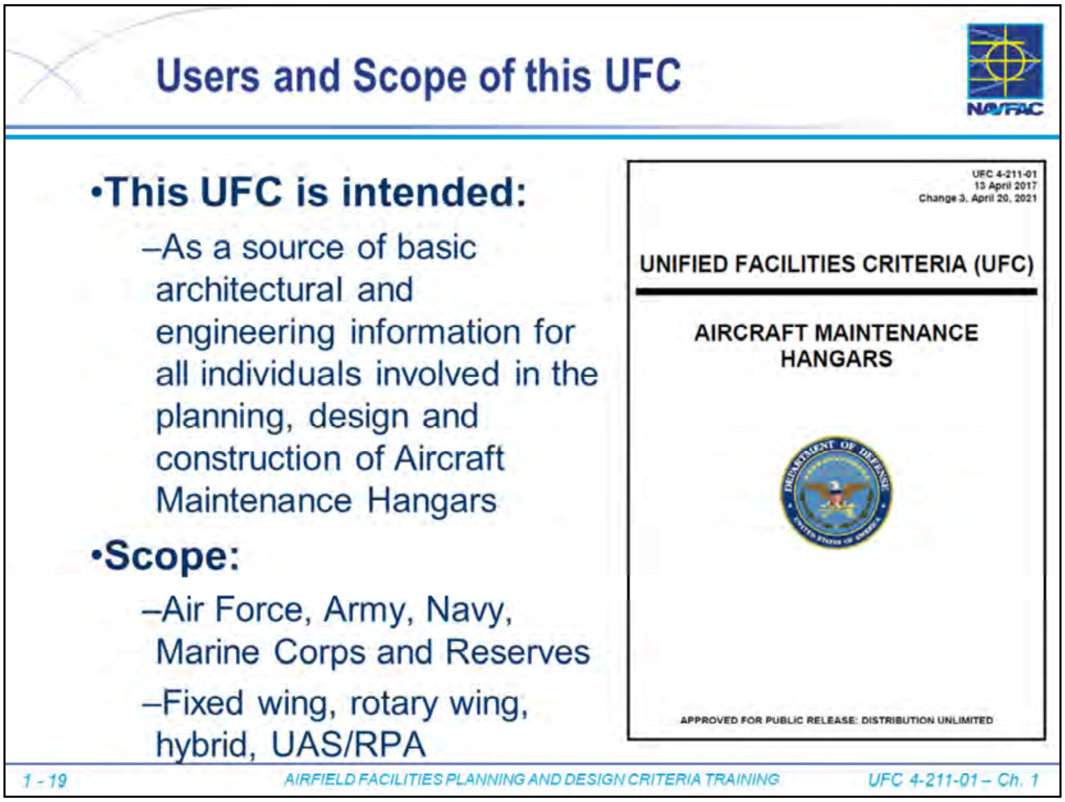
Since the 1990s, the fundamental Navy planning concept is to group similar aircraft by size and function and to establish common hangar bay sizes. This approach allows for some flexibility should there be a change in mission, aircraft layout, or introduction of new airframes during the lifespan of the hangar. The expectation is that if the hangar bay has been designed with adequate flexibility in size, then other renovations to the hangar can be reasonably accommodated for the change in mission. It is understood that there will always be substantial renovation costs to accommodate a new airframe. Hangars also often provide shelter for many different transient aircraft or short duration missions and deployments.

Flexibility of the hangar bay is critical and has been incorporated into these criteria where reasonable. Specific areas of consideration include hangar bay sizes, minimum slab design loading, maximization of door sizes, bridge crane capacities, and elimination of fixed obstructions or other features on the hangar bay floor that would impact revised aircraft layouts. The theory is that multi-purpose hangars with reasonable flexibility that can be utilized through their lifespan. Custom, non-standard, single purpose hangars should be avoided when possible and special caution should be given where frequent airframe changes are expected.



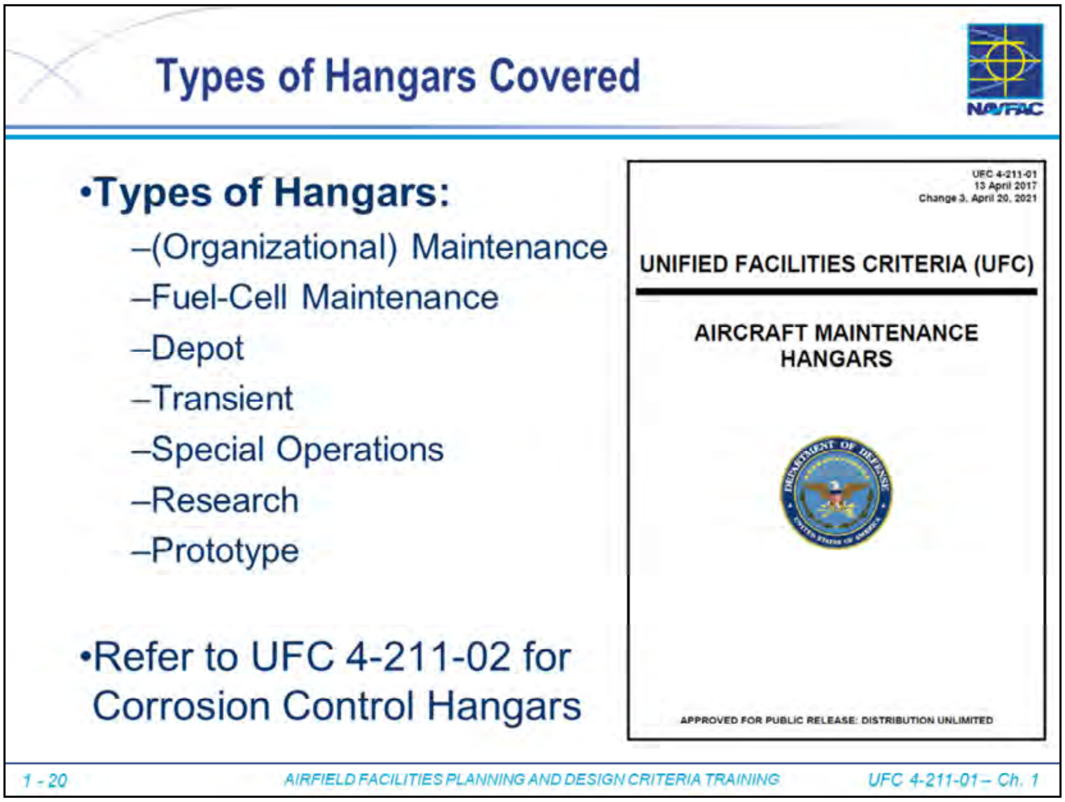
All new Navy and USMC standard hangars must meet all hangar Type I-IV requirements for the respective standard. In any case, design all hangars to accommodate the minimum safety clearances (Table 2-1). Clearances for non-standard hangars should be conservatively selected by comparing the design airframe size to those found in the various standard hangar Types. It is important for the planner to clarify the intent and scope of the renovation, variation and Non-standard on the 1391 planning document.

Renovations Only: Selective portions of this UFC apply only when renovating or re-purposing an existing hangar. As a minimum, comply with all safety and life-safety related criteria (includes, but is not limited to, fire protection, egress, and aircraft minimum clearances). Follow all other criteria of this UFC, including all standard hangar Type requirements (Table 7-1) to the maximum extent practical for the renovation. The intent of meeting all criteria in this UFC is to provide for future hangar flexibility to maintain alternate aviation platforms. If meeting those additional standard hangar Type requirements is not feasible or possible for a renovation project addressing a specific aircraft platform, then it is only necessary to meet the mission requirements for that specific platform and all safety and life-safety criteria as stated above.



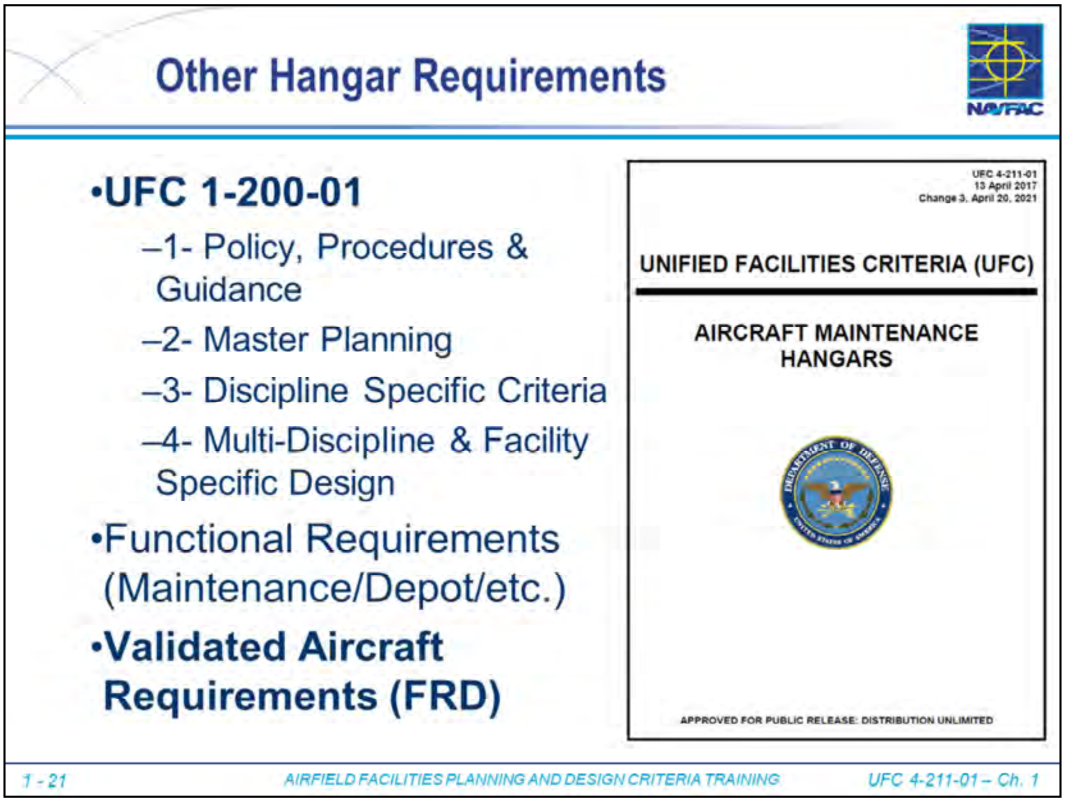
Note: Scope applies to ALL Hangars.

Depot maintenance (for example) would use its own identified requirements along with any requirements specifically connected to Type I, II, II, IV hangars.



Note: While this UFC covers all of these "Hangar Functions", for all hangars in the Tri-Service realm, in the NAVFAC world, there are primarily four standard types of hangars. These NAVFAC Hangar Types were introduced earlier and they will be covered in additional detail later in this presentation.

Air Force distinguishes between Fuel Cell and Organizational Maintenance - In Navy – General and Fuel Cell are both Maintenance Hangars.



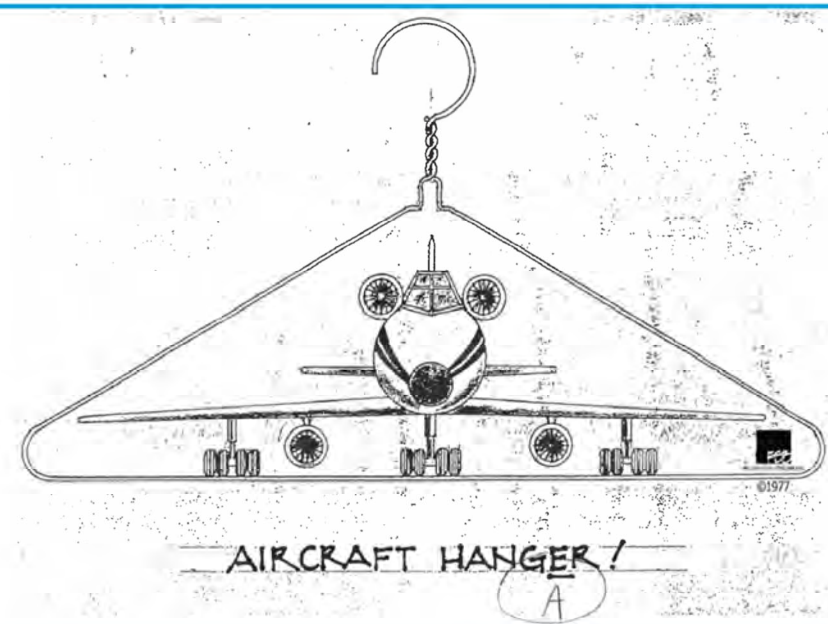
UFC 4-211-01 is a "Facility Type UFC" in that it provides the facility specific requirements which are layered with General Architectural and Engineering Requirements (such as UFC 1-200-01 and UFC 4-010-01) plus specific discipline UFC requirements in 3 and 4 series UFCs.

Remind audience of the criteria pyramid slide covered earlier.

Facility Requirements Document (FRD): the applicable additional (validated) requirements being used from this document should be identified during the planning phase in order to determine facility cost and write SOW for AE/Contractor.

Hangars vs. Hangers

Hangars vs. Hangers



Section 1b – UFC 4-211-01 Planning

Aircraft Hangars & Other Airfield Structures

9/19/2023

Planning and Layout

- Site: Comply with UFC 3-260-01
- Solar Glare Hazard Analysis required for Photovoltaic or Glass-Enclosed Solar
- Nightime Light Hazard Analysis

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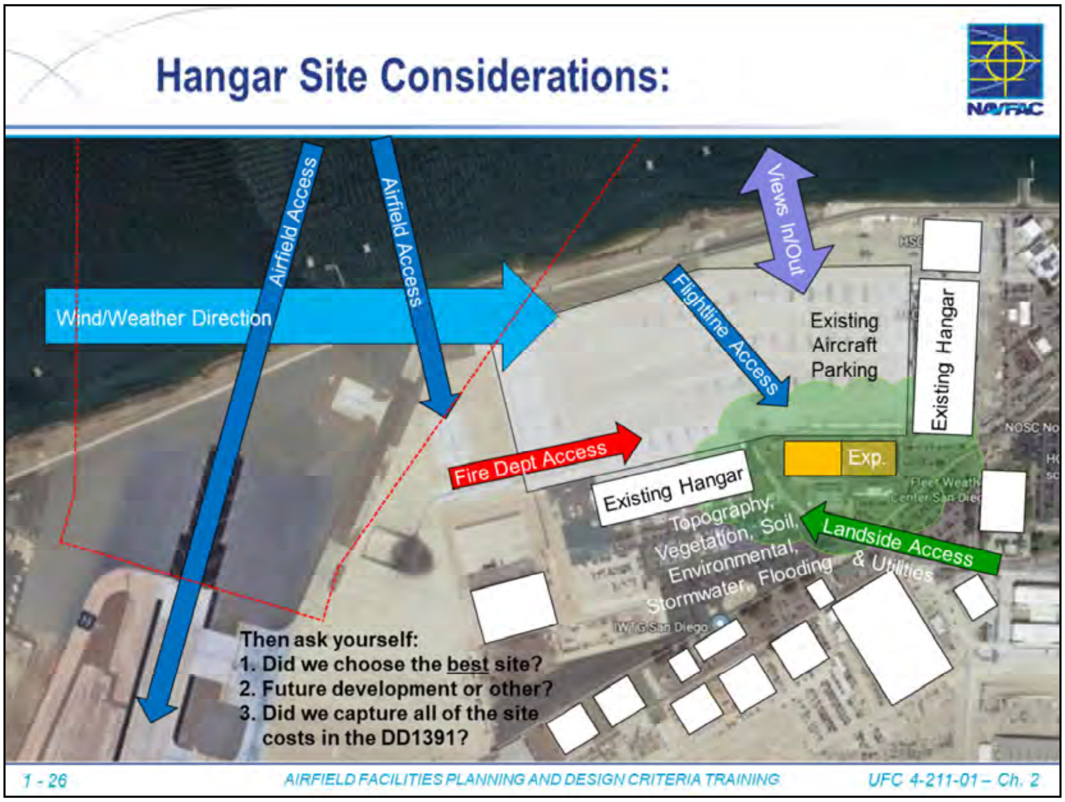
AOA safety and security, Tower site lines, FAA Advisory Circular, etc. (refer to prior coursework)

Photovoltaics shall not block, reflect or disrupt NAVAIDS – coordination is required with AHJ. Photovoltaic or glass-enclosed Solar Hot Water require glare analysis: https://share.sandia.gov/phlux

Minimize operational hazards due to nighttime light pollution emanating from both interior and exterior of facility. During conceptual design, perform computer rendering lighting studies from point of view of Control Tower and Ground Control stations to ensure no hazards exist

Intent: eliminate ocular impact to pilots & ATC

Airfield Manager Approval Required



Existing construction & Adjacent land use

Operation, Function & Expansion (rotary portion of airfield, similar adjacent use)

Availability of usable airspace and flightline access

Access from landside and to Utilities

Safety, Fire Dept & Emergency vehicle access

Predominant weather / wind direction

Topography and Vegetation

Soil Conditions

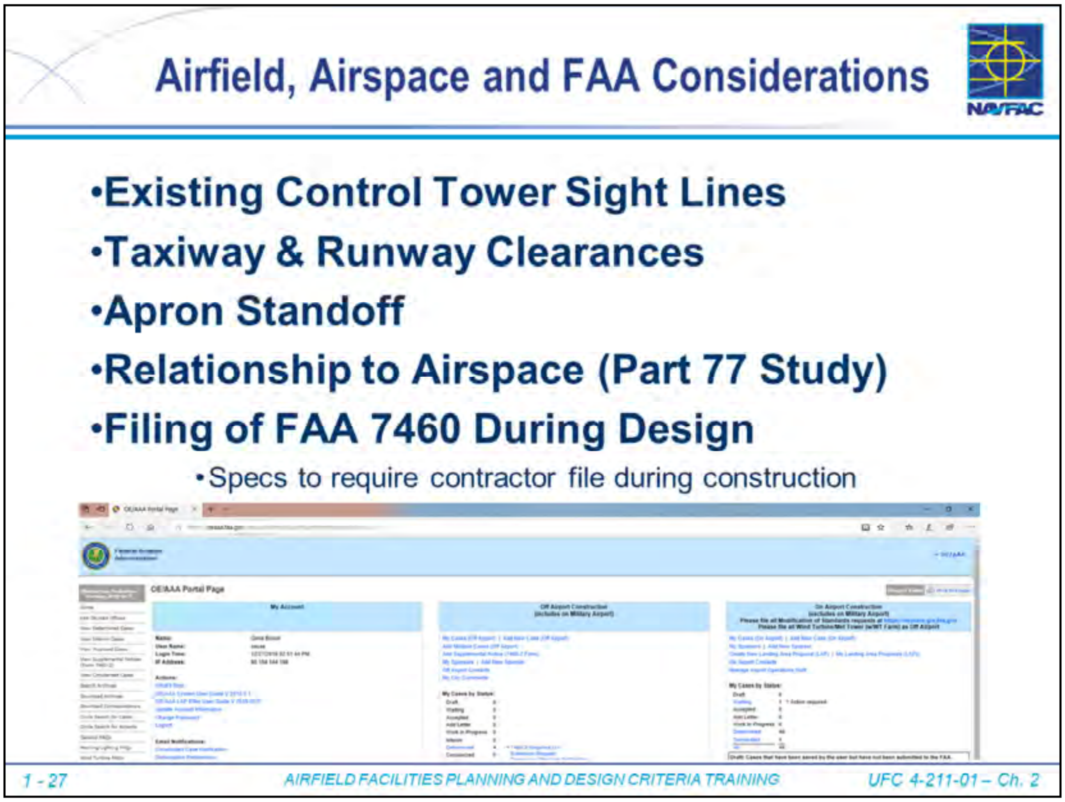
Environmental Conditions

Stormwater and Flood hazards

Views In/Out? Lights In/Out?

Also:

Aircraft Noise, Airfield Clearances, Explosive Arcs



Recommend always performing a Part 77 Study – at planning, at concept design, at schematic design and prior to starting Construction Documents (or issuing an RFP). Recommend filing FAA 7460 as early as possible if there is ANY concern with disruption of navigational aids along a runway.

Does the FAA govern your air traffic/installation?

Does the airport already have issues with navaids?

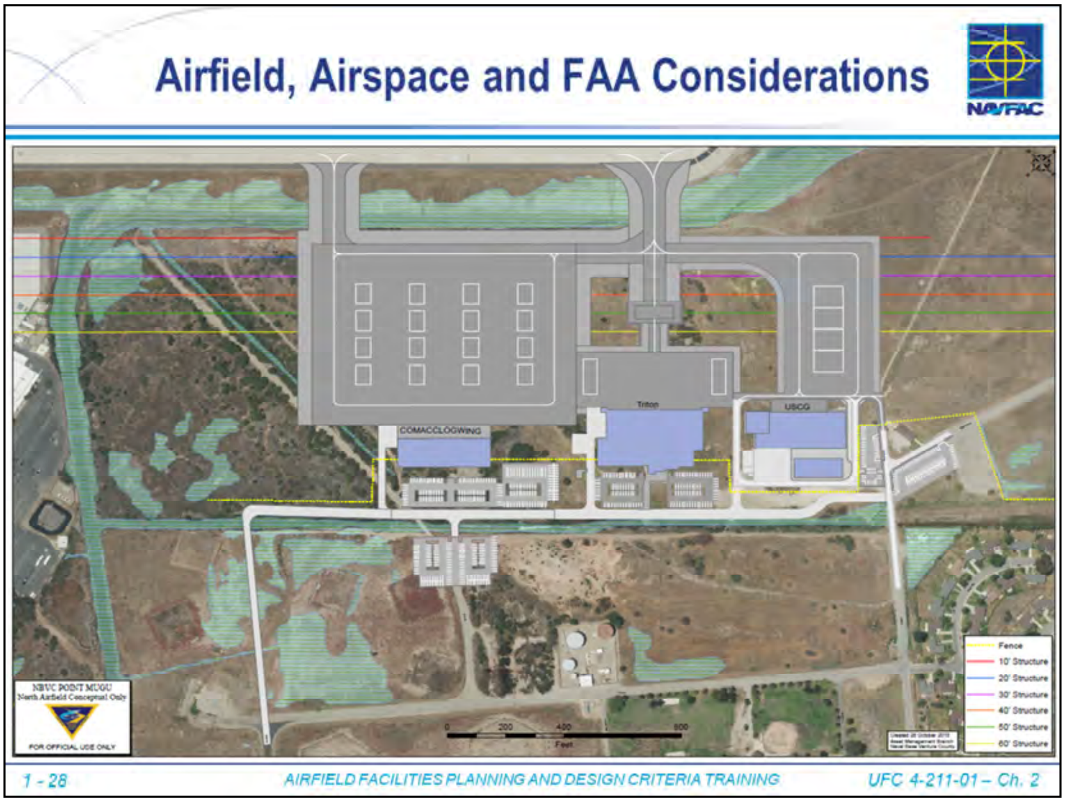
Does the facility have line-of-sight views of the antennae?

Is the facility taller than those around it (top horizontal portion has largest impact)?

Is the facility irregularly shaped?

Will the facility have a lot of large aircraft parked on an apron parallel to the runway?

Recommend requiring the contactor to file during design (AE or DB Contractor) and during construction (Contractor).



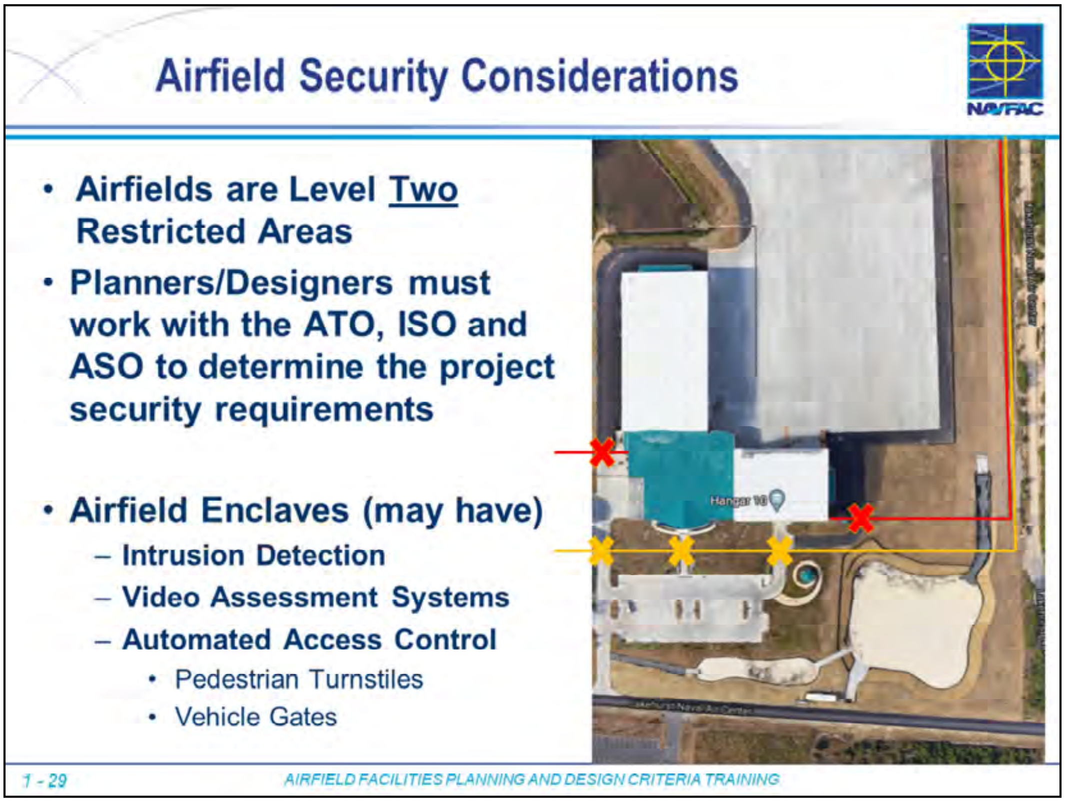
Primary/Transition surface

Hangar Height (including antenna)

Apron with aircraft height

Separation from other aprons/taxiways

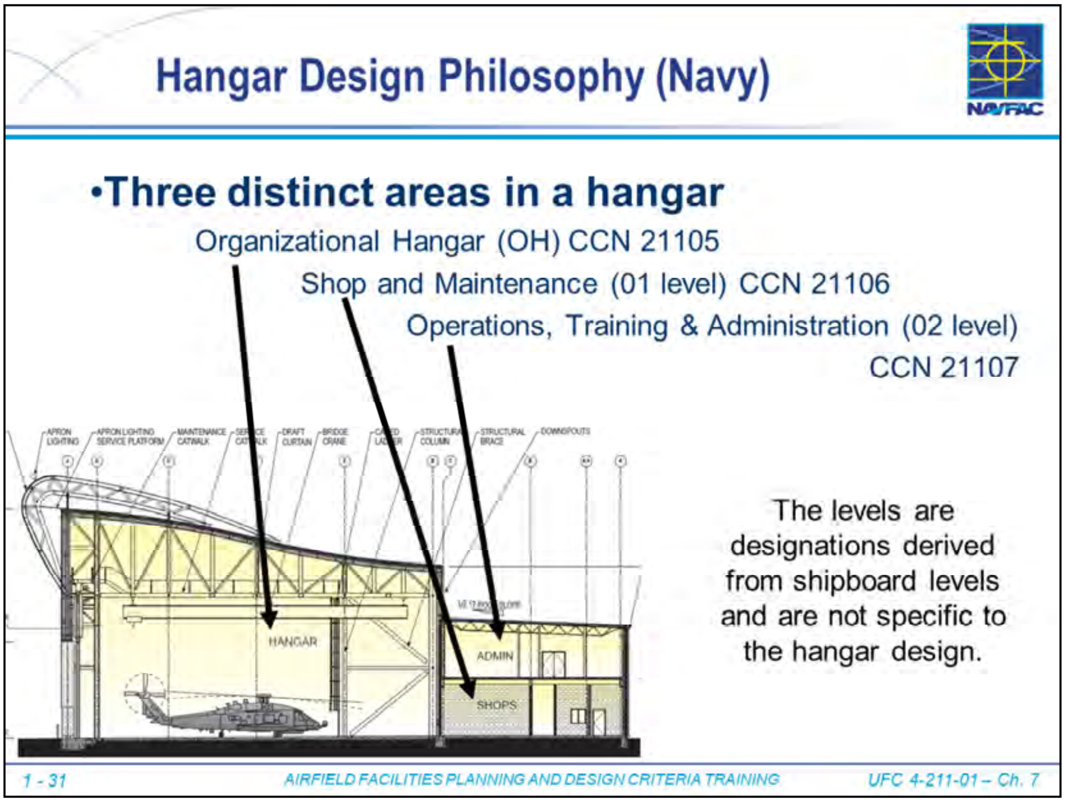
Access to existing runways/taxiways



- The baseline requirement for AT/PS are established by OPNAVINST 5530.14E NAVY PHYSICAL SECURITY AND LAW ENFORCEMENT PROGRAM and NAVY TACTICS, TECHNIQUES, AND PROCEDURES (NTTP) 3-07.2.3 LAW ENFORCEMENT AND PHYSICAL SECURITY.
- Airfields are Level Two Restricted areas.
- Planners/Designers must coordinate with Base to Determine Security Requirements
  - Antiterrorism Officer (ATO)
  - Installation Security Officer (ISO)
  - Airfield Security Officer (ASO)
- Airfield Enclaves may have different types of systems to monitor the site or control access including
  - Intrusion Detection, Video Assessment Systems and/or Automated Access Controls like Automated Pedestrian Turnstiles or Vehicle Gates
- Each Airfield has an Airfield Integrated Vulnerability Assessment (AIVA) conducted triennially.
  - AIVAs are Classified but reflect the foundation for requirements determination for the security of the airfield.

7-3.1.1 General

Refer to 7-1.1.2: Hangar Design Philosophy for additional discussion on the Navy Hangar Type concept. The Navy has established four (4) standard maintenance hangar bays including Type I, Type II, Type III and Type IV to efficiently meet the needs of its current aircraft inventory. Each Type is designed to accommodate commonly grouped aircraft which are categorized by size and function and are further defined in paragraphs below and in Table 7-1: Standard Hangar Bay Module Dimensions and Crane Capacities*. These hangar Types are based on the controlling aircraft size, controlling aircraft layout, additional maintenance clearance required (if any), and minimum required aircraft clearances shown in Table 2-1: Minimum Aircraft Maintenance Bay Clearances. Do not reduce the minimum clearances for standard hangar Types below the thresholds indicated. If necessary, increase the selected standard Hangar Type dimensions to accommodate the specific design airframe(s) layout with adequate clearances (Table 2-1: Minimum Aircraft Maintenance Bay Clearances) and any additional maintenance clearance per the manufacturer's Facilities Requirements Document (FRD). The intent is to prevent a situation where a new airframe or larger variant is introduced prior to an update of Hangar Type standard definitions. Refer to UFC 2-000-05N for hangar planning requirements, modular sizing, and square footage guidance.



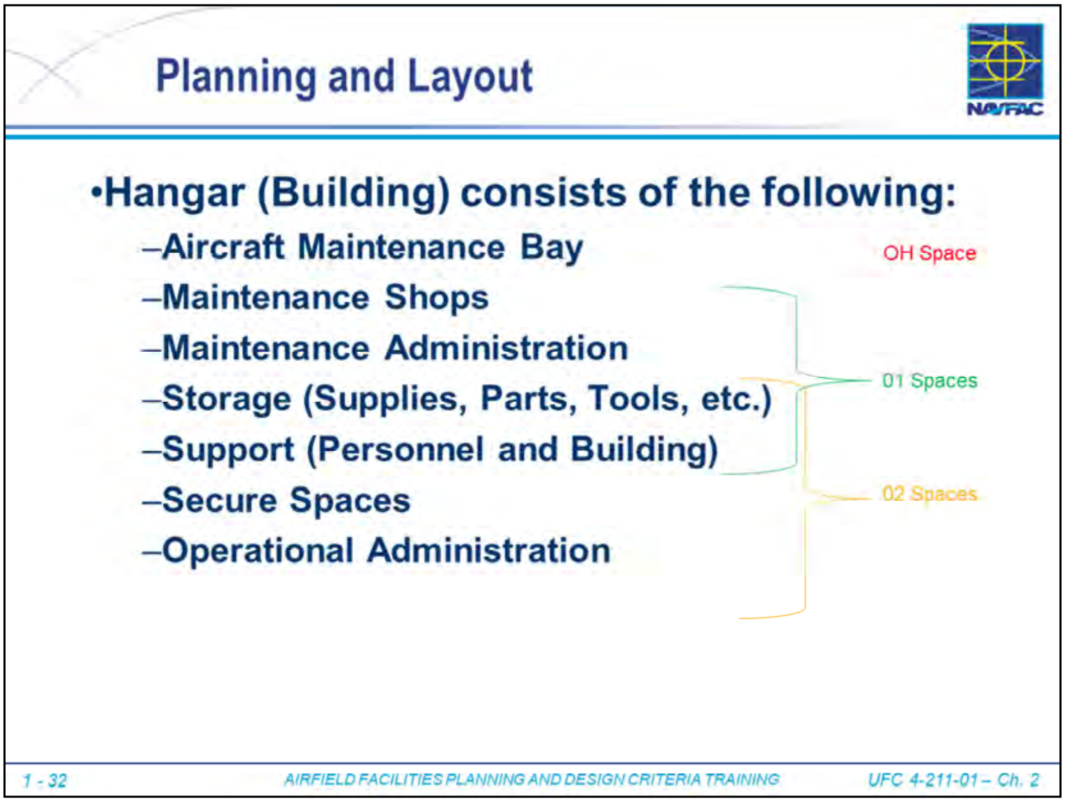
7-3.1.1.1 Organization

Navy aircraft hangars are comprised of three distinct areas; the hangar bay Organizational Hangar (OH) space, the Shop and Maintenance Administration (01 level); and the Operations, Training and Administration (02 level). The levels are designations from shipboard levels and are not specific to the hangar design. The hangar bay provides sheltered space to primarily perform Organizational "O" level maintenance to aircraft and limited additional levels as previously discussed in 7-1.1.3: US Navy Aircraft Maintenance Strategy. Layout of this space is determined by the planning documents for the module configuration identified. The net area of the hangar bay is defined in the module layout and is considered a fixed area.

Maintenance Hangar CATCODE 21105

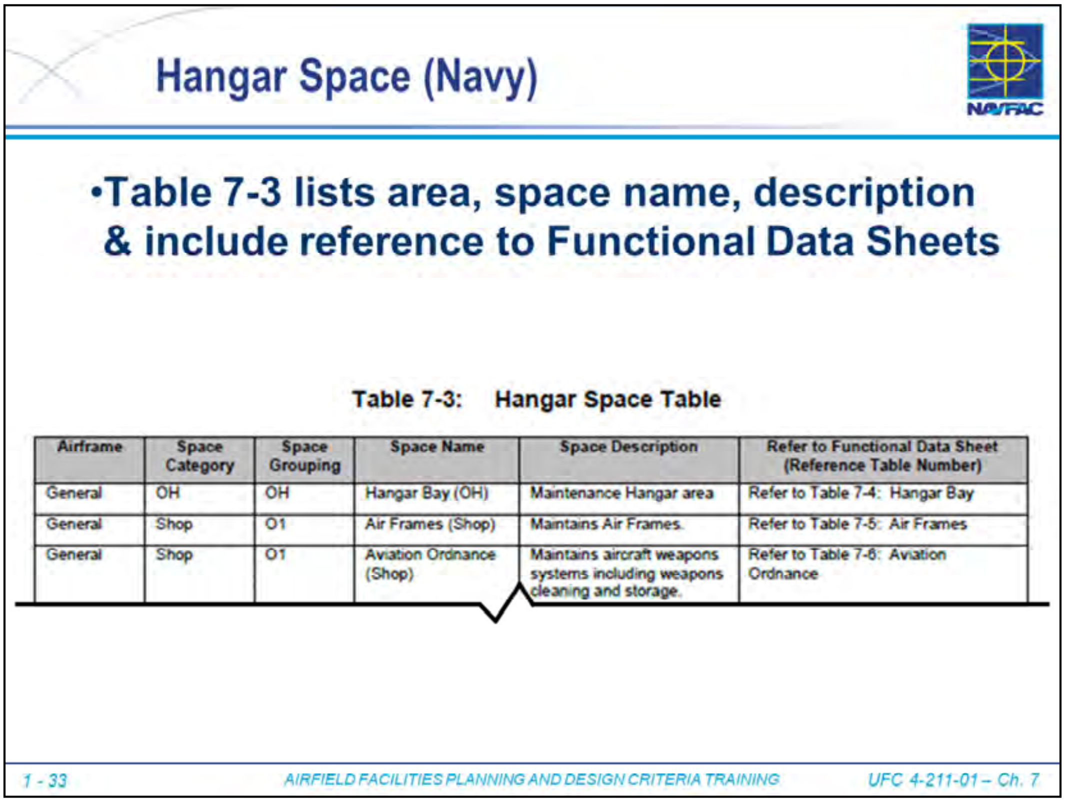
Maintenance Hangar 01 Space CATCODE 21106

Maintenance Hangar 02 Space CATCODE 21107



7-3.1.1.2 Standard Configurations

Hangar configurations, including heights, are provided to allow for maximum flexibility in accommodating all of the existing and proposed aircraft in the Naval Aviation Fleet. Do not modify the size of any hangar bay module without approval from Naval Facilities Engineering Command Atlantic, Capital Improvements Criteria and Programs Office (CIENG), Naval Air Systems Command (NAVAIR) and Commander, Navy Installations Command (CNIC). Additionally, Marine Corps hangar bay configurations may be modified by Headquarters, Logistics Facilities (USMC) (LF).



Airframe	Space Category	Space Grouping	Space Name	Space Description	Refer to Functional Data Sheet (Reference Table Number)
General	OH	OH	Hangar Bay (OH)	Maintenance Hangar area	Refer to Table 7-4: Hangar Bay
General	Shop	O1	Air Frames (Shop)	Maintains Air Frames.	Refer to Table 7-5: Air Frames
General	Shop	O1	Aviation Ordnance (Shop)	Maintains aircraft weapons systems including weapons cleaning and storage.	Refer to Table 7-6: Aviation Ordnance

These are minimums, representative of the typical requirements.

Verify with the users and FRD as this is not necessarily an exhaustive list.

Functional Data Sheets

NAVFAC

•Tables 7-4 through 7-21

Table 7-4: Hangar Bay (OH)

Description / Usage		Maintenance area for airframes
Minimum Ceiling Height		Refer to mandatory height requirements based on hangar type.
Finishes	Walls	Painted walls between O1/O2 and hangar bay.
	Floors	Fuel Resistive Resinous Flooring, 5-Coat System. Incorporate floor markings if required.
	Ceiling	Exposed construction.
Interior Construction / Built-in Equipment		Incorporate an approved Avian Intrusion Prevention System in the hangar bay.
Furniture, Fixtures & Equipment (FF&E)		Storage cabinets
Plumbing		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.
HVAC		Provide per Chapter 3. Specialized exhaust system(s) required. Exhaust directly outdoors through roof. Thermostatic control switch activated by hangar door to shutoff 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.
Fire Protection		Provide per Chapter 3 and Chapter 7.
Power		Provide per Chapter 3 and Chapter 7.

These are minimums, representative of the typical requirements.

Standard Hangar Types

	Type I	Type II	Type III	Type IV
Aircraft Type	Smaller, Carrier Type Aircraft: Rotary (MH-60) & Fighters (F-35)	Larger Aircraft: CH-53, MV-22 & C-130	Primarily land based patrol aircraft (P-8A) & large transport	Largest UAS: MQ-4C Triton
Notes:	01/02 spaces are configured for a typical strike fighter squadron	Primarily utilized by the USMC		UAS other than Triton: consider a non-standard hangar
Bridge Crane	1 per module	1 per module	not authorized	1 per module

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Type 1 note: The 01 and 02 level spaces are configured for a typical strike fighter squadron, two carrier airborne early warning squadrons, or one H-60 helicopter squadron.

Type 2 note: Hangar Type is used by both Navy and USMC. CH-53 Helicopters, MV-22 Tilt-Rotor and C-130 Refueler/Transport Aircraft.

Type 3 note: P-8A Poseidon

Type 4 note: MQ-4C Triton is an Unmanned Aircraft System (UAS) and will be a forward deployed, land-based, autonomously operated system that provides a persistent maritime intelligence, surveillance and reconnaissance capability using a multi-sensor mission payload. The MQ-4C Triton air vehicle is a Navy variant based upon the USAF RQ-4B Global Hawk.

Hangar Types – Table 7-1

\3\ /3/	HANGAR TYPE					
	TYPE I		TYPE II	TYPE III	TYPE IV	SEE NOTES
	NAVY	USMC				
WIDTH	212' 64.62 M	270' 82.30 M	325' 99.1 M	165' 50.3 M	161' 49.07 M	1, 2, 3
DEPTH	95' 28.96 M		119' 36.3 M	165' 50.3 M	141' 42.98 M	1, 2, 3
CLEAR HEIGHT	32.5' 9.91 M		44' 13.41 M	50' 15.24 M	32.5' 9.91 M	2, 4
BRIDGE CRANE CAPACITY	5-TON 4.5 METRIC TON		7 TON 6.5 METRIC TON	NONE	5-TON 4.5 METRIC TON	6
HOOK HEIGHT	29.5' 8.99 M		39' 11.9 M		29.5' 8.99 M	5, 6
DOOR WIDTH (MIN)	209' 63.7 M	267' 81.38 M	322' 98.15 M	162' 49.38 M	158' 48.16 M	7
DOOR HEIGHT	25' 7.62 M		44' 13.41 M	50' 15.24 M	25' 7.62 M	2

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

1 - 36 AIRFIELD FACILITIES PLANNING AND DESIGN CRITERIA TRAINING UFC 4-211-01 – Ch. 7

Notes: - ALSO CHECK WITH YOUR AIRCRAFT FRD TO CONFIRM APPLICABILITY!

1. The Width and Depth of the hangar are defined as the respective net clear horizontal dimension between the nearest fixed obstructions. Horizontal fixed obstructions along back walls and side walls include, but are not limited to the inside face of the wall, a structural column or bracing, bollard, liner panel, an open door extending into the Aircraft Maintenance Bay, mechanical equipment or ductwork, plumbing equipment, valves and pipes, electrical equipment (such as power transformers), or other fixed items. Fixed obstructions do not include furniture, tables, desks, benches, cabinets, tools, parts, carts or other movable objects. The depth at the hangar door is to the interior face of the innermost panel of a rolling steel door, or to the interior face of a vertical lift fabric door.

2. Dimensions for width, depth, and height are considered to be "standard." Variations in hangar bay sizes are not permitted without authorization of the NAVFAC HQ Chief Engineer. Additionally, Marine Corps hangar bay configurations may be modified by Headquarters, USMC (LF).

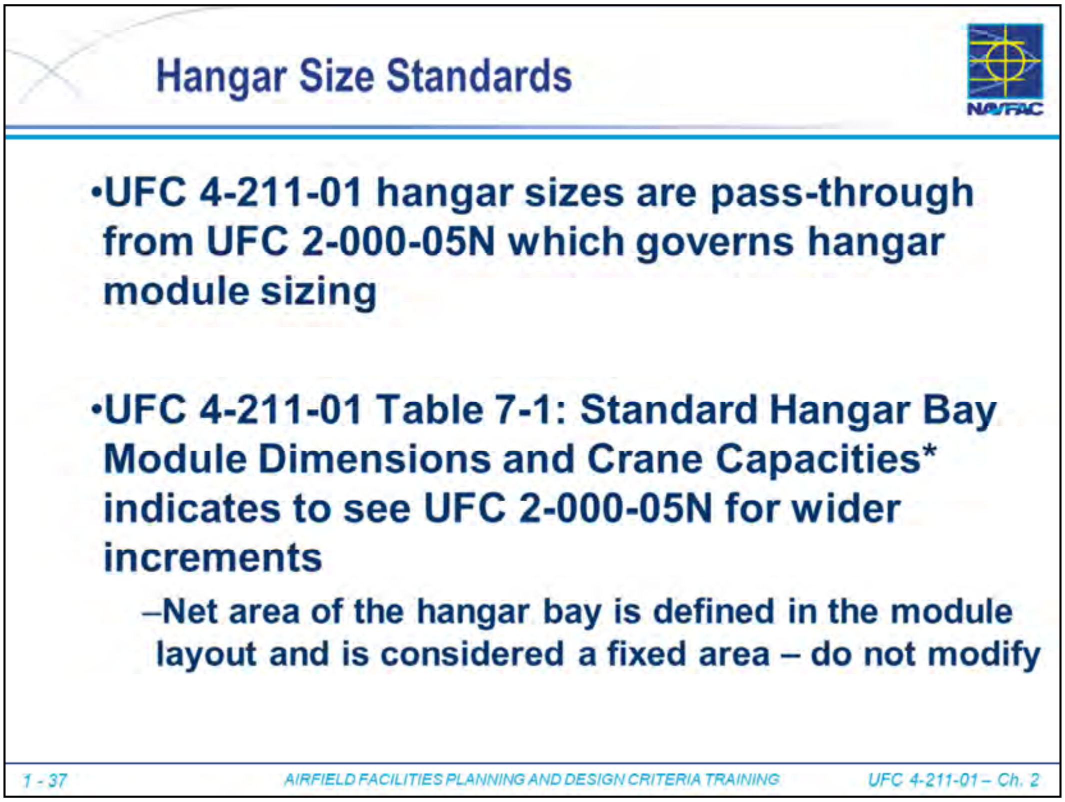
3. Table includes required NET clear hangar dimensions that are also to be used for square foot planning calculations. See UFC 2-000-05N for guidance and requirements on Net to Gross planning calculations. See also paragraph 2-4: Net to Gross Area in Aircraft Maintenance Hangars.

4. The clear height is the lowest obstruction including but not limited to, an overhead structure, and MEP equipment such as lighting, fans, heaters, ductwork, and sprinklers.

5. Hook height is to the saddle of the hook. Hook heights are minimum requirements. Increase height where possible to maximize for available structure height. Refer to crane requirements in Chapter 3: General Hangar Requirements and 7-9: Overhead Bridge Cranes.

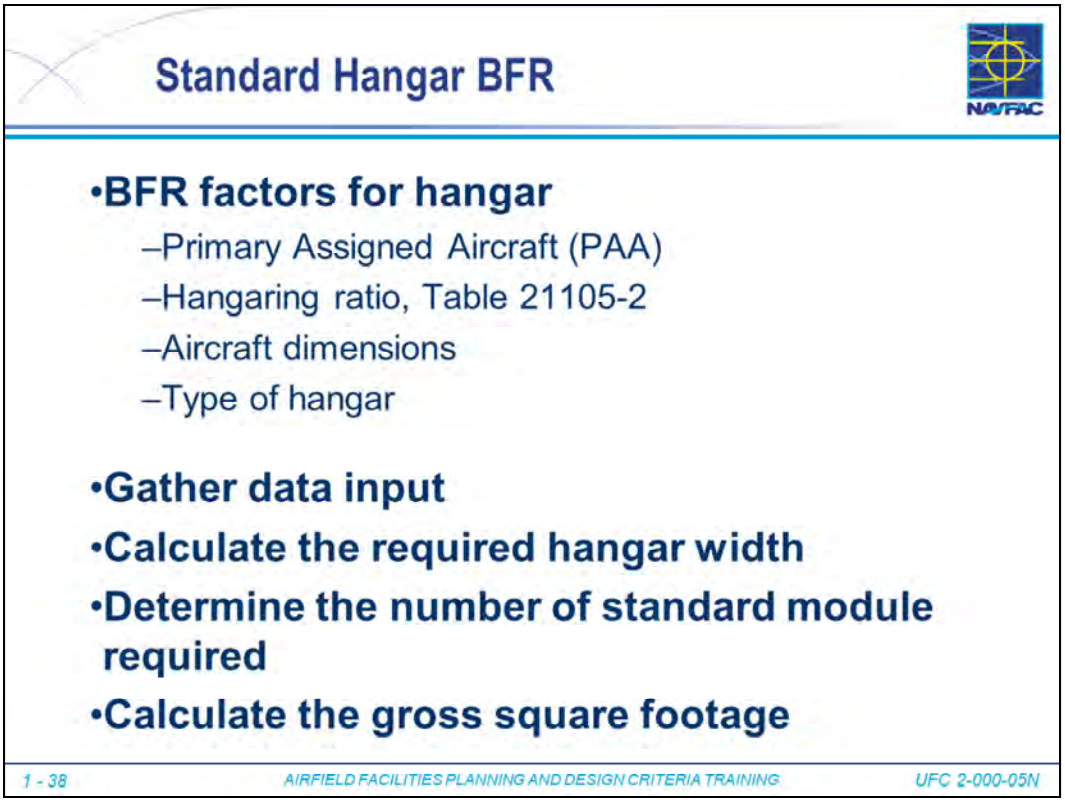
6. Refer to Figure 7-11: Section through Type II Hangar Crane Configuration and Vertical Clearances to clarify minimum hangar crane coverage area for Type II hangars. The bridge crane coverage must be designed to account for the possibility of servicing a C-130 aircraft. Coordinate crane coverage with the user.

7. The elements at the edge of the hangar door opening determine the width of the opening. Provide an opening not less than 3 ft. (1 m) less than the width of the aircraft maintenance bay.



Nomenclature is important – especially on DD1391.

For example: If called a “Modified Type II” then the identified modifications are acceptable – otherwise an exemption/waiver may be required.



BFR (Building Factor Ratio)

Standard Hangar BFR – Type I Example

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 = Rounding of PAA x Hangar Ratio (no PMI space required)
   - = 14 x 1/3
   - = 4.66
   - = 5 Rounded from 4.66
   - RHW = N x WF + (N-1) x D + 2 x SC (assuming no additional PMI bay required)
   - = 5 x 31' + (5-1) x 7.5' + 2 x 7.5'
   - = 200'

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

4. *Calculate the GSF required*
   - NSF = 1.0 x 20,140 sf
   - = 20,140 sf
   - GSF = 1.12 x NSF
   - = 1.12 x 20,240 sf
   - = 22,557 sf

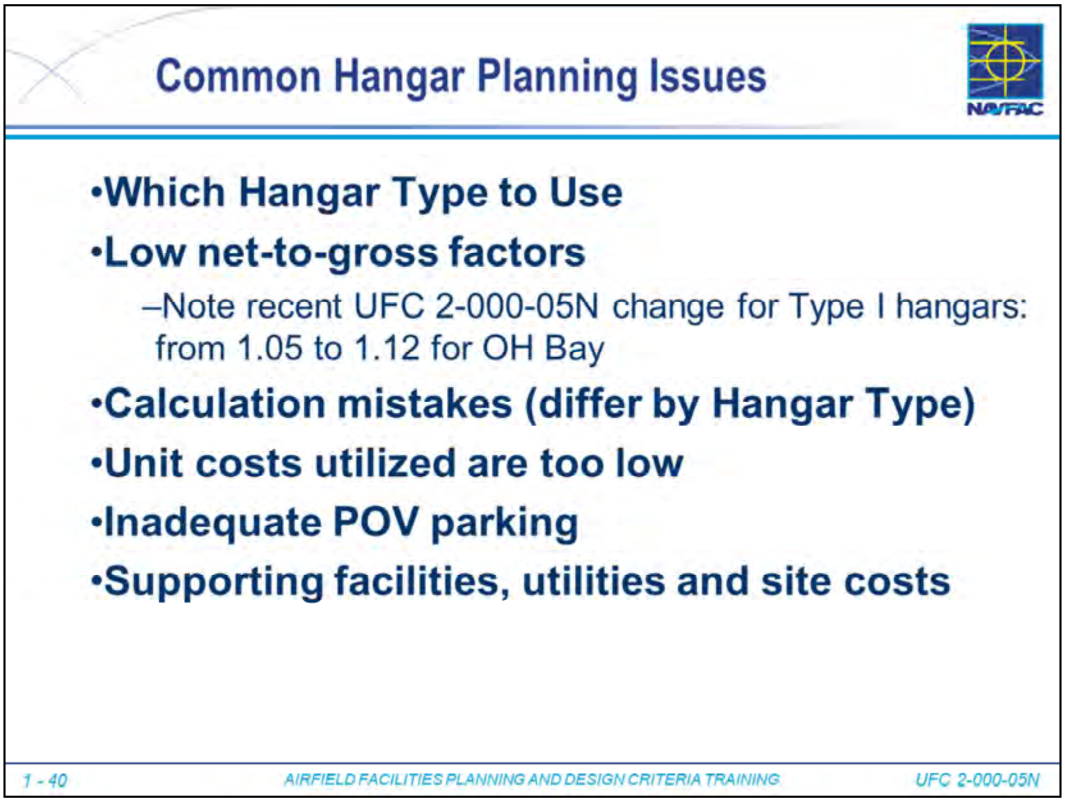
01 Space requirement: 19,658 gsf (Table 21105-1a)

02 Space requirement: 13,181 gsf (Table 21105-1a)

Note: this calculation is an example and applies only to Type I Hangars. Refer for UFC 2-000-05N for other Hangar Types.

May customize 01 and 02 Areas as well based upon the squadron's aircraft, personnel and operations.

Note: a SCIF is not included in 02 area for Type II, III and IV Hangars – need to identify if one is required.



Example Calculation Mistakes Include:

Calculation with correct net to gross factor

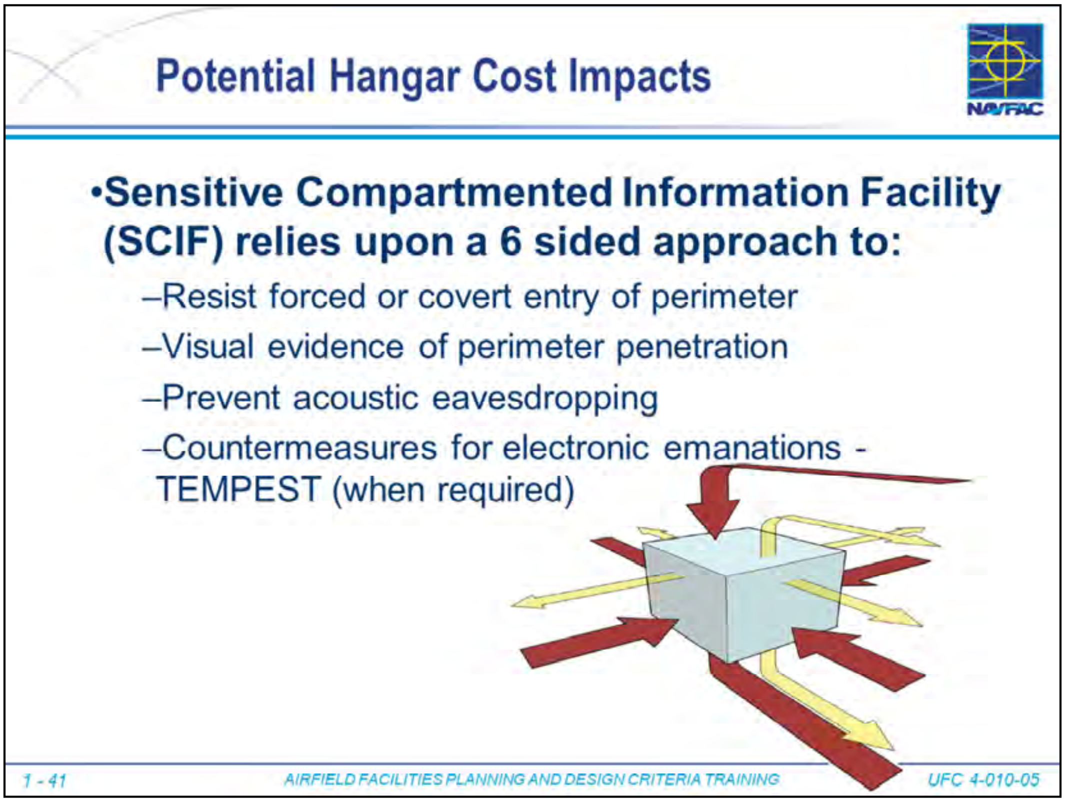
Missed area requirements for AFFF room, note:

AFFF area included in UFC 2-000-05N Table 21105-1a Note 4 in 38% allowance

AFFF area included in UFC 2-000-05N Table 21105-1b Note 4 Excludes an allowance of up to 1,536 sq.ft. for AFFF – so it needs to be added in.

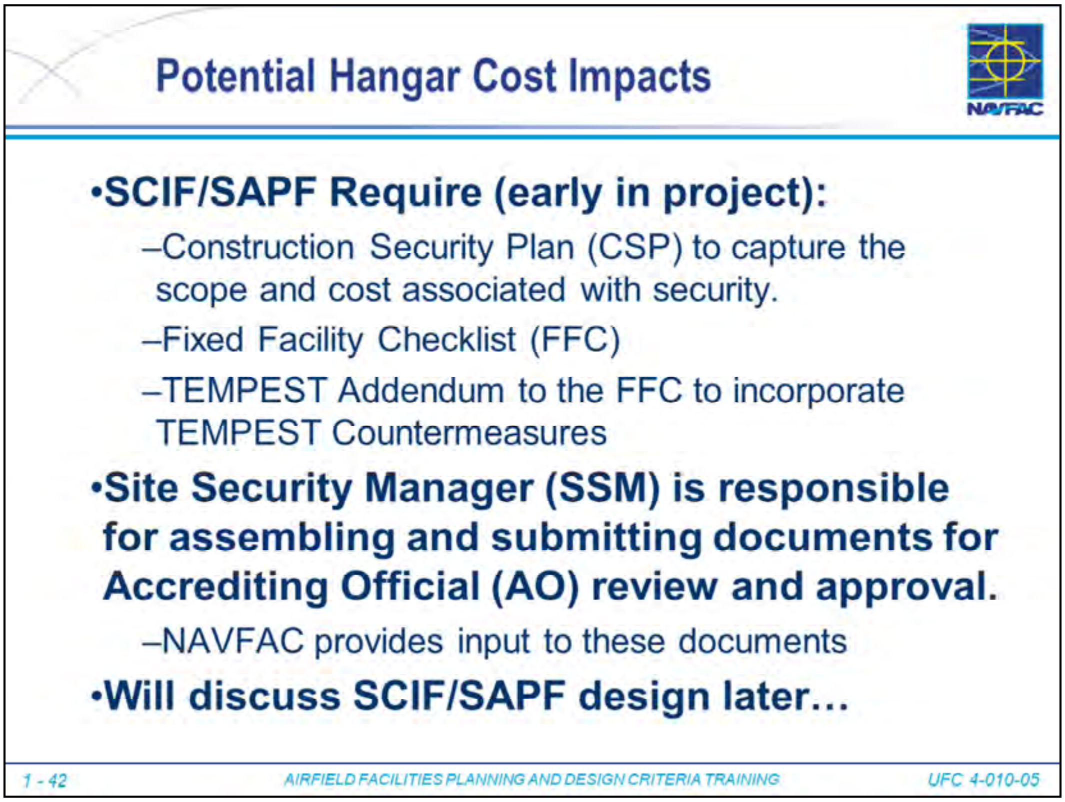
Missed area requirements for Inclusion of corrosion control requirements - (bathrooms, clean/dirty rooms – if needed at O-level hangars)

Improper understanding of aircraft clearances (clear width/depth)



Many hangars require some level of physical security for the protection of assets such as classified materials, Sensitive Compartmented Information (SCI) or Special Access Program (SAP) information. The requirements for the protection of assets is defined in DoD and Service regulatory guidance or policy. The security requirements must be coordinated with the supported command and their security representatives to ensure the configuration will meet their operational (compartmented) and the regulatory and policy based security requirements. When a hangar has more than one secure space, serious consideration should be given to consolidate multiple secure spaces. Any consolidation will reduce the initial and sustainment cost for infrastructure, electronic security systems and the associated accrediting requirements. When required, integrate the physical security protective measures into the site, building, room(s), or area(s) as applicable.

Example TEMPEST countermeasure may include (at the direction of the CTTA when the facility utilizes electronic processing) a foil backed GWB or R-Foil in accordance with *Best Practices Guideline for Architectural Radio Frequency Shielding*.



SCIF Criteria:

UFC 4-010-05 Sensitive Compartment Facilites Planning, Design and Construction

UFC 4-021-02 Electronic Security Systems

Engineering Criteria Bulletin (ECB) 2017-03 Sensitive Compartment Facilites

DoDM 5105.21-Vol 1-3, Sensitive Compartmented Information (SCI) Administrative Security Manual

IC Tech Spec-for ICD/ICS 705: Technical Specifications for Construction and Management of Sensitive Compartmented Information Facilities

SAPF Criteria:

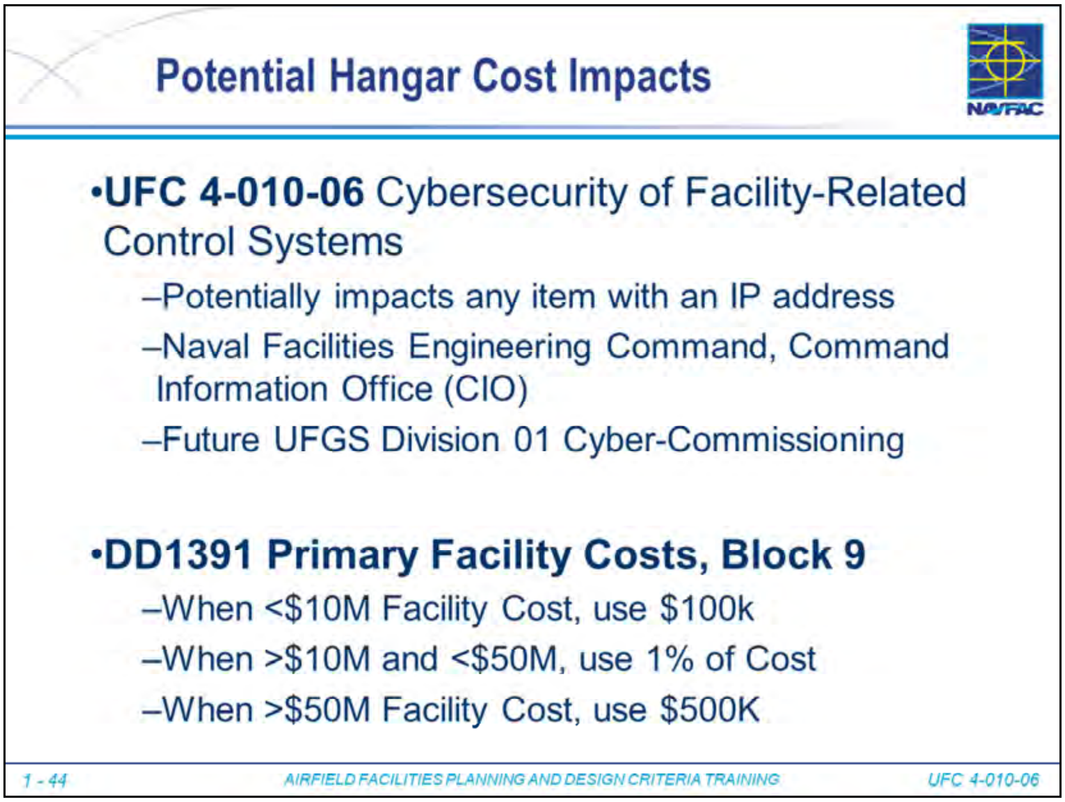
DODM 5205.07 Volume 1-3, DoD Special Access Program (SAP) Security Manual

IC Tech Spec-for ICD/ICS 705: Technical Specifications for Construction and Management of Sensitive Compartmented Information Facilities

Potential Hangar Cost Impacts

- **UFC 4-010-01** Minimum Antiterrorism Standards for Buildings
  - –Glazing and Doors
  - –Structural Isolation
  - –Equipment Bracing

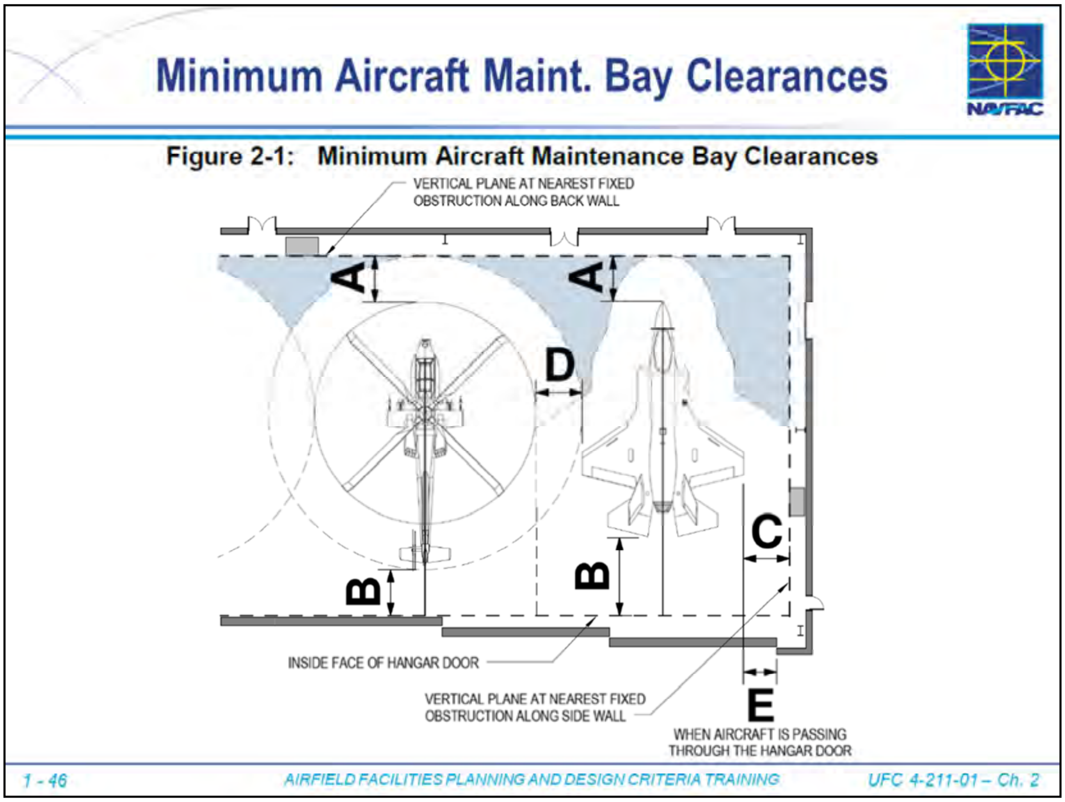
Antiterrorism: The purpose of this standard is to establish minimum engineering standards that incorporate antiterrorism (AT) based mitigating measures where no identified threat or level of protection has been determined in accordance with UFC 4-020-01 – This is a Base by Base and Facility by Facility threat assessment which must be complete prior to finalizing the DD1391 funding as it may have a significant impact on construction cost.



Cyber: This UFC describes requirements for incorporating cybersecurity in the design of all facility-related control systems. It defines a process based on the Risk Management Framework (RMF) suitable for control systems of any impact rating, and provides specific guidance suitable for control systems assigned LOW or MODERATE impact level.

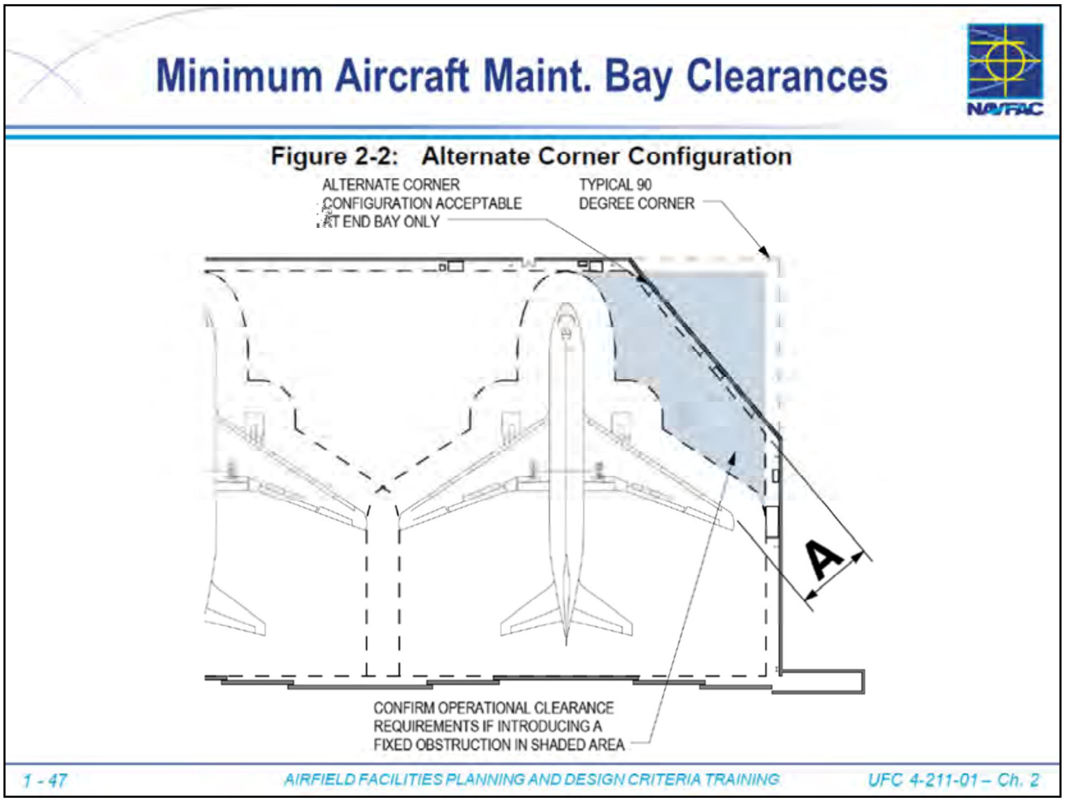
Cybersecurity scope and cost must be determined during the preparation of the DD1391.

Think of this as an obstruction free, three dimensional, invisible, clearance box.



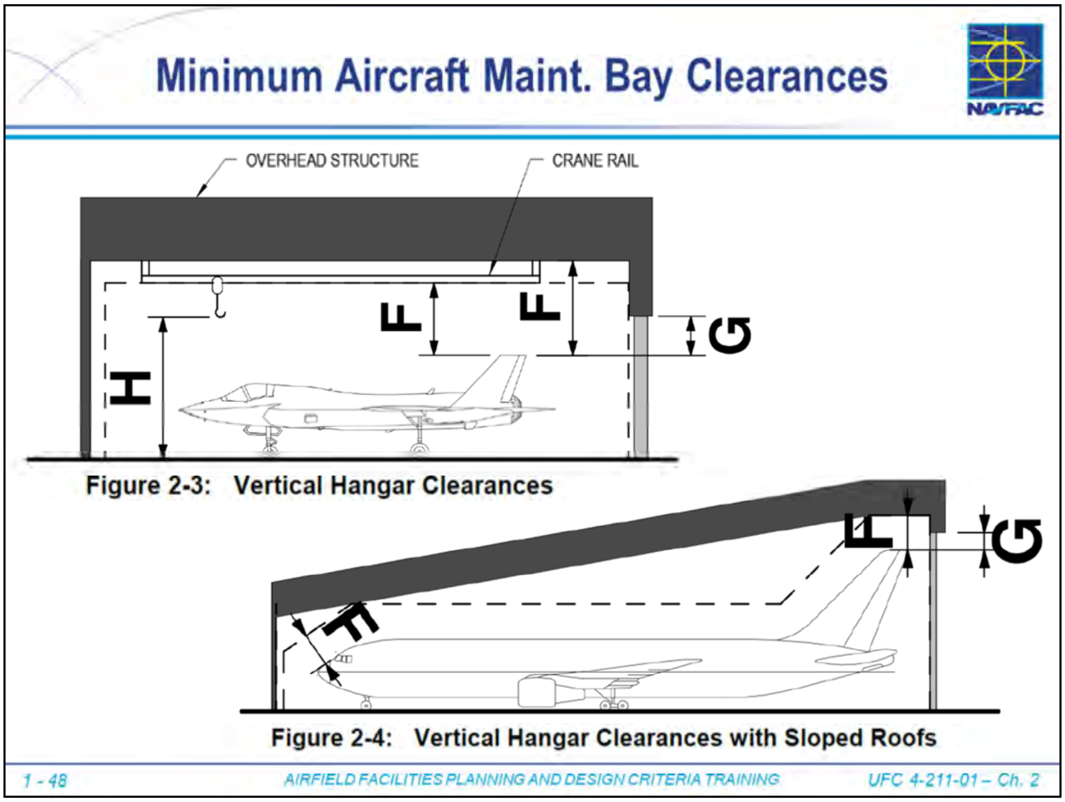
Discussion Points:

1. Use these to develop custom hangar for any aircraft
2. Perimeter clearances to obstructions



Discussion Points:

1. Use these to develop custom hangar for any aircraft
2. Perimeter clearances to obstructions
3. Note 'A' in the diagonal wall (corner) option is the same as the front wall, not the same as the side wall.
4. Rarely used in Navy Hangars



Note: Figure 2-3 Typical of Standard Hangar

Figure 2-4 occurs in some large Air Force Hangars

Discussion Points:

1. Use these to develop custom hangar for any aircraft
2. Perimeter clearances to obstructions
3. Nose-In or Tail-In can have an impact with larger aircraft and a shaped hangar.

Minimum Aircraft Maint. Bay Clearances

NAVFAC

Table 2-1: Minimum Aircraft Maintenance Bay Clearances

SEE CLEARANCES A THROUGH H ON FIGURES 2-1 THROUGH 2-4			AIR FORCE AND ARMY		NAVY - NOTE 10				NOTES:
			WINGSPAN [illegible]	WINGSPAN [illegible]	HANGAR TYPE I	HANGAR TYPE II	HANGAR TYPE III	HANGAR TYPE IV	
FIGURE 2-1 AND 2-2	A	AIRCRACT TO NEAREST FIXED OBSTRUCTION ALONG BACK WALL	[illegible]	[illegible]	10'-0" 3.05M	10'-0" 3.05M	20'-0" 6.01M	15'-0" 4.57M	1, 2, 3
	B	AIRCRAFT TO INSIDE FACE OF HANGAR DOOR	[illegible]	[illegible]	7'-6" 2.29M	10'-0" 3.05M	15'-0" 4.57M	15'-0" 4.57M	1, 2, 4
	C	AIRCRAFT TO NEAREST FIXED OBSTRUCTION ALONG SIDE WALL	[illegible]	[illegible]	7'-6" 2.29M	10'-0" 3.05M	20'-0" 6.01M	15'-0" 4.57M	1, 2, 3
	D	AIRCRAFT TO ADJACENT AIRCRAFT	[illegible]	[illegible]	7'-6" 2.29M	10'-0" 3.05M	20'-0" 6.01M	15'-0" 4.57M	1, 2, 5
	E	AIRCRAFT TO HANGAR DOOR JAMB	[illegible]	[illegible]	6'-0" 1.83M	8'-6" 2.59M	18'-6" 5.64M	13'-6" 4.12M	1, 2, 6
FIGURES 2-3 AND 2-4	F	AIRCRAFT TO NEAREST FIXED OR MOBILE OVERHEAD OBSTRUCTION	[illegible]	[illegible]	5'-0" 1.52M	5'-0" 1.52M	5'-0" 1.52M	5'-0" 1.52M	1, 7, 8
	G	AIRCRAFT TO UNDERSIDE OF DOOR HEAD	[illegible]	[illegible]	5'-0" 1.52M	5'-0" 1.52M	5'-0" 1.52M	5'-0" 1.52M	1, 7, 8
	H	HOOK HEIGHT (SADDLE OF HOOK)	[illegible]		Refer to Table 7-1				1, 7, 9

Notes:

1. Refer to 2-3: Minimum Aircraft Maintenance Bay Clearances.

2. Refer to Figure 2-1: Minimum Aircraft Maintenance Bay Clearances.

3. Minimum clearances A and C are to a vertical plane at the face of the fixed obstruction that extends furthest toward the aircraft.

4. The minimum clearance from the aircraft to the hangar door is to a vertical plane at the interior face of the innermost panel of a sliding door, or to the interior face of a vertical lift door panel or mullion. Fixed columns along the hangar door separating bays are considered hangar door jambs for the purpose of determining clearances.

5. Minimum clearance between aircraft is from any part of the aircraft. Depending on the hangar configuration, the minimum clearance between aircraft is wingtip to wingtip, nose to nose, tail to tail, nose to tail, or rotor blade arc to rotor blade arc. Do not assume wingtips or rotor blades are folded. Do not determine minimum clearances between aircraft based on specific stationary rotor blade positions.

6. Minimum horizontal clearances at hangar door jambs are from wingtip or rotor blade to the edge of the clear width of the hangar door opening as the aircraft passes through the door opening. Rotor blades are assumed to be fixed in the narrowest configuration possible when entering and leaving the hangar. Do not assume wingtips or rotor blades are folded. Fixed columns along the hangar door separating bays are considered hangar door jambs for the purpose of determining clearances.

7. Refer to Figure 2-3: Vertical Hangar Clearances and Figure 2-4: Vertical Hangar Clearances with Sloped Roofs.

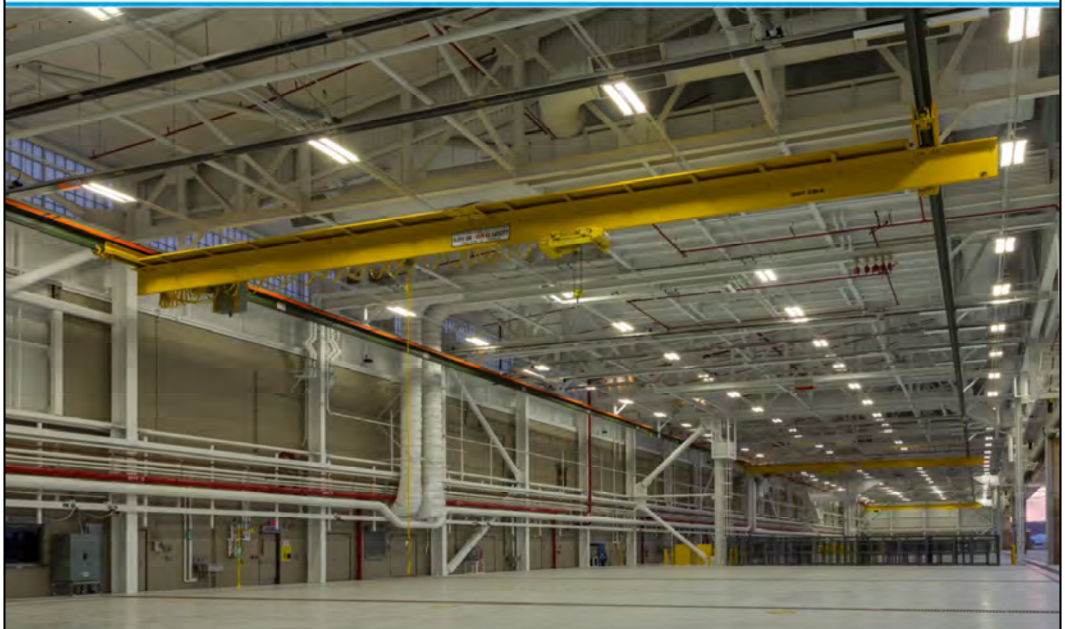
8. Minimum vertical clearances are from the top of the aircraft to the bottom of the nearest fixed or mobile overhead obstruction.

9. Minimum Hook height is to the saddle of the hook.

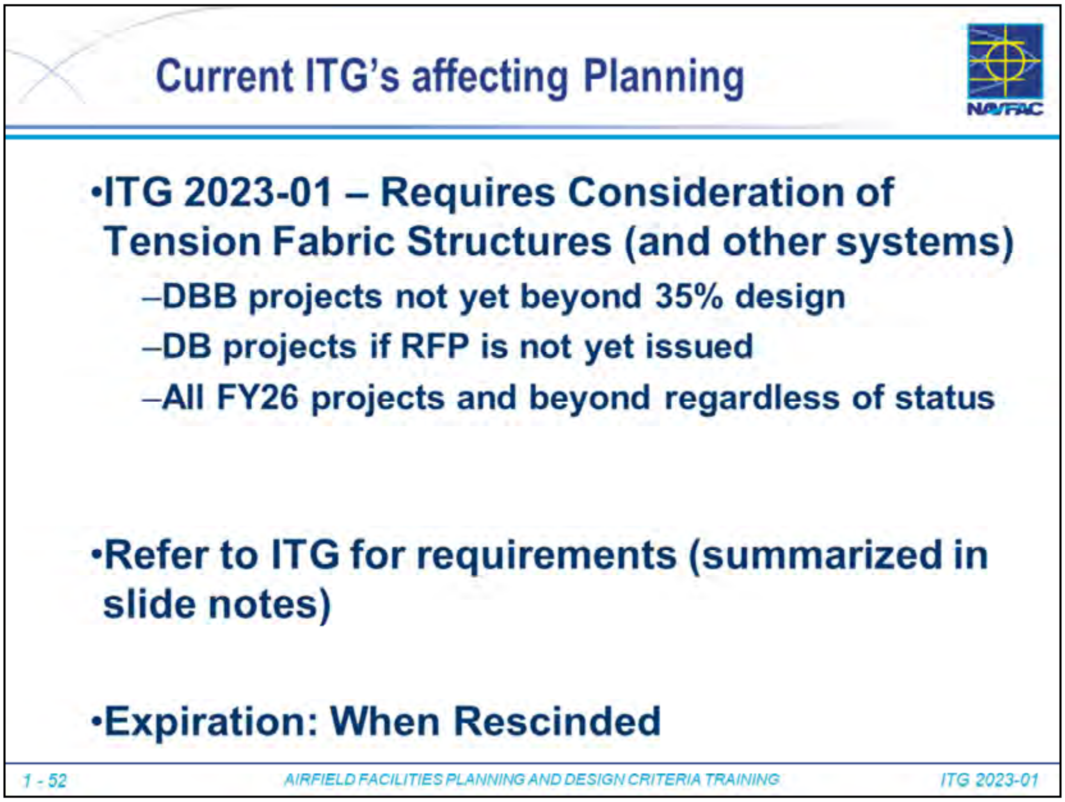
10.Refer to 7-3.1: Types of Hangars.

For Custom hangars clearances: choose what is closest as far as aircraft size, and do not be less than air force. Clearances are for safety and are non-negotiable.

Minimum Aircraft Maint. Bay Clearances



Minimum Aircraft Maint. Bay Clearances



Perform a life cycle cost analysis (LCCA) of alternative structural systems as a basis for determining optimal system selection during the Budget Project Readiness Index Authority (BPA) phase, in accordance with the following criteria.

1. Analysis must include TFS, in addition to other feasible structural systems such as structural steel, reinforced concrete framing systems, pre-engineered metal building, laminated timber, reinforced concrete masonry, and modular or off-site/pre-fabricated systems.

2. Assume a 50-year period and include initial cost, maintenance costs, and fabric replacement costs. For the TFS alternative, assume fabric has 15-year life expectancy.

3. For TFS only, develop conceptual design (15%) for comparison to traditional steel-framed construction. The TFS portion is intended for the hangar bay only while administrative, shop, and support functions are attached as traditional construction. Regardless of structural system selected, hangar must comply with requirements for permanent construction of all relevant Unified Facilities Criteria (UFC)

4. Develop a written summary of each alternative considered, include a discussion of advantages and disadvantages and potential mission impacts. Include written summary in project file as backup and include short narrative in the DD-1391.

The above examples of American Airlines Hangars (left to right, top to bottom): laminated timber (& steel), conventional steel (& reinforced masonry), reinforced concrete (& steel), (tension) fabric structure, pre-engineered metal building. (all of these may be constructed using a modular technique)

ITG – Interim Technical Guidance

AFFF - Aqueous Film Forming Foam

ILDFA - Ignitable Liquid Drainage Floor Assembly

Break

Section 2 – UFC 4-211-01 General Requirements & Navy Specific Criteria

Aircraft Hangars & Other Airfield Structures

9/19/2023

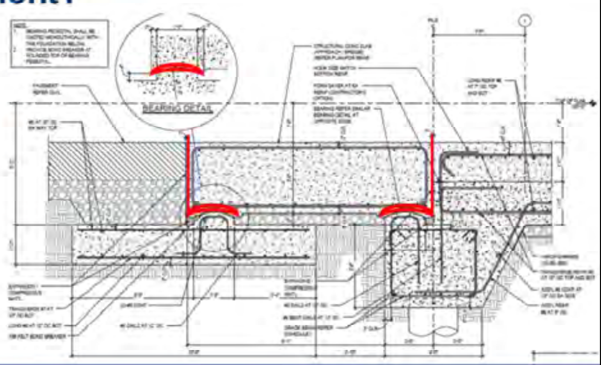
Associated Site Design References

- 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.

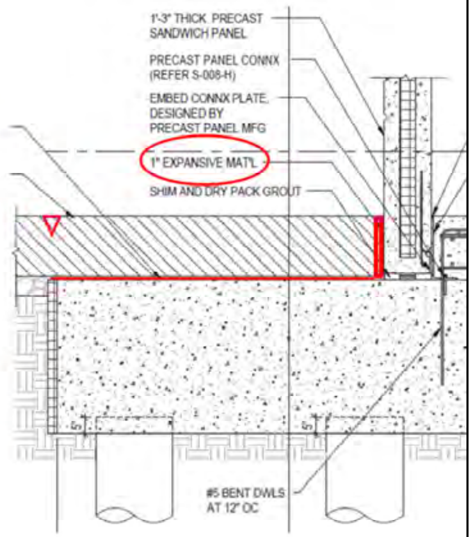


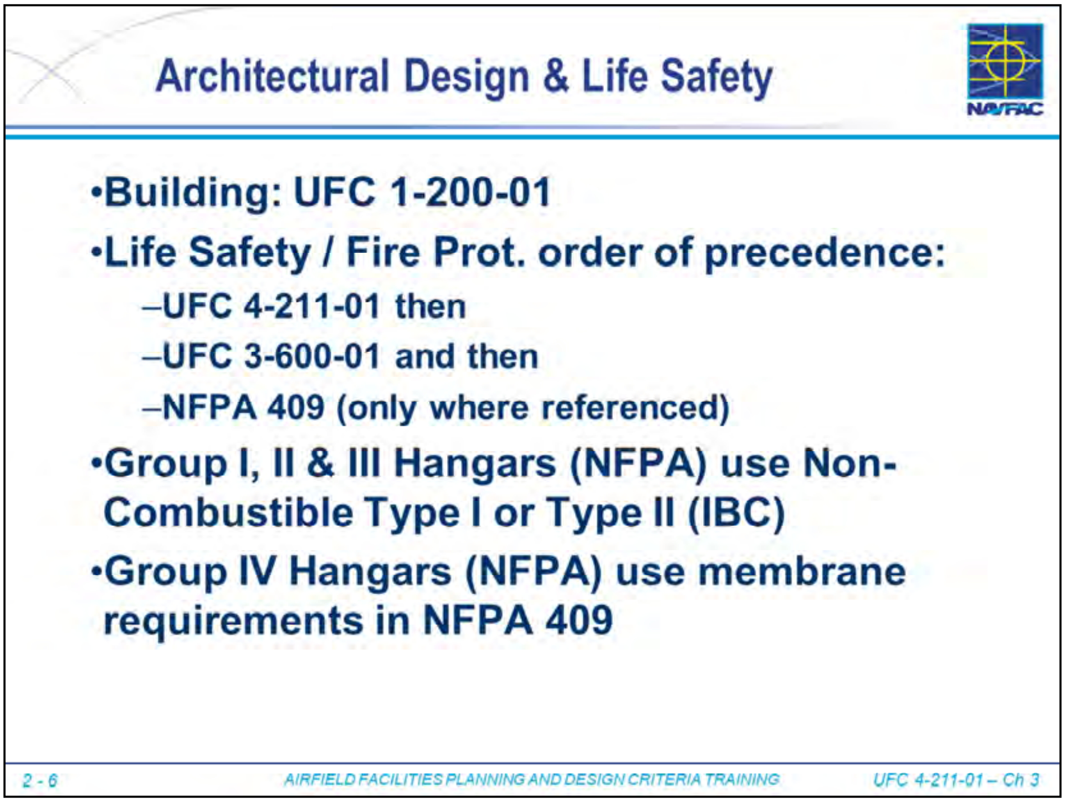
Site & Building Potential Movement

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

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**



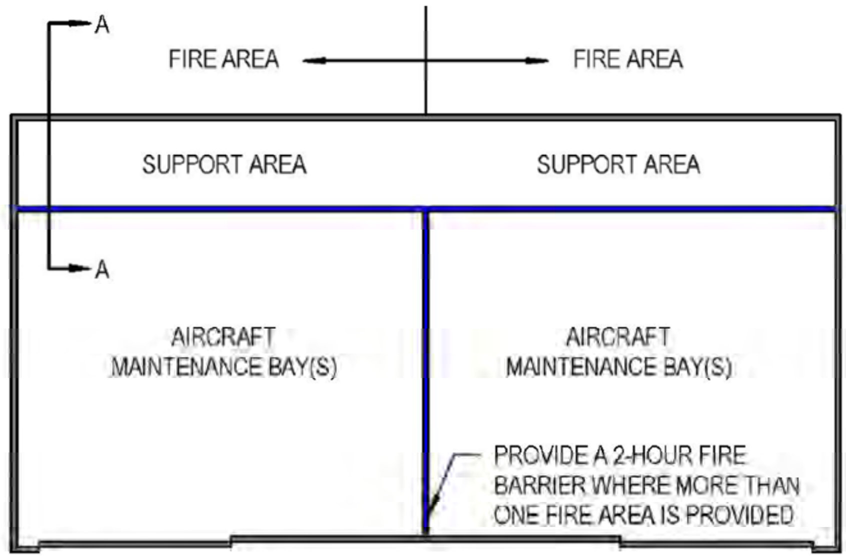


Note: do not confuse NFPA Groups or IBC Construction Types with Standard Navy Hangar Types.

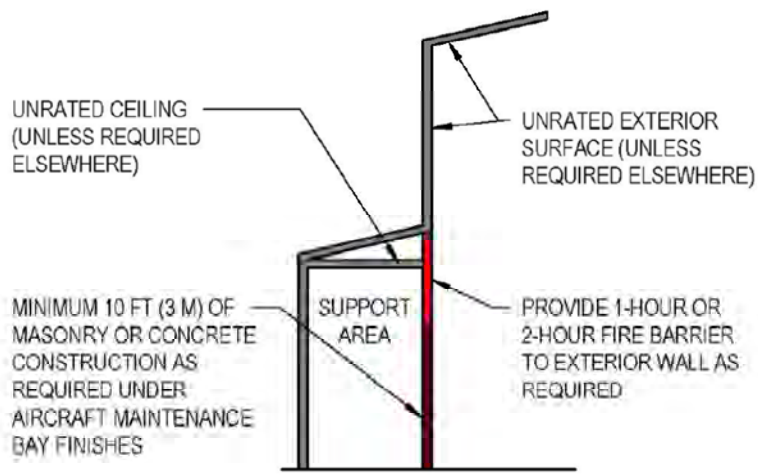
Internal Fire Rated Separations

- 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

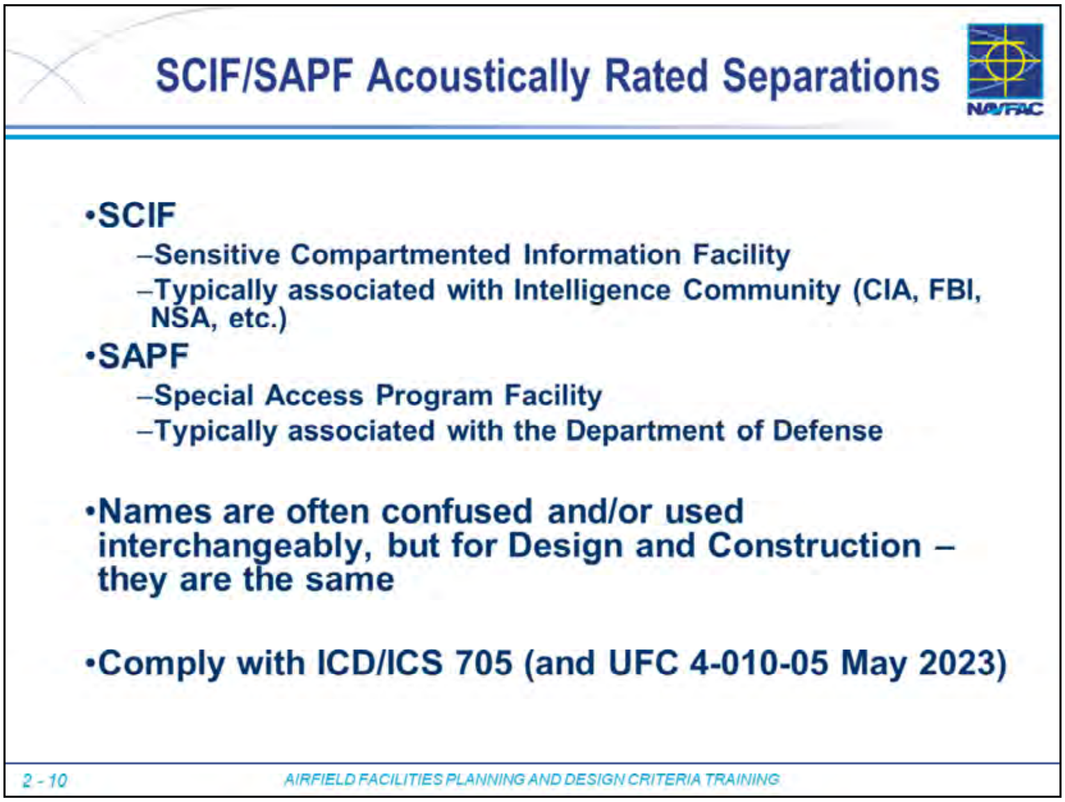
Internal Fire Rated Separations



Internal Fire Rated Separations



SECTION A-A
SUPPORT AREAS ATTACHED TO AIRCRAFT MAINTENANCE BAY



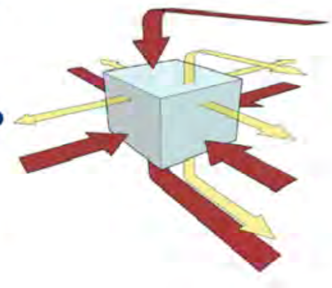
Although built to the same standard, many of the SAPF procedural standards for accrediting a facility still do not align with the ICD 705 accrediting processes; however, the two have never been more reciprocal than they are today.

The intelligence community itself considers SCI and SAPs distinct kinds of controlled access programs.

SCIF/SAPF Acoustically Rated Separations

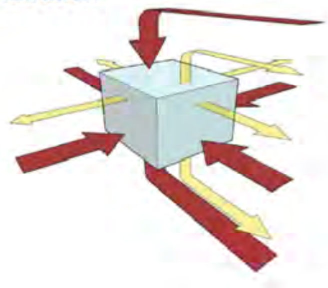
- Designers must take a six-sided approach when developing the design
- The perimeter includes all walls, floors, ceilings, doors, and windows
- Special attention must be paid to the perimeters

  and all penetrations
  - Ductwork, Pipes, Conduit, Cable Trays, etc
  - Switches, Outlets, Lighting, Thermostats, etc

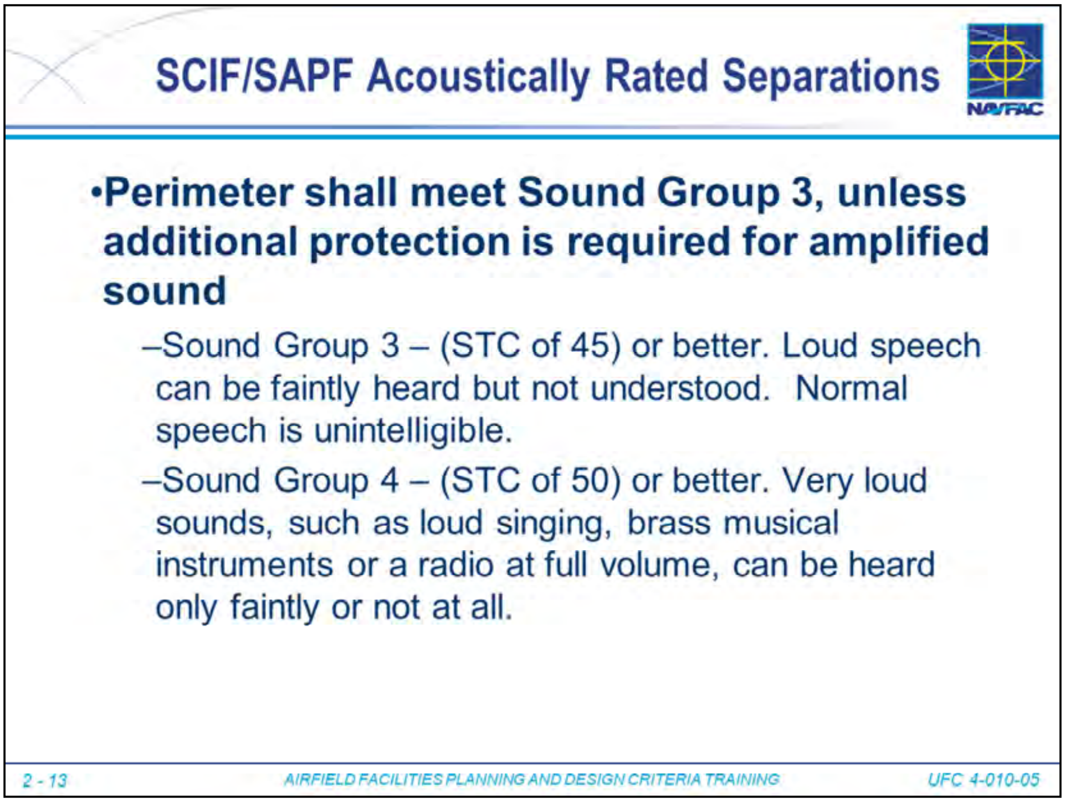


SCIF/SAPF Acoustically Rated Separations

- **At a minimum, the perimeter provides:**
  - **Resistance to forced entry**
  - **Resistance to covert entry**
  - **Visual evidence of surreptitious penetration**
  - **Sound Attenuation for acoustic eavesdropping**
  - **Countermeasures for Electronic Emanations**
    - TEMPEST (when required)



- **Primary SCIF/SAPF Issues:**
  - **Acoustic protection**
  - **TEMPEST**



IC Tech Spec-for ICD/ICS 705

UFC 4-010-05 Sensitive Compartment Facilities Planning, Design and Construction

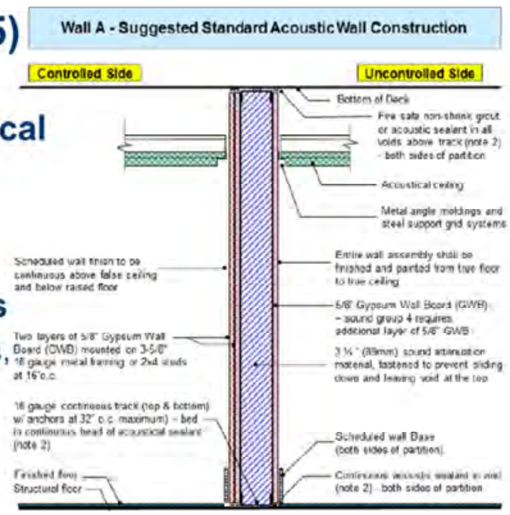
Engineering Criteria Bulletin (ECB) 2017-03 Sensitive Compartment Facilities

Conference rooms, where multiple people discuss, or areas where amplified audio is used shall meet Sound Group 4 performance criteria.

The sound group rating applies to the entire perimeter of the space to include walls floors, and ceiling and perimeter penetrations such as ducts, doors, and windows. Think about all six sides of the space (idealized as a cube).

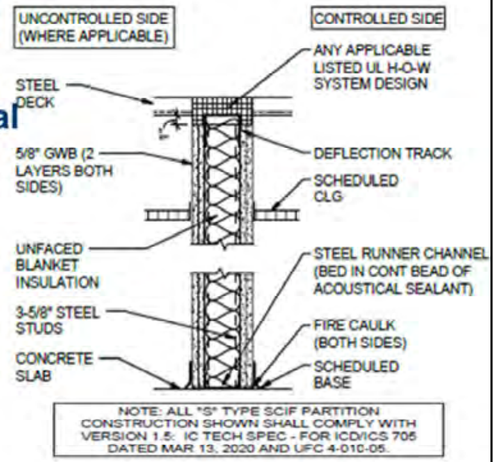
SCIF/SAPF Acoustically Rated Separations

- **Sound Group 3 (STC 45)**
  - **Sealed partition continuously with acoustical sealant whenever it abuts another element**
    - Wall, column, floor, roof, etc.
  - **Surface mount all devices**
    - Power/Comm outlets, switches, thermostats, conduit, junction boxes, etc.



SCIF/SAPF Acoustically Rated Separations

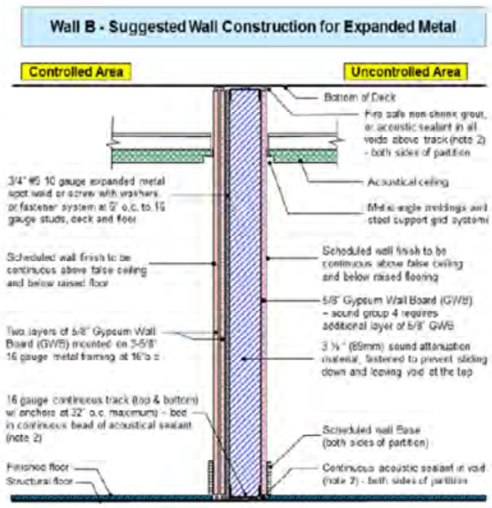
- **Sound Group 4 (STC 50)**
  - **Sealed partition continuously with acoustical sealant whenever it abuts another element**
    - Wall, column, floor, roof, etc.
  - **Surface mount all devices**
    - Power/Comm outlets, switches, thermostats, conduit, junction boxes, etc.



SCIF/SAPF Acoustically Rated Separations

- **Wall Type B (w/ Expanded Metal) is required for "Open Storage without SID"**
  - **3 layers of Gyp for STC 45**
  - **4 layers of Gyp for STC 50**

- **When RF Frequency Protection is required by Gov't in Wall Type A or B, Provide R-foil or foil backed gypsum placeed between the first and second layers of gypsum board**



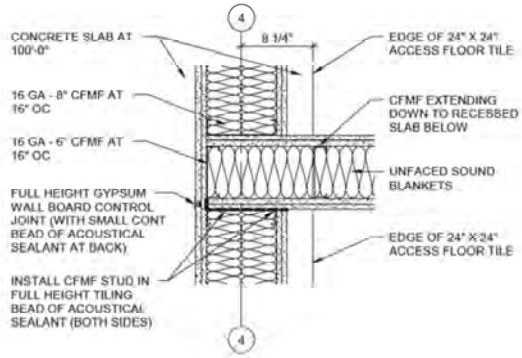
SCIF Acoustically Rated Separations

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

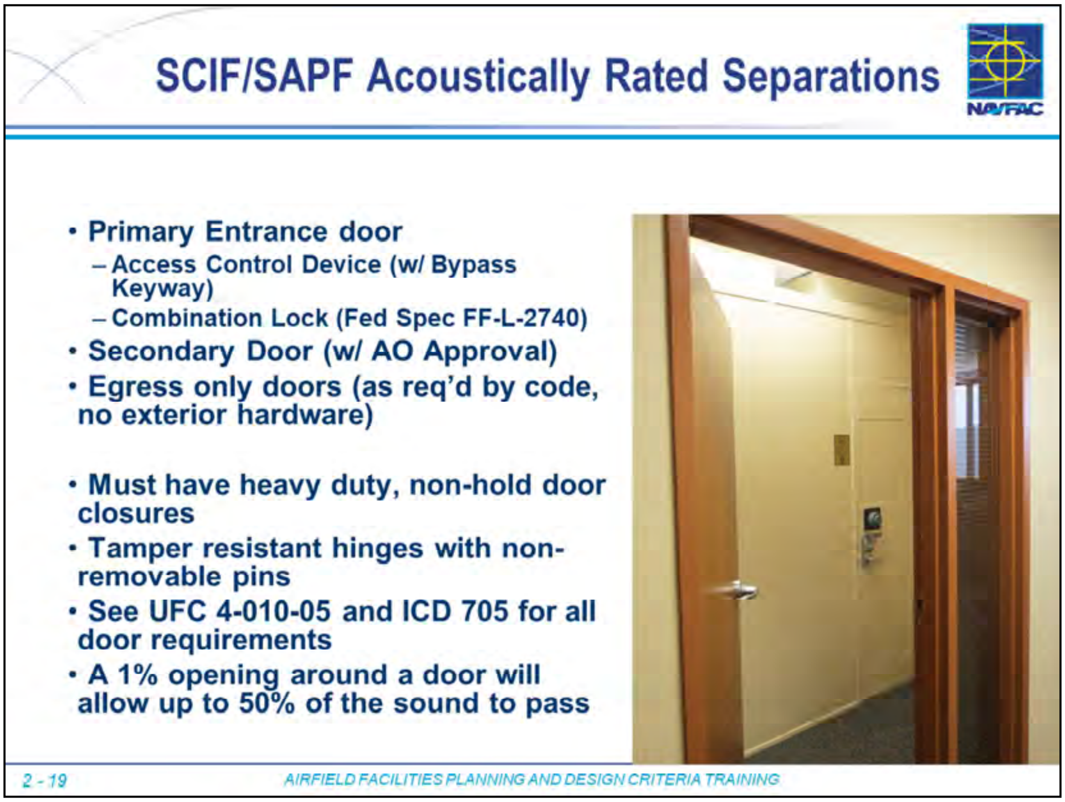
- **When detailing the perimeter pay attention to:**
  - **Corners, Base and Top of wall details**
  - **Detailing of flush mounted (or recessed) devices** such as switches, outlets, thermostats, etc.
  - **Detailing of penetrations** such as doors, windows and utility entrances – all of which have special requirements.

SCIF/SAPF Acoustically Rated Separations

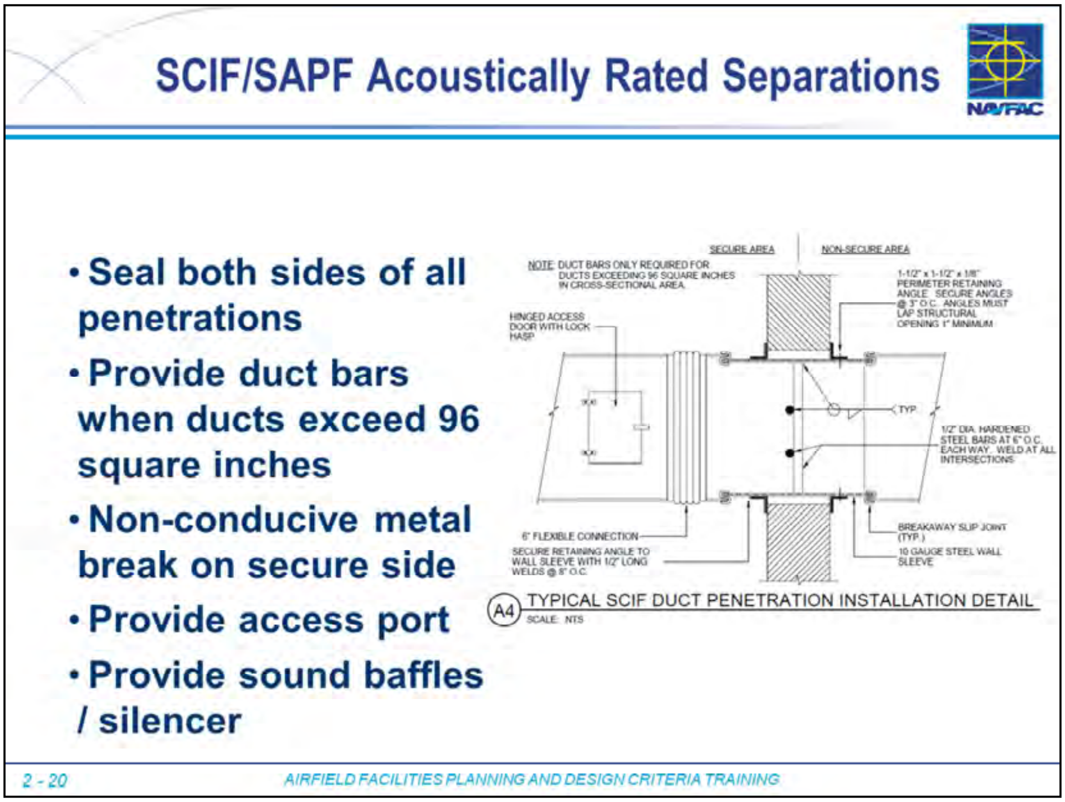
- **Corner and Joint Details must accommodate Field Construction Challenges:**
  - **Corner Conditions at Walls**
  - **Control Joints**



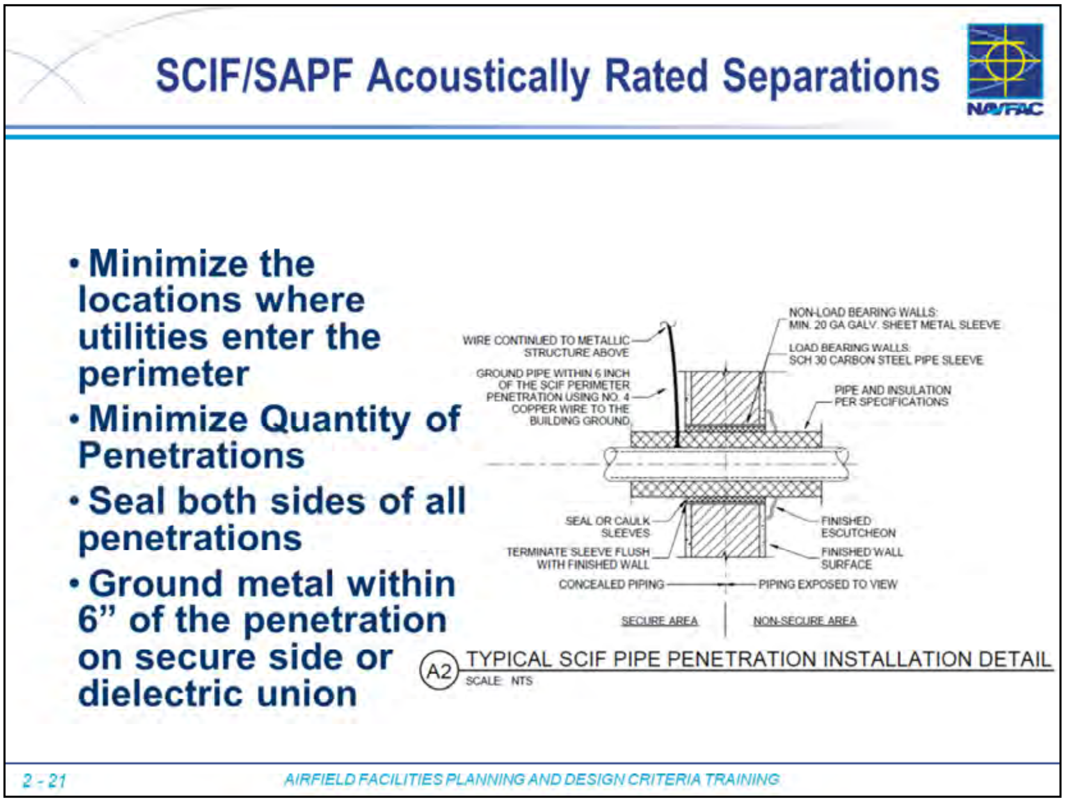
D3 PLAN DETAIL-STC 50 CONTROL JOINT
SCALE: 1 1/2" = 1'-0"



REMEMBER: The perimeter and the penetrations to the perimeter is the primary focus of design and construction.

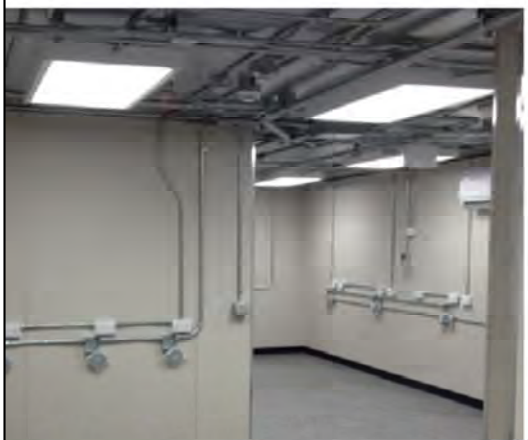


REMEMBER: The perimeter and the penetrations to the perimeter is the primary focus of design and construction.



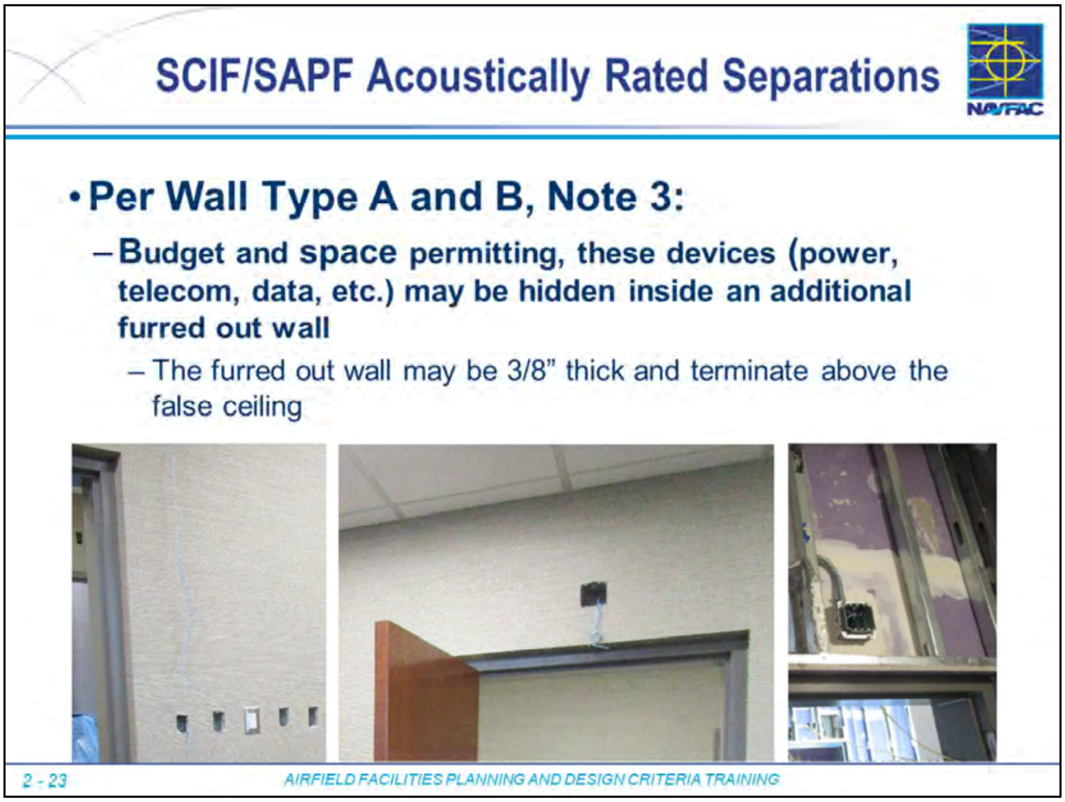
Utilities servicing areas other than a SCIF shall not pass through the SCIF

SCIF/SAPF Acoustically Rated Separations



- Per Wall Type A and B, Note 3:
  - All devices and conduit required on these STC rated walls must be surface mounted (attach w/ tight screws which do not create air gaps)

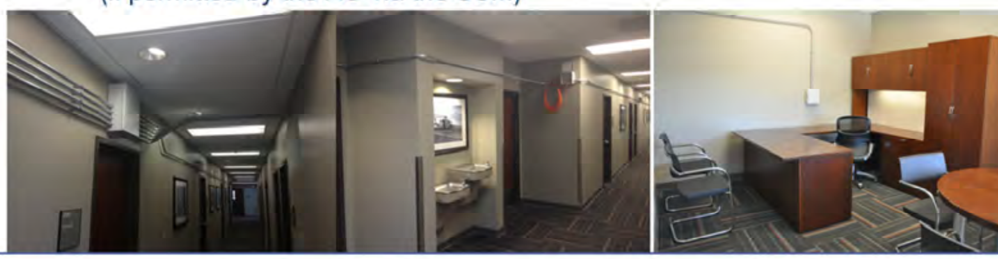
REMEMBER: The perimeter and the penetrations to the perimeter is the primary focus of design and construction.



No recessed fire extinguisher cabinets on walls treated for acoustic or RF (perimeter walls).

SCIF/SAPF – TEMPEST Countermeasure

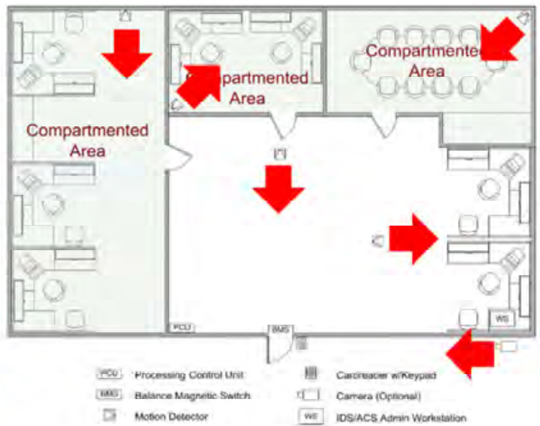
- Protected Distribution Systems (PDS).
  - A signal distribution system (raceway, conduit or duct) containing unencrypted National Security Information (NSI) which enters an area of lesser classification, an unclassified area or uncontrolled (public) area must be protected according to the requirements of the current PDS standard.
  - For a SCIF, that means a signal distribution system containing unencrypted NSI that leaves the SCIF
  - Instead of fully exposed and inspectable, you can also use Alarmed Cable (if permitted by the AO via the SSM)



Instead of fully exposed and inspectable, you can also use Alarmed Cable (if permitted by the AO via the SSM).

SCIF/SAPF – Intrusion Detection Systems

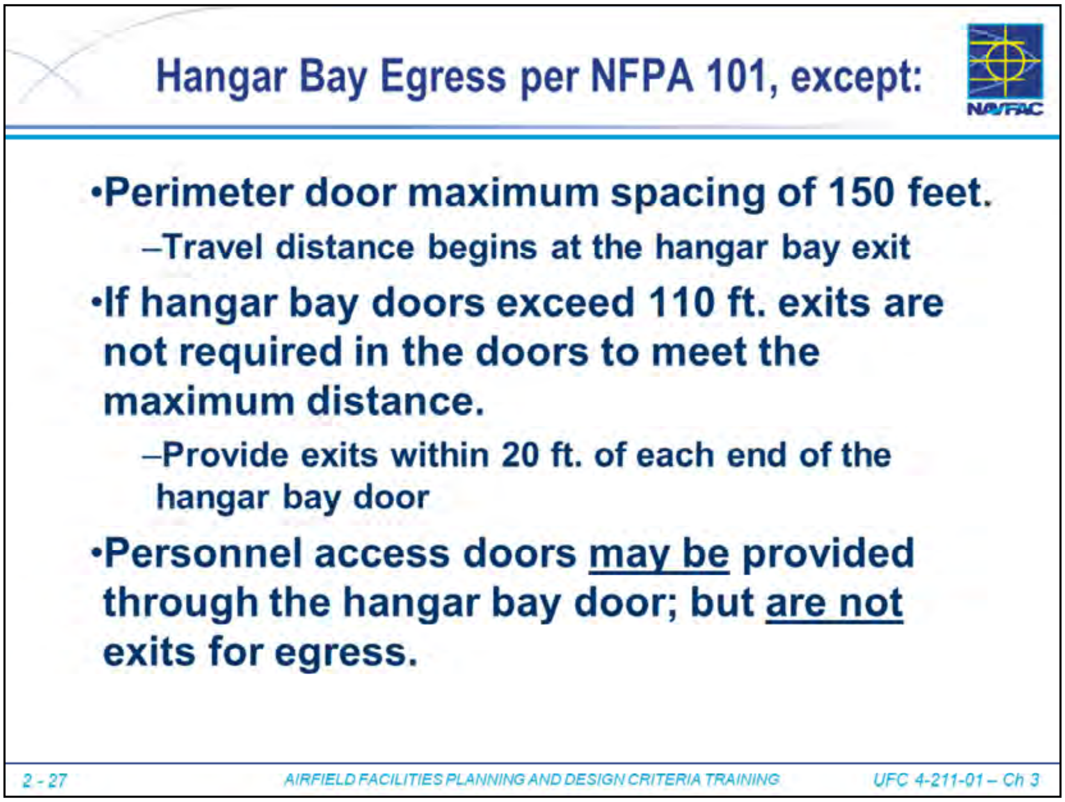
- Provide point sensors on all doors, and man-passable openings.
- Provide motion sensors within SCIF to protect all windows, doors, and man-passable openings and detect movement within the SCIF to include compartmented areas.
- Motion detection sensors are not required above false ceilings or below false floors; however, these detectors may be required for critical and high threat facilities outside the U.S.



Notes:

- Point sensor protect door
- Motion sensor monitoring door and space with access to SCI
- Camera (optional) monitors primary entrance - No cameras within SCIF
- Card reader with keypad located at primary entrance
- PCU and administrative workstation located within SCIF

Note: The clear space is permitted to be around a group of buildings, where those buildings are considered a portion of one building on the same lot as defined by IBC.

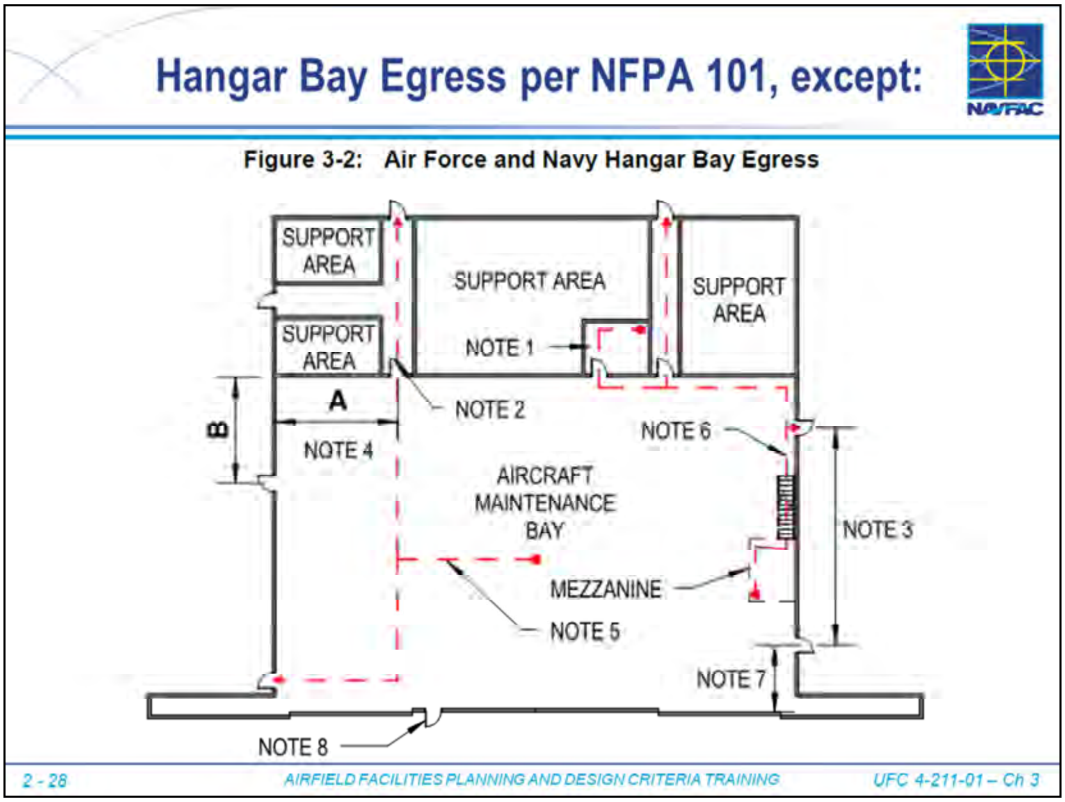


Install an egress door in the structure between hangar bay doors, when the structure is greater than 7 ft. in width. Provide this door regardless of whether the 110 ft. limitation is exceeded.

Provide each required exit or exit access door from the hangar bay with panic hardware, and swing the door in the direction of egress travel.

Support areas are not permitted to have their required egress through the hangar bay with the exception of normally unoccupied rooms less than 100 sq. ft. This limitation is not inclusive of equipment platforms as defined by IBC.

Do not exceed a travel distance of 75 ft. from the most remote location on the mezzanine to an exit or exit access. Equipment platforms as defined per IBC are not considered mezzanines.



Air Force and Navy Egress Notes:

1. Normally unoccupied rooms less than 100 sq. ft. (9.3 sq. m) may have their sole means of egress through the hangar bay.

2. Travel distance limitations begin at the door from the hangar bay.

3. Except where noted, do not exceed 150 ft. (45.7 m) between exits and exit access doors along the hangar bay perimeter.

4. Do not exceed a cumulative total of 150 ft. (45.7 m) for the distance of A + B.

5. Except where noted, travel distance limitations do not apply within the hangar bay.

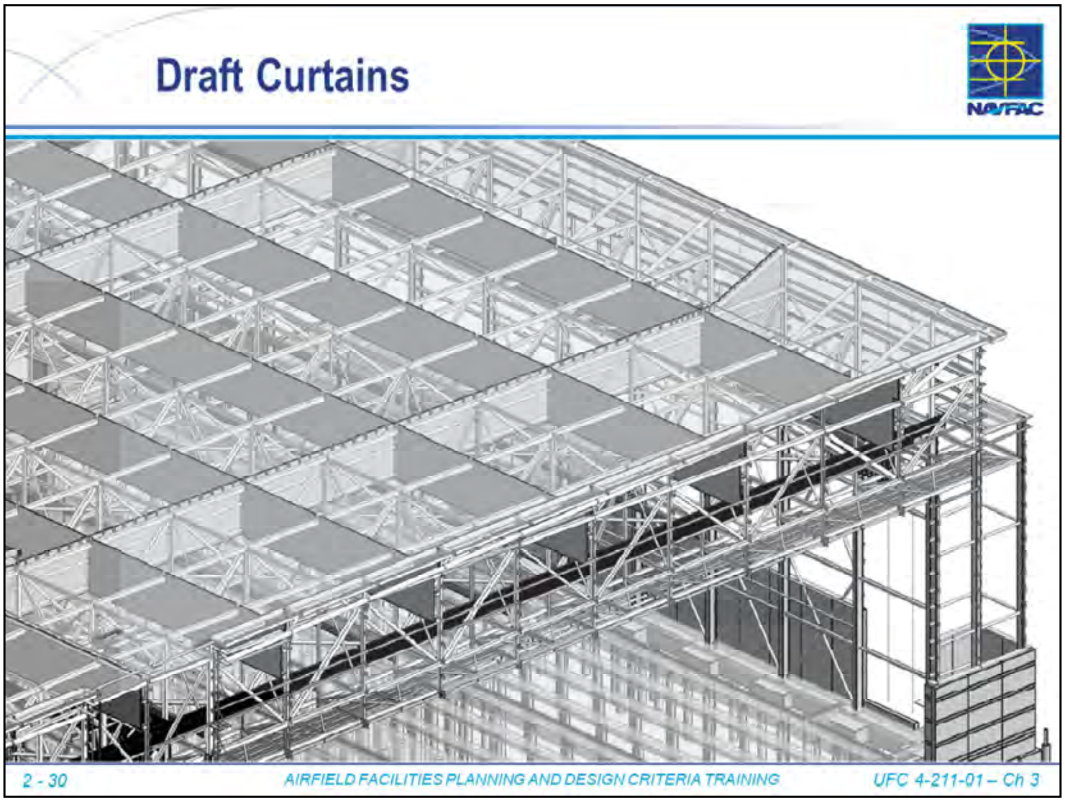
6. Do not exceed a travel distance of 75 ft. (22.9 m) from the most remote location on the mezzanine to an exit or exit access.

7. Where the hangar bay door opening exceeds 110 ft. (33.5 m), provide the first exit or exit access within 20 ft. (6.1 m) of the hangar bay door opening.

8. Personnel doors are permitted in the hangar bay door, however they are not considered exits for egress.

Draft Curtains

- Navy (7.6.1): Classify all hangars as Group I in accordance with NFPA 409
  - Draft Curtains Required
- Air Force (5.6.1) and Army (6.6.1): Classify hangars as Group I, II, III, or IV in accordance with NFPA 409 (per Change 3)
  - Draft Curtain may be omitted if Group II (door less than 28 feet in height) and less than 40,000sf fire area, consult your AF/Army AHJ



Provide draft curtains in accordance with NFPA 409 and the following requirements.

Steel sheeting (we use steel deck) 26 gage or thicker.

Aluminum, fiberglass reinforced plastic or other plastic materials are not permitted.

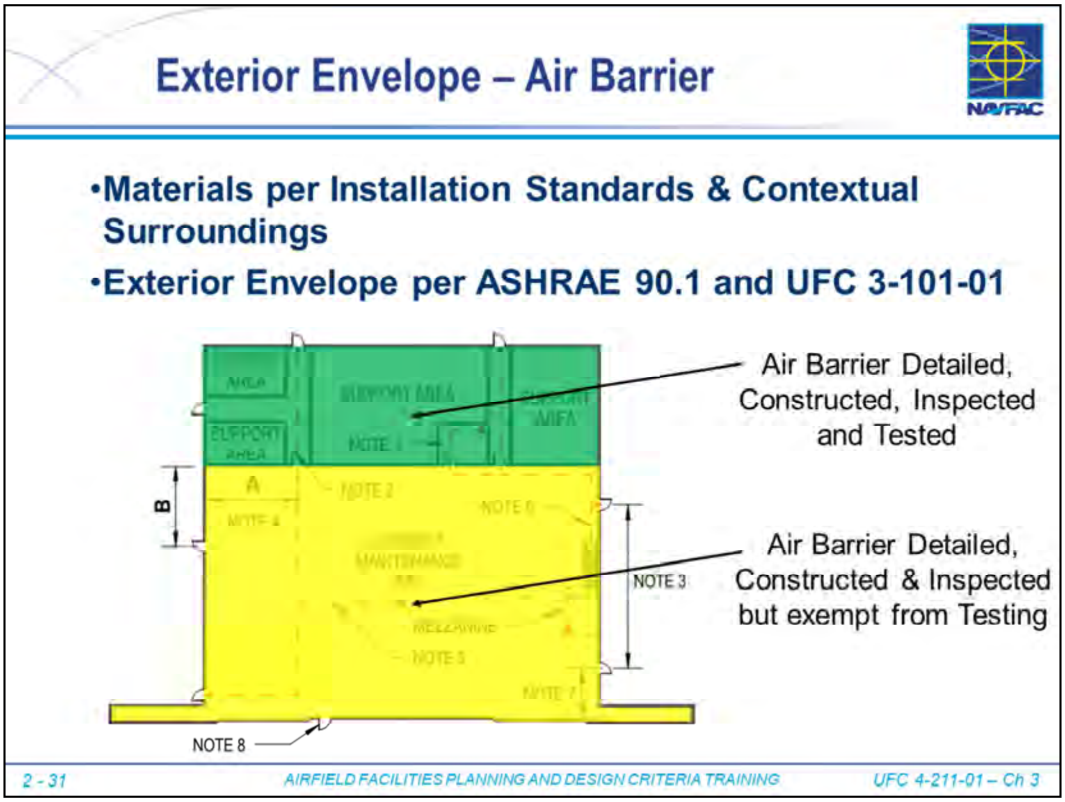
Fit the curtain tightly against the underside of the roof. Use mineral wool, ceramic fiber or another approved fire stop material to fill steel deck flutes or other gaps through the curtain.

Install draft curtains to form rectangular roof pockets of 7,500sf.

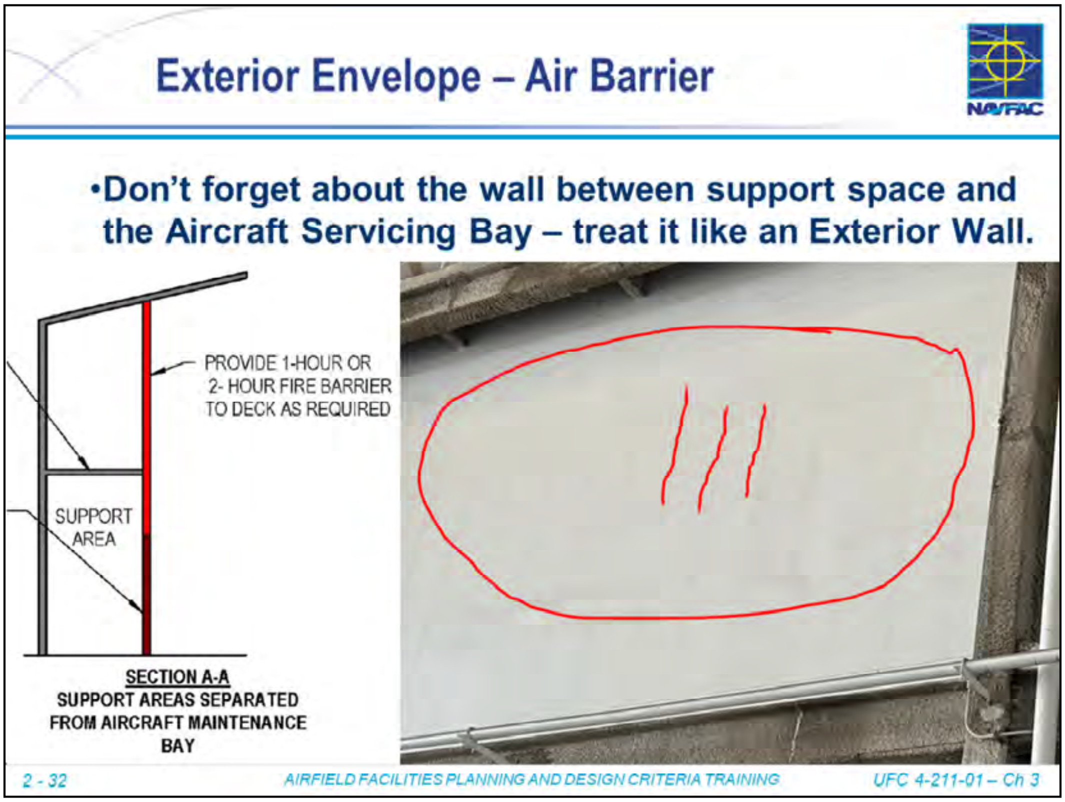
Where structural roof supports extend below the roof or ceiling, install draft curtains on structural roof supports to the extent practical.

Construct the bottom edge of the draft curtain at a constant height above and parallel with the finished floor.

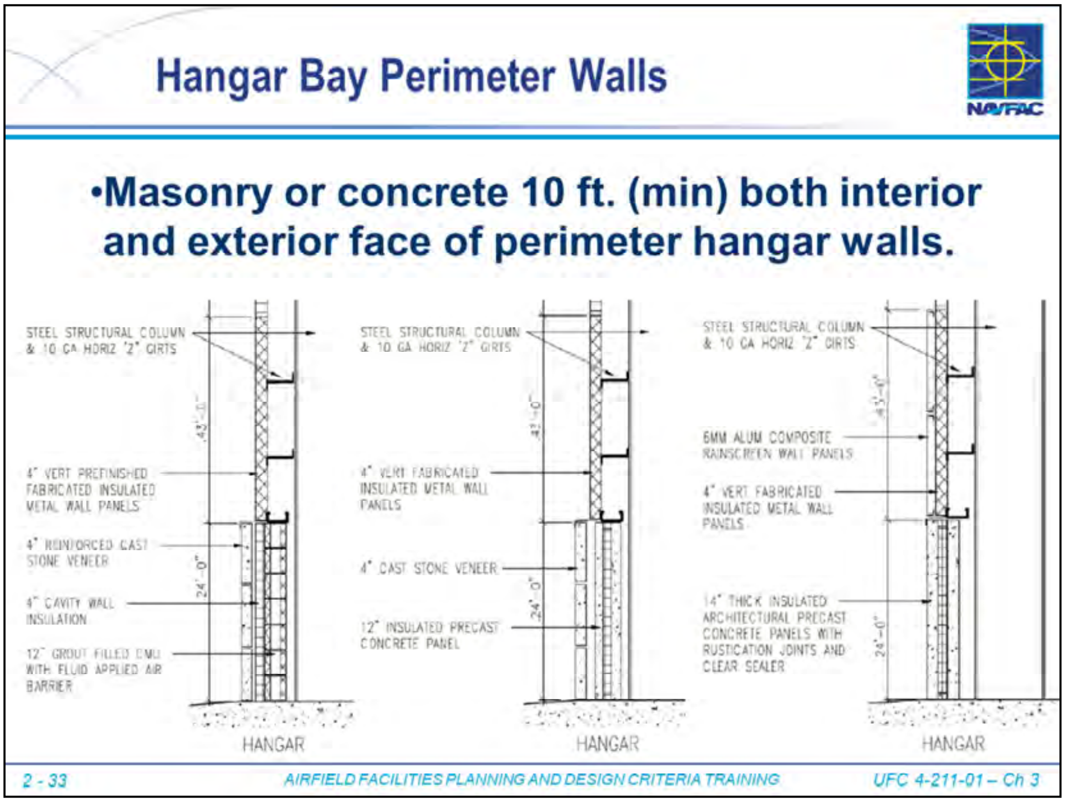
Draft curtains are not required to extend below the tail height of the aircraft plus the clearance dimension in Table 2-1: Minimum Aircraft Maintenance Bay Clearances.



Note different environmental conditions between the OH spaces and the 01/02 spaces and the need for an Air barrier separation between the two major areas.

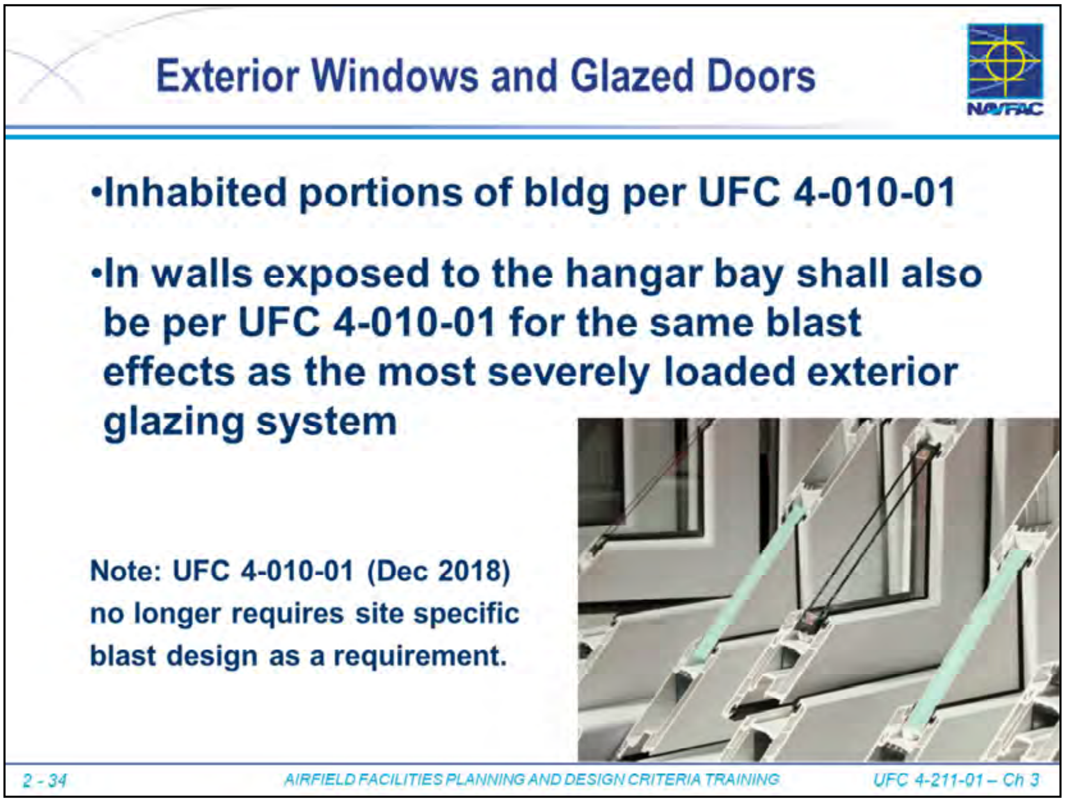


Note different environmental conditions between the OH spaces and the 01/02 spaces and the need for an Air barrier, Insulation, and think about thermal bridging.



Masonry and/or Concrete provides the desired durability on the lower (wear) surface.

Images shown above are from a hangar exterior wall study performed by FSB, and the concrete materials (24') exceeded the minimum of 10'.



1/4 inch laminated glass will consist of two nominal 1/8 inch glass panes bonded together with a minimum of a 0.030 inch interlayer of a material designed for blast resistance.

Roof System per UFC 3-110-03, except

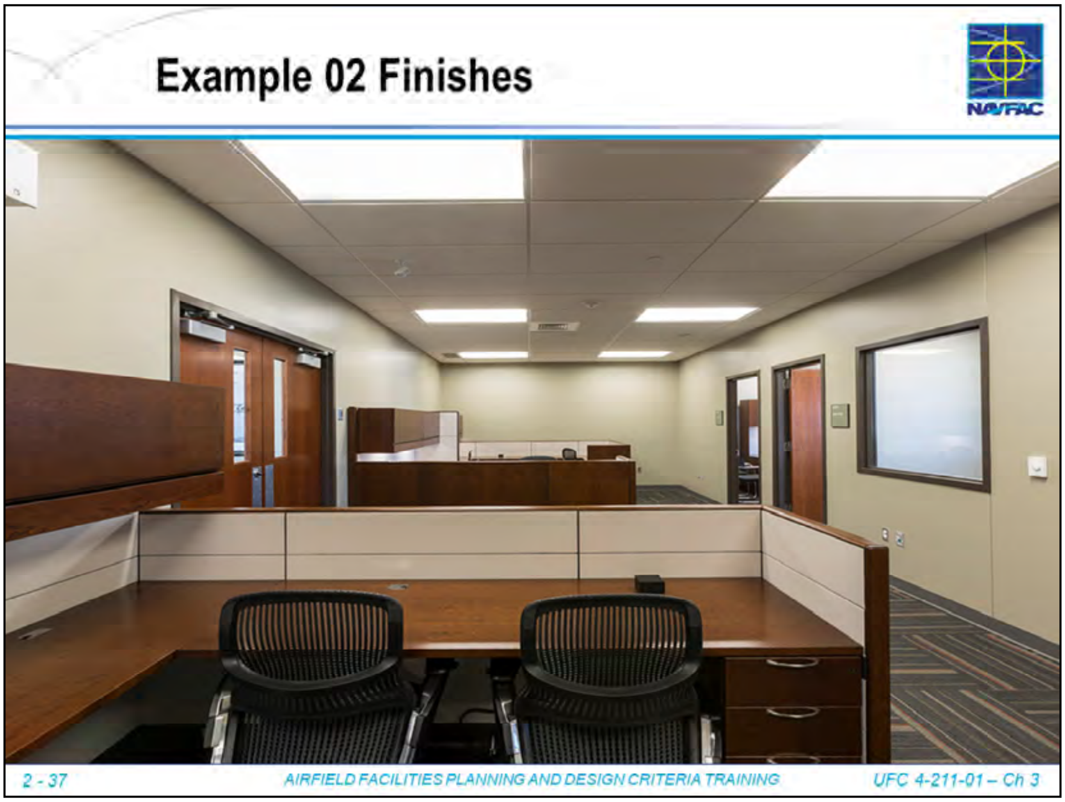
- No aggregate or vegetative roofs (FOD)
- Slope roof away from hangar doors and apron
- Slope roof away from airfield (unless taken below grade to stormwater drain system)

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

Reminder: Solar Glare Analysis required for PV along with approval of the Airfield Manager

Interior Finishes

- Interior Finishes, Doors, Hardware, Durability, Signage and Elevators
  - The following photos are illustrative examples of the above requirements in various spaces.



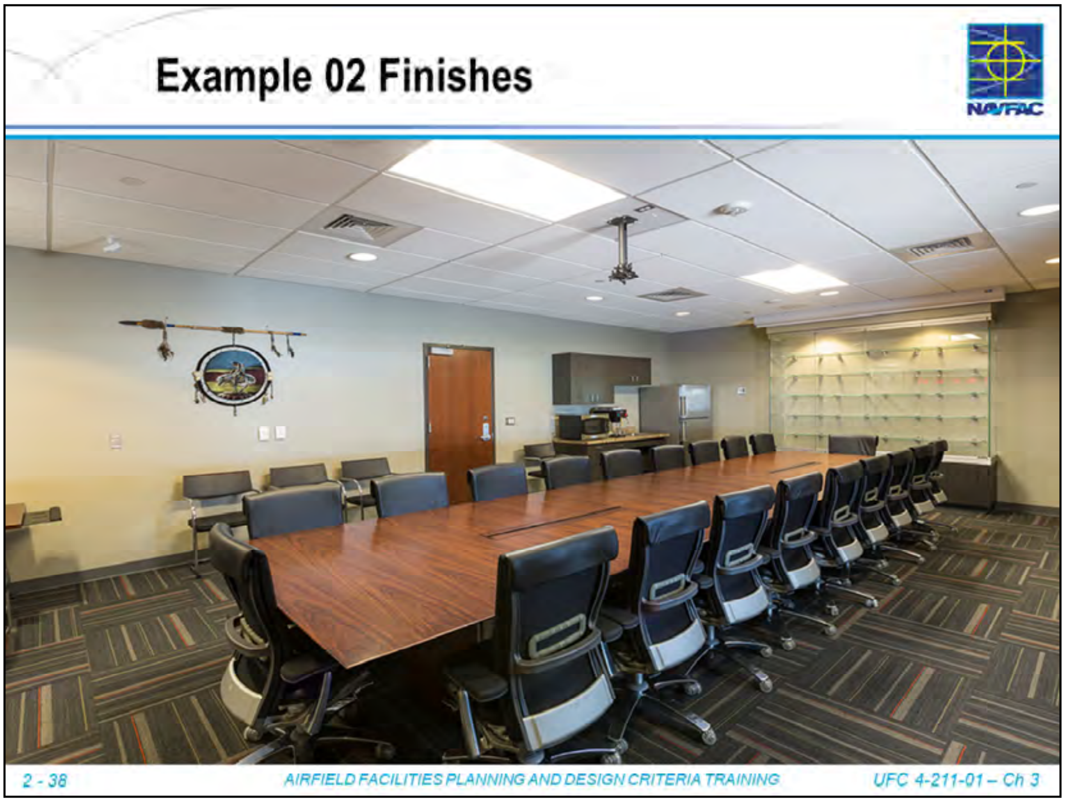
Interior Partitions: Extend partitions up to the bottom of the floor/roof construction above for the following areas:

• Commanding Officers Office • Executive Officers Office • Conference or Briefing Rooms • Classrooms or Training Rooms • Rooms or offices with secure communication systems • Corridors • Perimeter of toilet and locker room areas • Offices and operational spaces where privacy issues are of significant concern • Flight planning

Stairs: In stairs, provide resilient flooring and stair accessories, painted concrete, masonry or impact resistant gypsum wall board up to a minimum of 8 ft. (2.44 m) above stair level.

Upper Level: Finish upper level spaces similar to commercial office spaces.

Operational Administration: Provide carpet tile, resilient base, painted gypsum board walls and suspended acoustical ceiling systems.



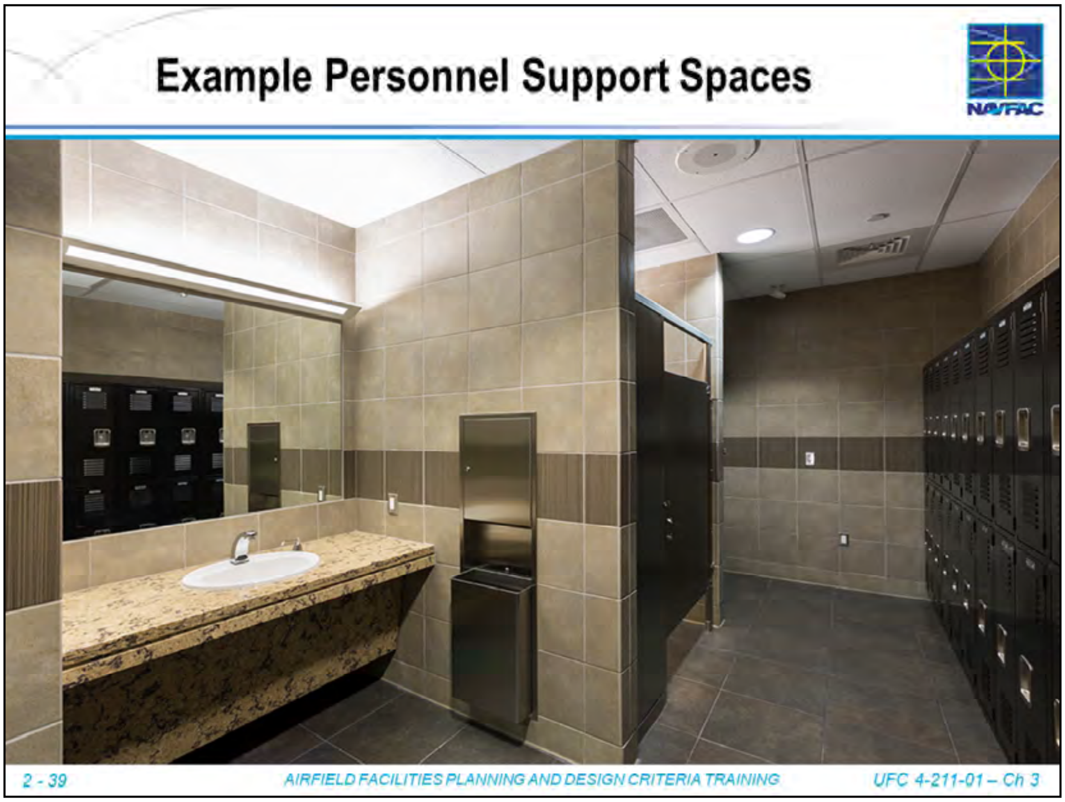
Interior Partitions: Extend partitions up to the bottom of the floor/roof construction above for the following areas:

• Commanding Officers Office • Executive Officers Office • Conference or Briefing Rooms • Classrooms or Training Rooms • Rooms or offices with secure communication systems • Corridors • Perimeter of toilet and locker room areas • Offices and operational spaces where privacy issues are of significant concern • Flight planning

Stairs: In stairs, provide resilient flooring and stair accessories, painted concrete, masonry or impact resistant gypsum wall board up to a minimum of 8 ft. (2.44 m) above stair level.

Upper Level: Finish upper level spaces similar to commercial office spaces.

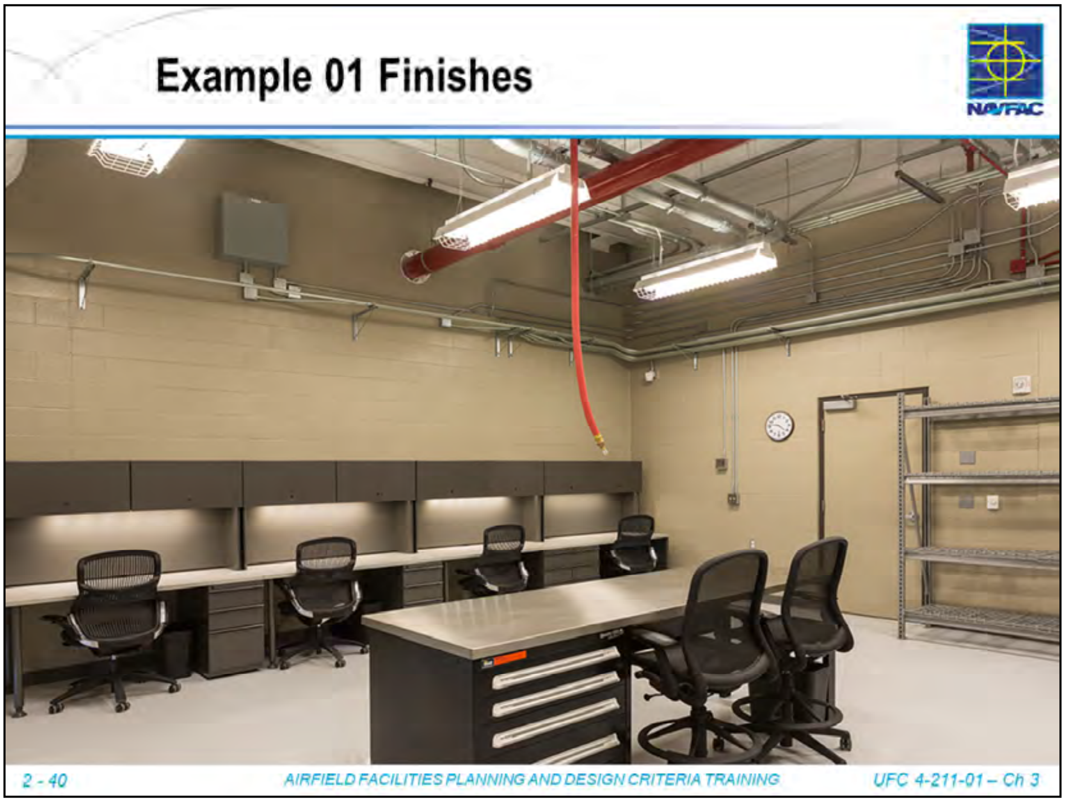
Operational Administration: Provide carpet tile, resilient base, painted gypsum board walls and suspended acoustical ceiling systems.



Personnel Support: Provide porcelain tile floors in shower, toilet and locker rooms. Provide painted concrete or masonry partitions around shower, toilet, and locker rooms. Provide full-height or wainscot-height ceramic or porcelain tile at "wet" walls, at a minimum. Provide moisture-resistant gypsum board or moisture-resistant suspended acoustical ceiling system. In support spaces such as break rooms provide resilient flooring or seamless resinous flooring, painted gypsum board walls and suspended acoustical ceiling system.

Building Support: Provide sealed concrete floors and painted masonry or concrete walls and unpainted exposed bottom of floor/roof construction above.

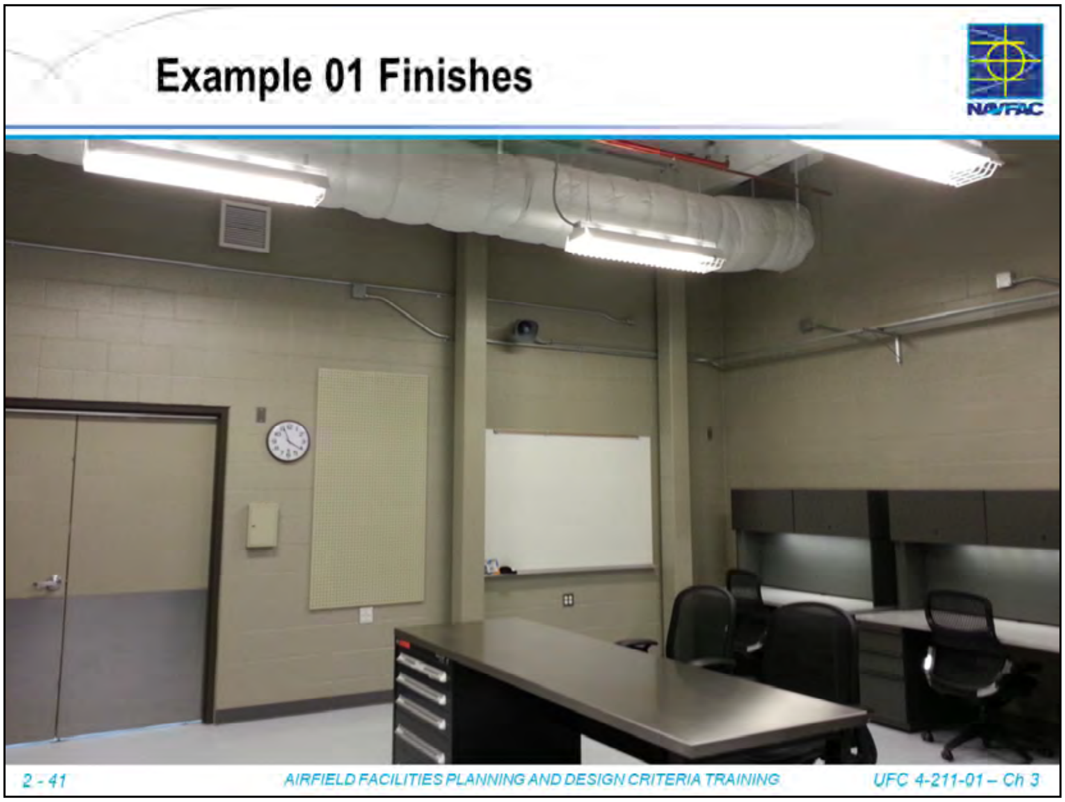
Corridors: Provide flooring equal to the most durable finish provided in the spaces served by the corridor. Provide 5-coat fuel resistive resinous flooring in corridors providing indirect access to heavy maintenance shops. Provide resilient flooring or 3-Coat fuel resistive resinous flooring in corridors serving light maintenance shops. Provide sealed concrete or resilient flooring in corridors serving only personnel and building support spaces. Provide painted concrete, masonry or impact resistant gypsum board walls, resilient base, and suspended acoustical ceiling systems. Provide full-height corner guards at all exterior corners, including columns.



Ceilings: The following spaces may have exposed ceiling structure: • Hangar Bay • Maintenance Shops • Corridors (Ground Level) and Stairs • Building Support Spaces

Maintenance Administration: Provide resilient flooring, painted walls, resilient base, and suspended acoustical ceiling systems. Partitions separating administrative spaces may be gypsum board on metal stud construction. Partitions may extend to above the ceiling for similar office types and spaces where noise between offices is not an acoustical issue.

Light Maintenance Shops: Provide resilient flooring or 3-coat fuel resistant resinous flooring. Provide painted gypsum board on metal stud walls and suspended acoustical ceiling systems. Provide static dissipative flooring in electronics, avionics, paraloft, flight gear, ordnance shops and other spaces as required by the user.

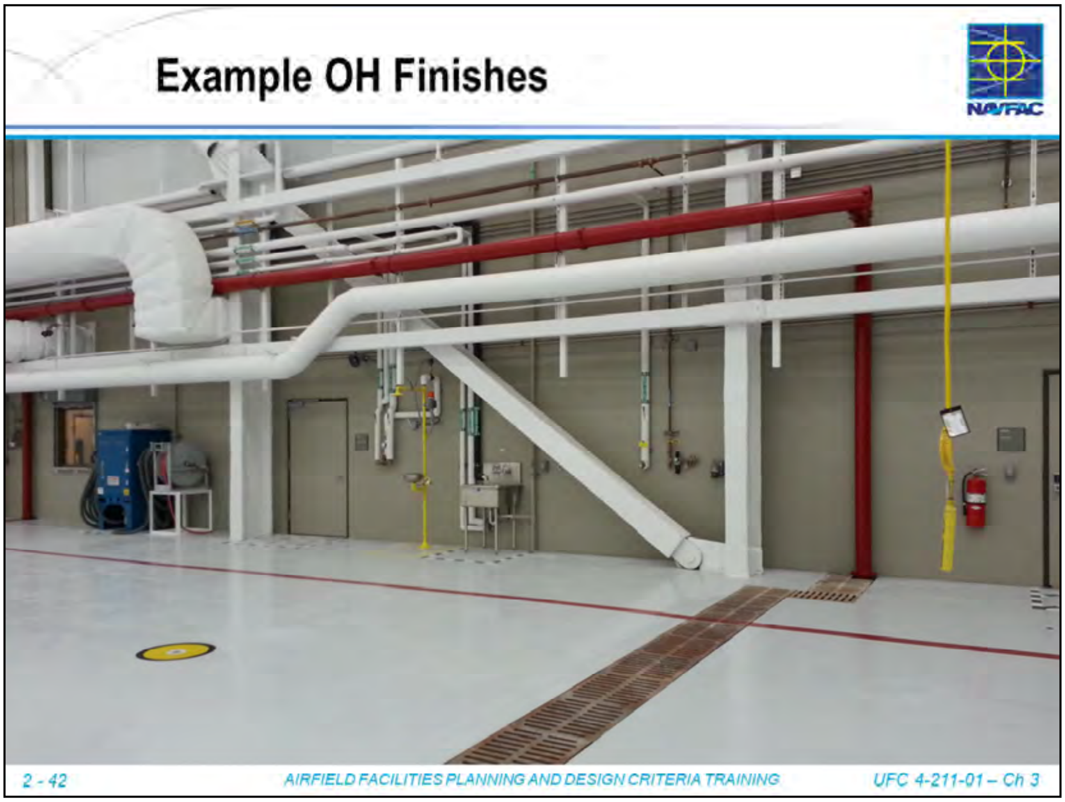


Ceilings: The following spaces may have exposed ceiling structure: • Hangar Bay • Maintenance Shops • Corridors (Ground Level) and Stairs • Building Support Spaces

Maintenance Administration: Provide resilient flooring, painted walls, resilient base, and suspended acoustical ceiling systems. Partitions separating administrative spaces may be gypsum board on metal stud construction. Partitions may extend to above the ceiling for similar office types and spaces where noise between offices is not an acoustical issue.

Heavy Maintenance Shops: Provide light gray, 5-coat fuel resistive resinous flooring system with striping for safety markings. Coordinate colors, striping and grit level with the users. Provide painted concrete or masonry walls up to 10 ft. (3.0 m) minimum around perimeter of each shop. Provide painted exposed ceilings.

Storage: Provide sealed concrete floors, painted masonry or concrete walls, painted exposed ceilings.



Aircraft Maintenance Bay: Slope Aircraft Maintenance Bay floors to prevent liquid spills from flowing into adjacent areas in compliance with NFPA, IBC, and ABA. Provide light gray 5-coat fuel resistive resinous flooring with striping of safety lanes, lead-in lines, nose gear stop lines, grounding points, and other safety markings. Coordinate colors, striping and grit level with the users. Provide a grit level meeting OSHA slip resistance requirements.

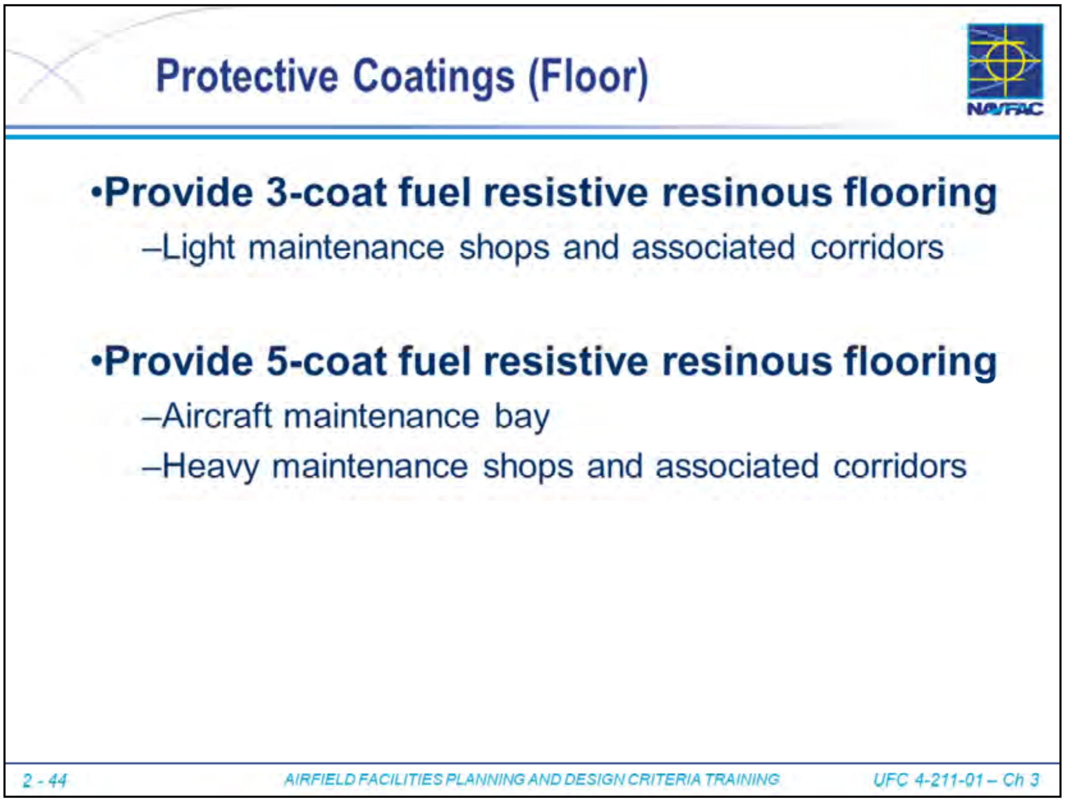
Provide painted masonry, or concrete construction to a minimum of 10 ft. (3.0 m) Above Finished Floor (AFF) around perimeter of Aircraft Maintenance Bays except at hangar door. Refer to 3-3.1: Construction, Life Safety, and Fire Fighter Access for fire rated separations between the Aircraft Maintenance Bay and other spaces. A wall base is not required in the hangar bay.

Example OH Floor Finishes

Fuel Resistive Epoxy Floor

Sealed Concrete

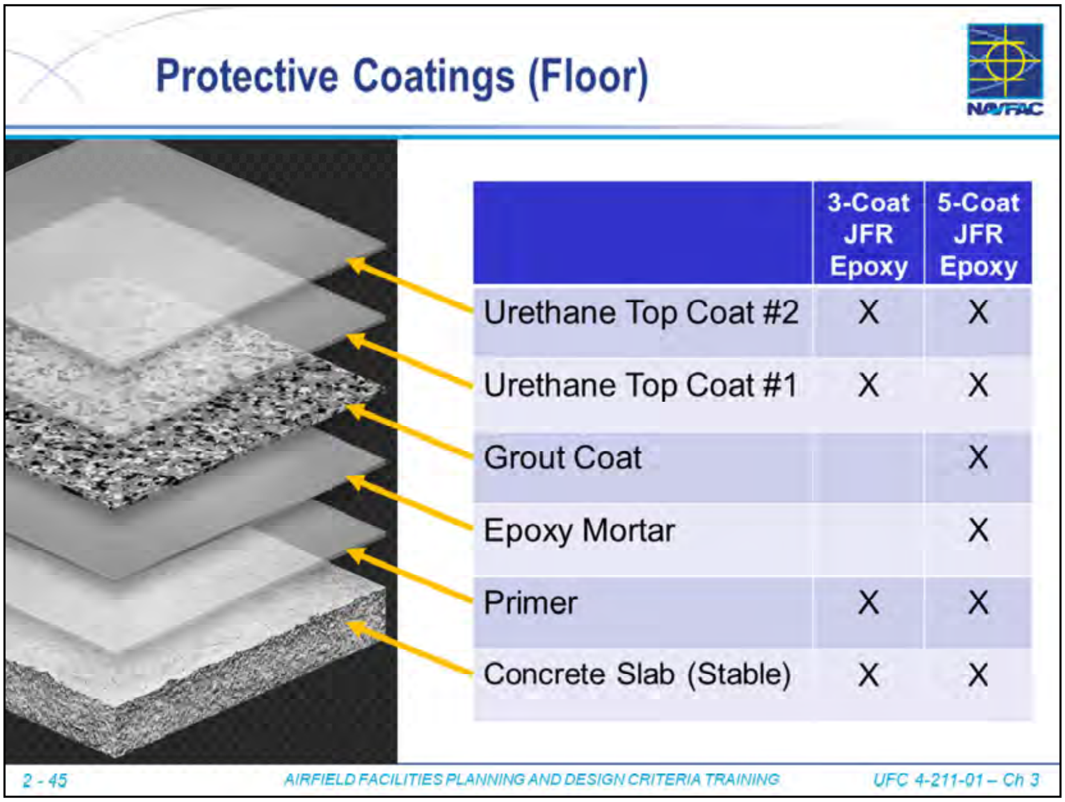
Dry Shake Floor Hardener



Provide 3-coat fuel resistive resinous flooring per UFGS 09 67 23.15. Provide striping safety markings. Coordinate colors, striping and grit level with the users. Do not use spray-on curing compounds. Specify the manufacturer's Moisture Vapor Reducer coating and then don't use it if the concrete test come in at acceptable vapor emissivity rates.

Provide 5-coat fuel resistive resinous flooring per UFGS 09 67 23.16. Provide striping of safety lanes, lead-in lines, nose gear stop lines, grounding points, emergency eye wash fixtures, fire extinguishers and other safety markings. Coordinate colors, striping and grit level with the users. Provide grit to meet OSHA Requirements for wet floors. Refer to Chapters 5, 6, and 7 for figures showing Service-specific striping requirements. Do not use spray-on curing compounds. Specify the manufacturer's Moisture Vapor Reducer coating and then don't use it if the concrete test come in at acceptable vapor emissivity rates.

Watch slab design and vapor emissions (and follow specifications and manufacturer’s requirements).



UFGS 09 67 23.15: FUEL RESISTIVE RESINOUS FLOORING, 3-COAT SYSTEM (read all of the great notes in this spec section)

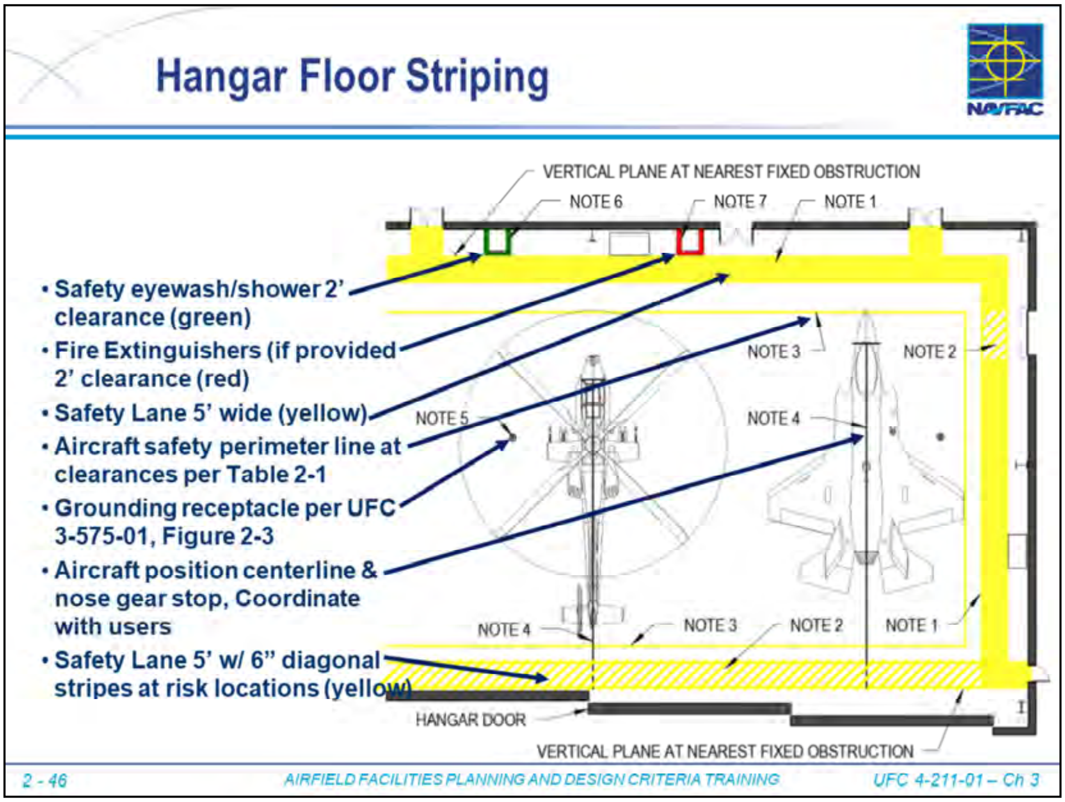
A three-coat flooring system consisting of primer and two urethane topcoats with broadcast of aluminum oxide non-skid grit

Installation costs: $2.00 to $4.50 per square foot. Nominal thickness: 15.0 mils. Can be rejuvenated by replacing urethane topcoats, and non-skid, only. Approximate service life: Urethane top coating with non-skid grit at three or more years.

UFGS 09 67 23.16: FUEL RESISTIVE RESINOUS FLOORING, 5-COAT SYSTEM (read all of the great notes in this spec section)

A five-coat flooring system consisting of primer, epoxy mortar, grout coat, and two urethane topcoats

Installation costs: $5.00 to $10.00 per square foot. Nominal thickness: 1/4 inch. Benefits: Tolerates high Moisture Vapor Emission (MVE) rates, produces a level surface over coarse concrete, high impact resistance, good chemical resistance, and may provide a suitable topcoat base for more than 10 years service. Can be rejuvenated by replacing urethane topcoats, and non-skid, only.



Striping Notes:

1. Safety Lane; 5 ft. (1.5 m) wide stripe; color - yellow.

2. Safety Lane; 5 ft. (1.5 m) with 6 in. (152 mm) boundaries and 6 in. (152 mm) diagonal stripes at locations where there is risk of being hit by vehicles; hangar door and rolling service doors, e.g.; color - yellow.

3. Six inches wide solid white aircraft safety perimeter line following clearances per Table 2-1: Minimum Aircraft Maintenance Bay Clearances.

4. Aircraft position centerline & nose gear stop; 6" wide stripe; color – yellow or

white to match marking from outside the hangar to inside the hangar. May not be

required at multi-aircraft position hangars. Coordinate with users.

5. Grounding receptacle; paint per UFC 3-575-01, Figure 2-3.

6. Safety eyewash/shower; color - green; provide 2 ft. (610 mm) clearance from safety equipment. Slope to drain, if provided.

7. Fire Extinguishers (if provided); color - red. Provide 2 ft. (610 mm) clearance from extinguishers.

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

Discussion Points:

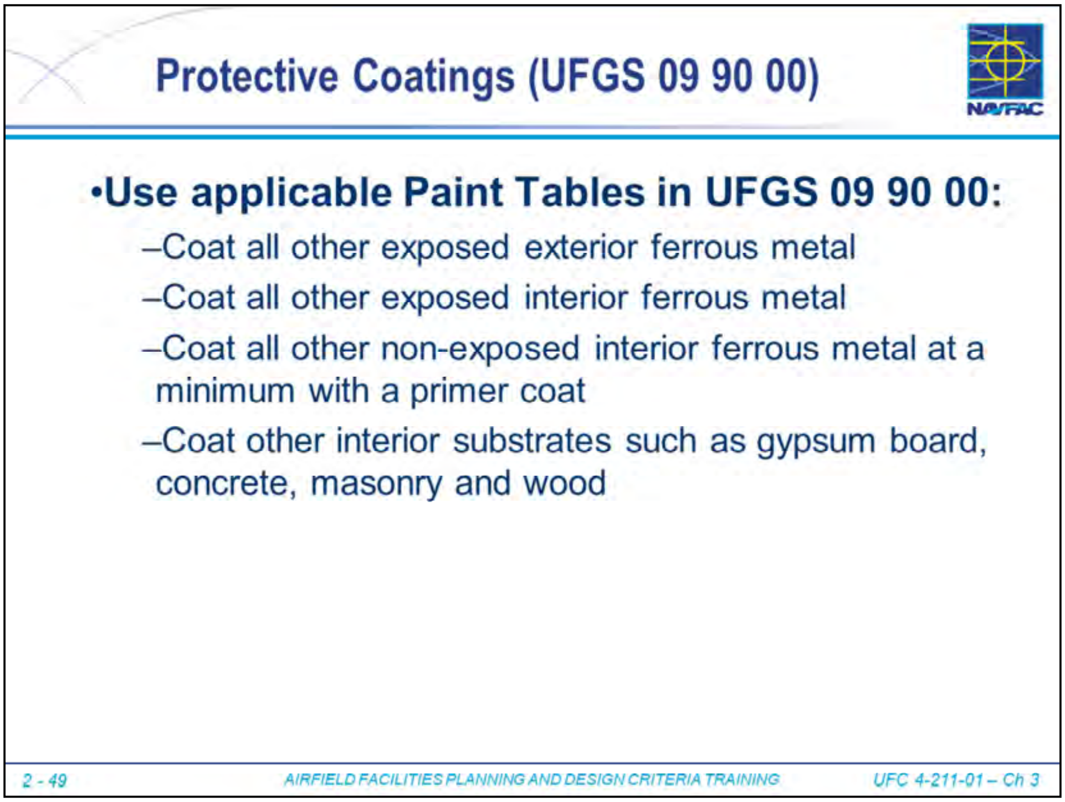
Importance of the heavy duty epoxy coating system and why it is specified

Why it needs to be shop coated

Importance of making sure architectural drawing notes on finishes and specs are carefully coordinated (between this and 09 90 00)

Protective Coatings (UFGS 09 97 13.27)

- Exterior (primary and secondary), Interior Hangar Bay (primary and secondary), and Hangar Door Steel



UFGS 09 90 00 – this is the standard paint spec with the standard paint tables.

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

Category	Seismic	Snow	Ice	Wind*
II	1.0	1.0	1.0	118 MPH (1.0)
III	1.25	1.10	1.25	128 MPH (1.18)
IV	1.50	1.20	1.25	131 MPH** (1.23)

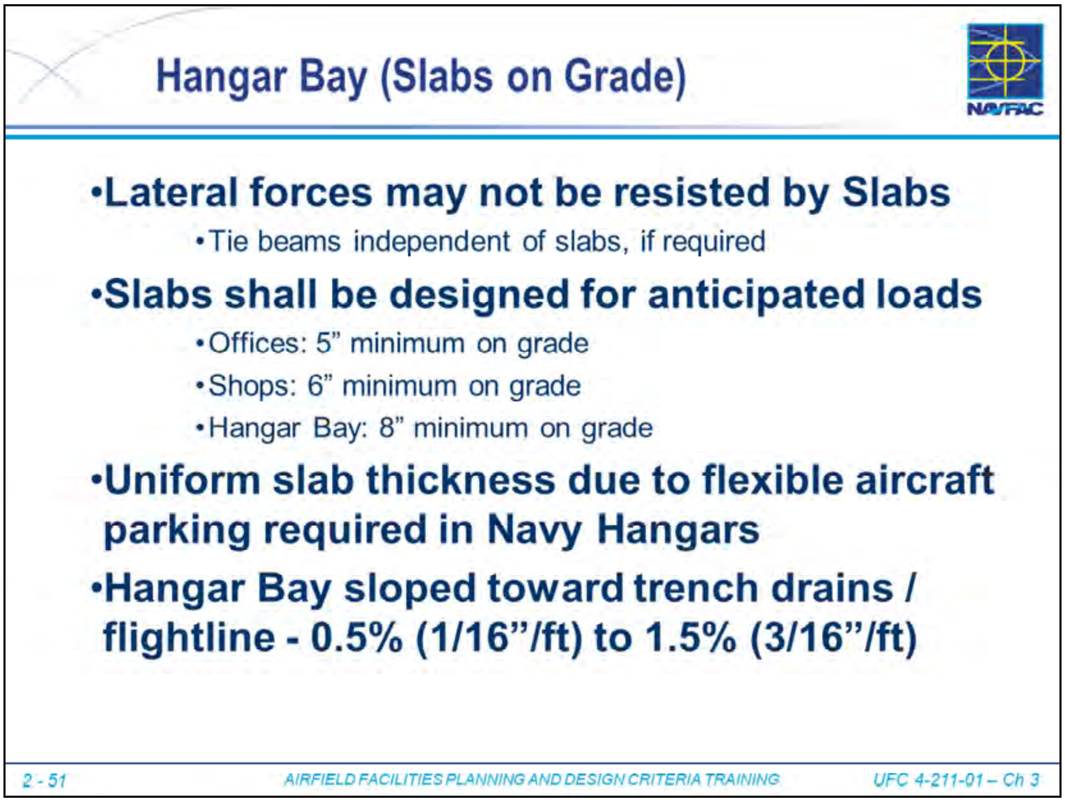
* Example wind speeds (and factors) shown per UFC 3-301-01: Naval Station Norfolk

** Wind-borne debris region within 1 mile of coastal mean high water line

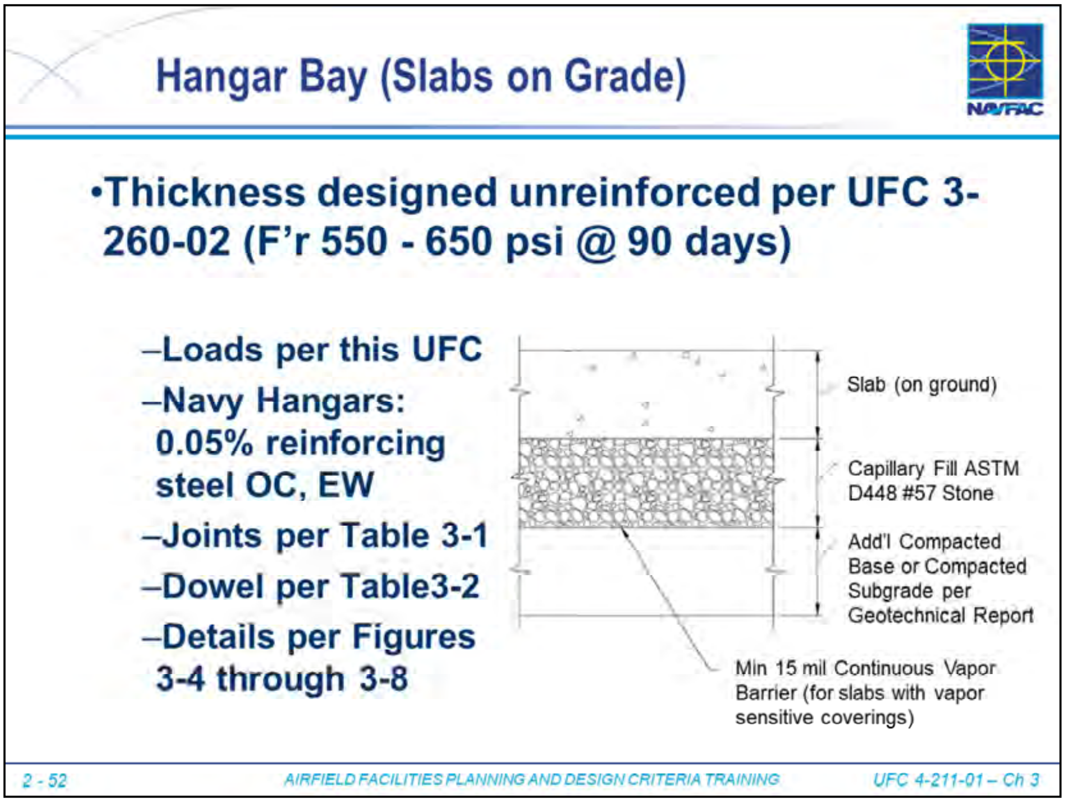
2 - 50 AIRFIELD FACILITIES PLANNING AND DESIGN CRITERIA TRAINING UFC 4-211-01 – Ch 3

This change was made to recognize high asset value of aircraft – however – this does note make a hangar a shelter for hurricanes.

AHJ – Authority Having Jurisdiction



Note: Air Force permits variable slab thickness for Single Fixed Position Aircraft Hangar Bays (in certain situations)



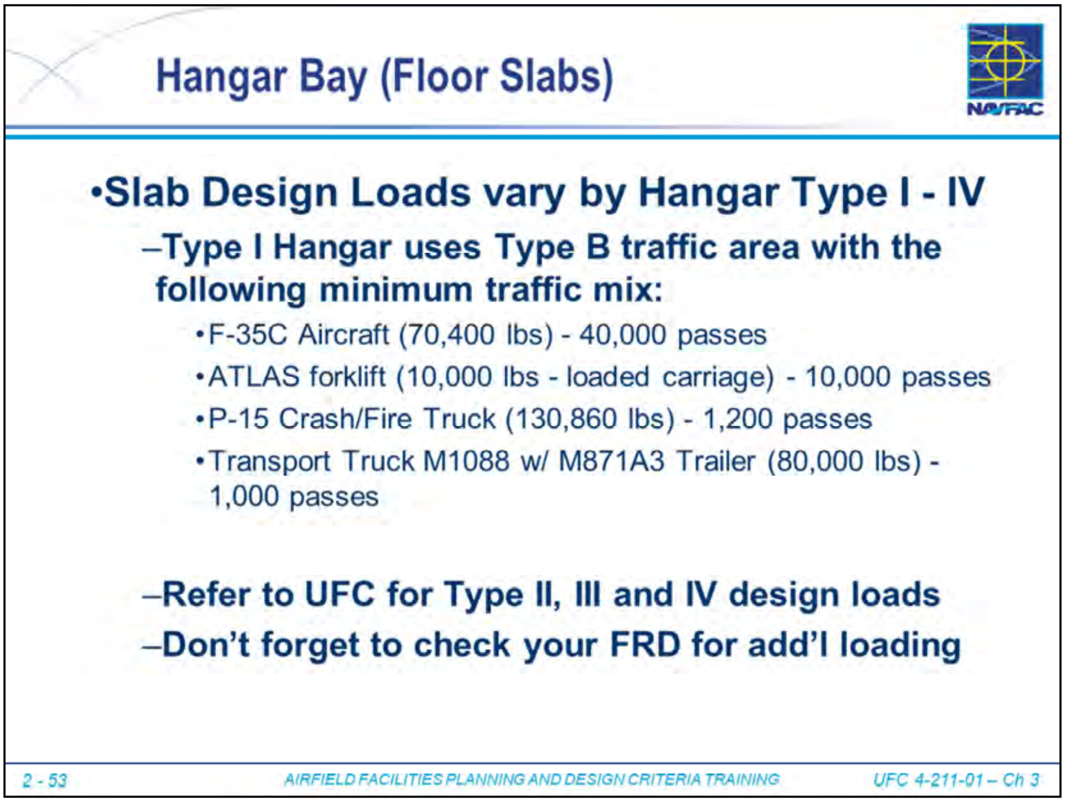
Determine the concrete slab on ground thickness for the Aircraft Maintenance Bay in accordance with UFC 3-260-02, utilizing a non-reinforced concrete section with the Service-specific minimum loads shown in this UFC. It is acceptable to design and install reinforcing for temperature and/or crack control but the reinforcing cannot be used to decrease the slab on ground thickness from the calculated non-reinforced slab thickness. If point loads other than wheel loads require a thicker slab section, then reinforcing can be utilized in the area of the point load to keep from increasing the slab thickness for the point load.

• Minimum concrete slab on ground thickness will be 8 inches. Increase slab thickness in 1/2" increments.

• Minimum concrete flexural strength will be 550 pounds per square inch (psi) at 90 days.

• In hangar bays that allow for multiple aircraft parking positions, provide a uniform slab on ground design throughout the hangar bay. Do not reduce the slab on ground thickness in areas not subject to the design aircraft wheel loads.

For Navy: Utilize a minimum of 0.05% reinforcing steel in both directions in the aircraft maintenance bay slab on ground.



7-4.1.1 Type I Hangar

Use 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 and M871A3 Trailer (80,000 lbs.) - 1,000 passes

7-4.1.2 Type II Hangar- Type B traffic area

7-4.1.3 Type III Hangar

7-4.1.4 Type IV Hangar

Hangar Bay (Floor Slabs)

- Other Slab Design Considerations
  - Trenches
  - Grounding Points
  - Utility Pits (if permitted)

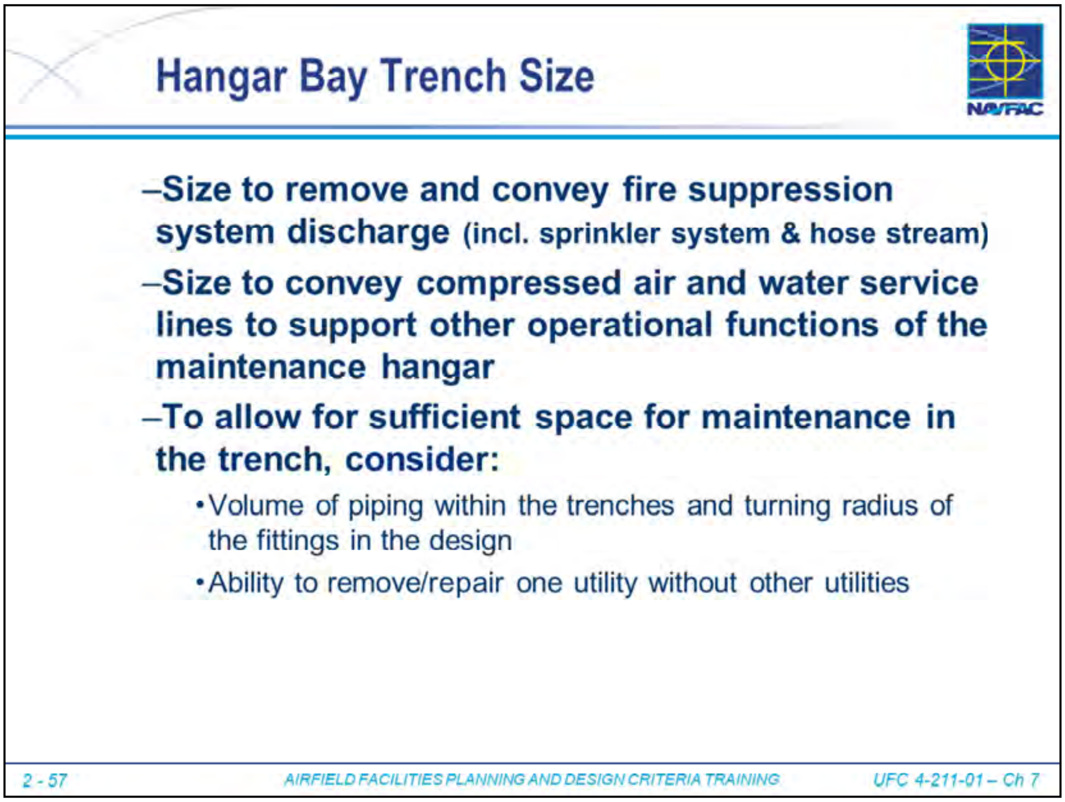
Hangar Bay Trench Drains

- **<u>Provide where and as required</u> by Chapter 7**
  - **–Slope drainage trench inverts at a minimum 0.5% towards and empty into the hangar bay door trench**
  - **–Capture <u>inadvertent</u> 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.
  - **–Provide drainage from the door <u>rails</u>**

Best Practice: Contain oil / contaminants and do not allow them to enter drains.

Note: Ductile Iron trench covers are typical, galvanized may be used if an upgrade is warranted (rare occasions).

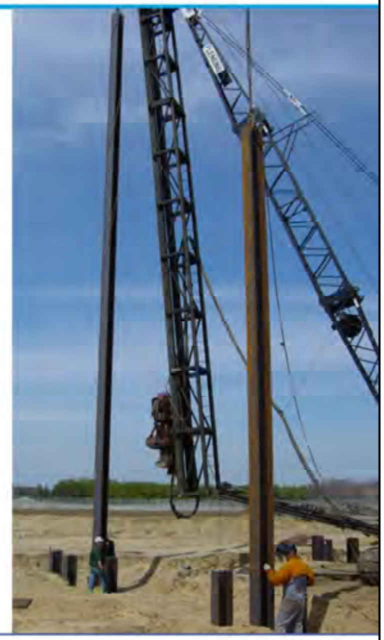
Change 2 removed the minimum proof-load of 100,000 lbs from a tire with a 250 psi pressure.



Minimum width is mandated by the ITG 19-01 when CASS is also in the trench

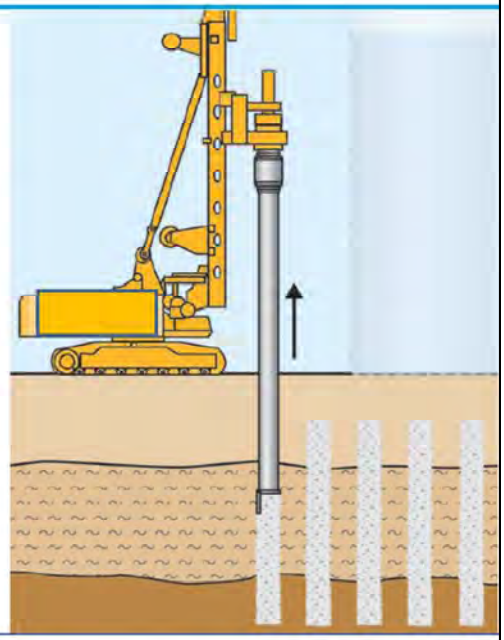
Substructure (Foundations)

- 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 design control



Soil Matrix Modifications

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

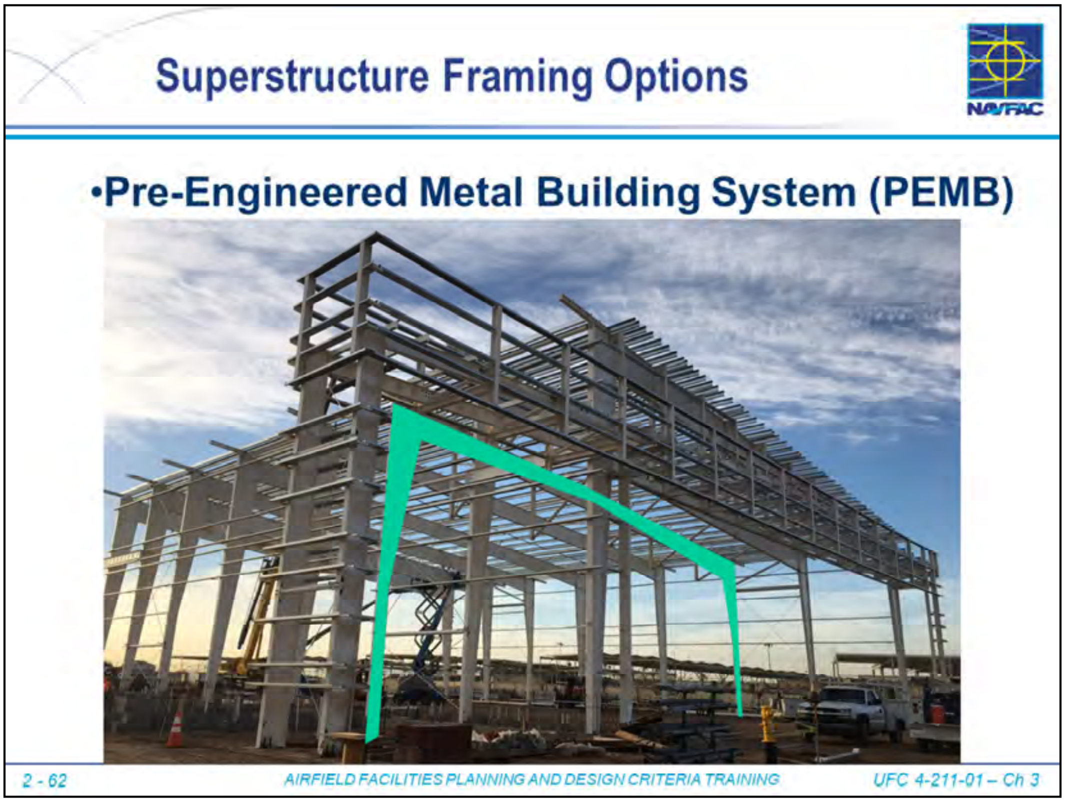


Aircraft Maintenance Bay: Traditionally, the superstructure of the Aircraft Maintenance Bay is steel framed, however, alternate framing systems can be considered with approval. Design Pre-Engineered Metal Building systems to the standards applicable to traditional steel framing, including adherence to all requirements of the American Institute of Steel Construction and this UFC.

Aircraft Maintenance Bay Superstructure and Hangar Doors: Coordinate the total anticipated roof deflection with the door manufacturer. Show on the construction documents the expected maximum deflection, both upward and downward. For cantilever roof systems, design the hangar door system to have adjustment capability to allow for final leveling after all loads are in place.

Superstructure Framing Options

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



Pros/Cons:

Typical Roof Shapes/Slopes: normally smaller span hangars, with typical metal building roof lines

When (most) Cost Effective: with typical metal building roof lines, usually smaller hangars, with shorter spans. With regular frames in one direction and orthogonal braced frames.

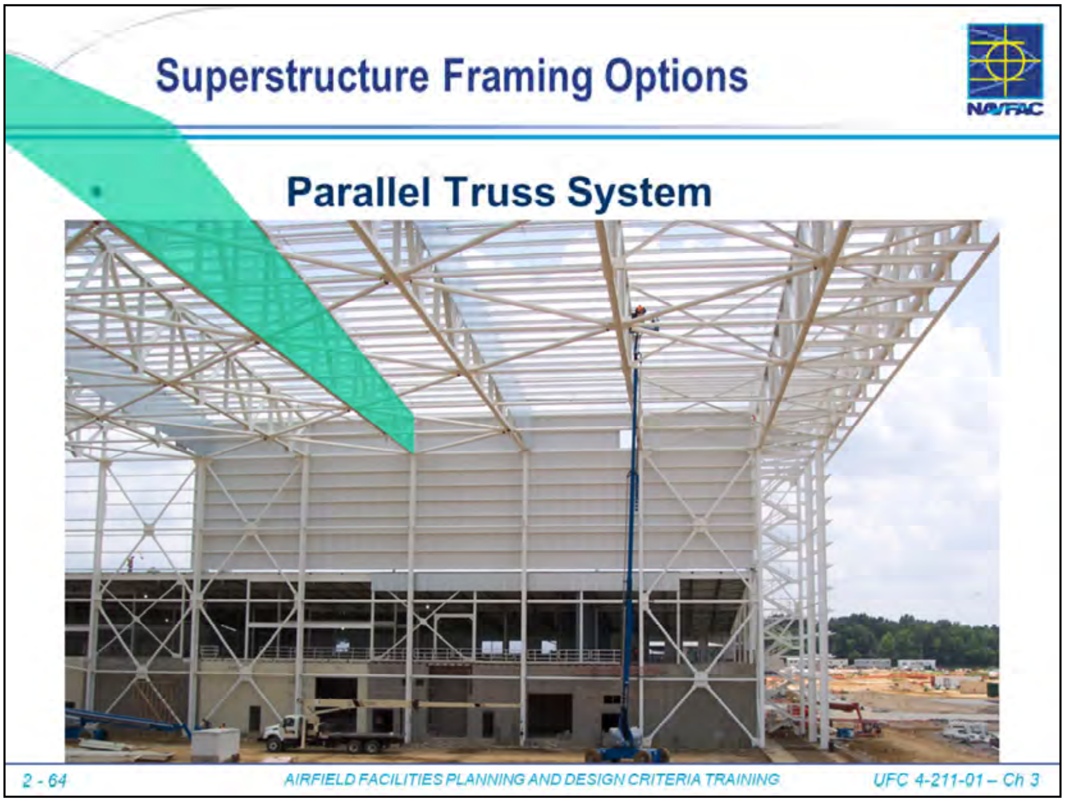
Typical Hangar Door System: horizontal rolling doors (can do VLFD, but coordination can be a challenge and really watch compatibility with horizontal and vertical building deflections)

Advantages: Very economical (design straight to fabrication) using proprietary software.

Limitations: Taller hangars with longer spans, irregular shapes, and often higher-end architectural designs. Future renovations/modifications will likely be a challenge. If there is an admin area with masonry/concrete walls or a two story building with concrete floors, this can also be an issue, and will likely not be done as a PEMB. Often drawings will not match DoD CAD standards and proprietary software and PEMB process does not lend itself to multiple design submissions.

Superstructure Framing Options

- **Pre-Engineered Metal Building System (PEMB)**
  - **Cost Effective:**
    - With typical metal building roof lines with regular frames in one direction and orthogonal braced bays, usually smaller hangars, with shorter spans
    - Typical Hangar Door System: horizontal rolling doors; can do VLFD, but compatibility can be a challenge with horizontal drift & vertical deflections
  - **Designed, Drawn using proprietary software**
    - PEMB industry does not work well with multiple submissions
  - **Challenges:**
    - Taller or longer spans, irregular shapes, elevated design aesthetics
    - Shop/Admin area with masonry/concrete walls or a two-story building with concrete floors
    - Future renovations/modifications are difficult



Pros/Cons:

Typical Roof Shapes/Slopes: Typically pitched down the centerline of the bay or mono-sloped (for regular shaped trusses with repetitive member sizes) – in either case, the roof slopes to the sides, not to the back.

When (most) Cost Effective: Tall/Long spans, sloped roof, with cranes/fall protection.

Typical Hangar Door System: Either Horizontal Rolling Steel Doors or Vertical Lift Fabric Doors.

Advantages: Renovations/Modifications are easily accomplished.

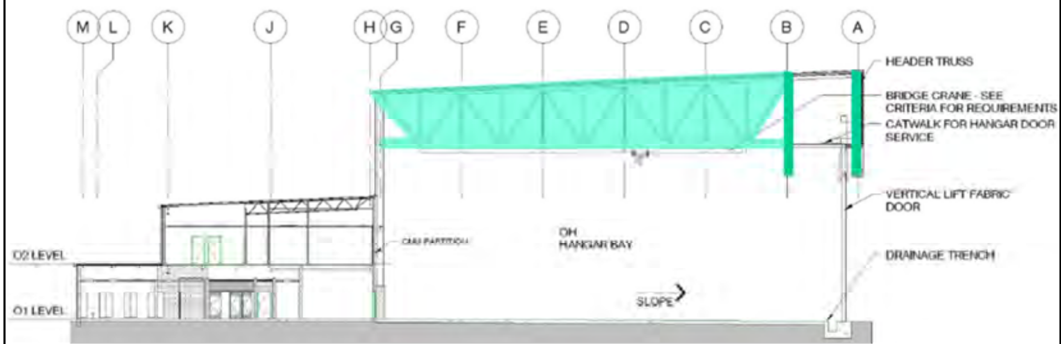
Limitations: Typically used over a square shaped bay, not well suited for shallower hangars with wide opening over hangar doors (rectangular).

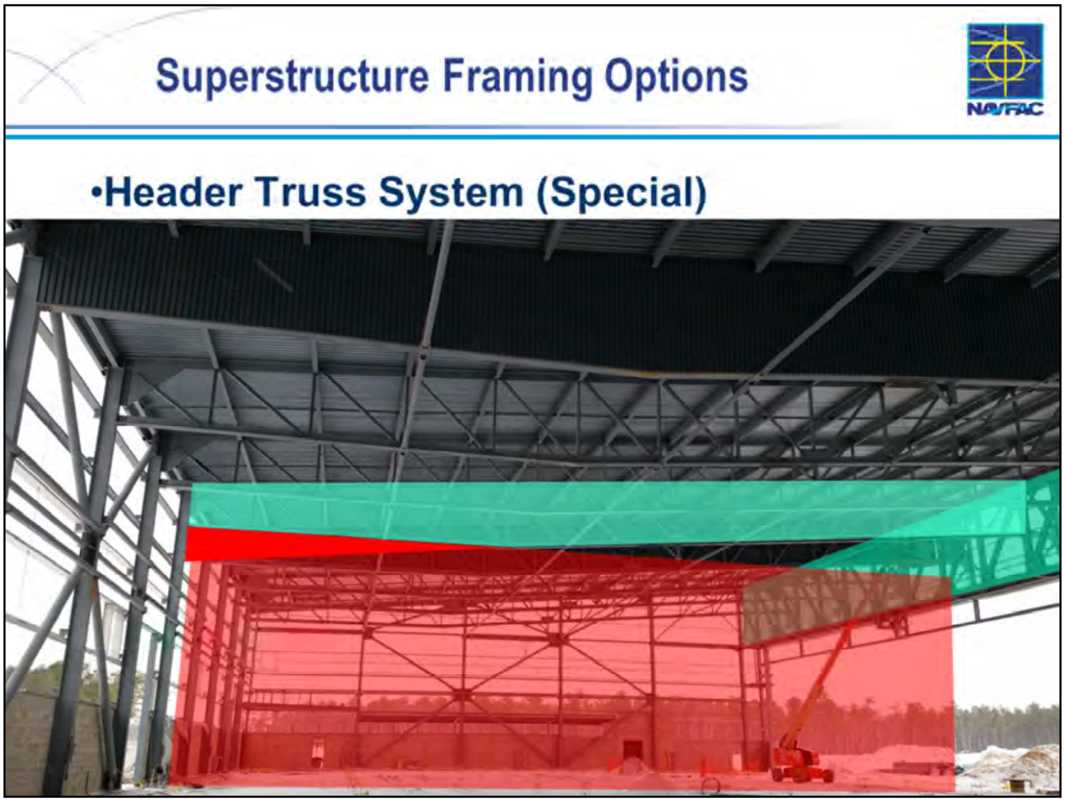
Superstructure Framing Options

- **Parallel Truss System**
  - **Cost Effective:**
    - With Tall/Long spans, Gable or Mono-Slope (to side) Roof, Square or Narrow Rectangular, with Bridge Cranes as these all result in regular shaped trusses with repetitive member sizes
    - Typical Hangar Door System: Horizontal Rolling Steel Doors or Vertical Lift Fabric Doors with modifications above
  - **Renovations/Modifications are easily accomplished**
  - **Limitations:**
    - Not well suited for wide rectangular hangars with wide opening over hangar doors

Superstructure Framing Options

•Header Truss System (Typical)





Pros/Cons:

Typical Roof Shapes/Slopes: Typically mono-slope from front (airfield side) down to rear of hangar (land side). Front to back trusses are regular shaped trusses with repetitive member sizes for economy.

When (most) Cost Effective: Tall/Long spans, sloped roof, with cranes/fall protection.

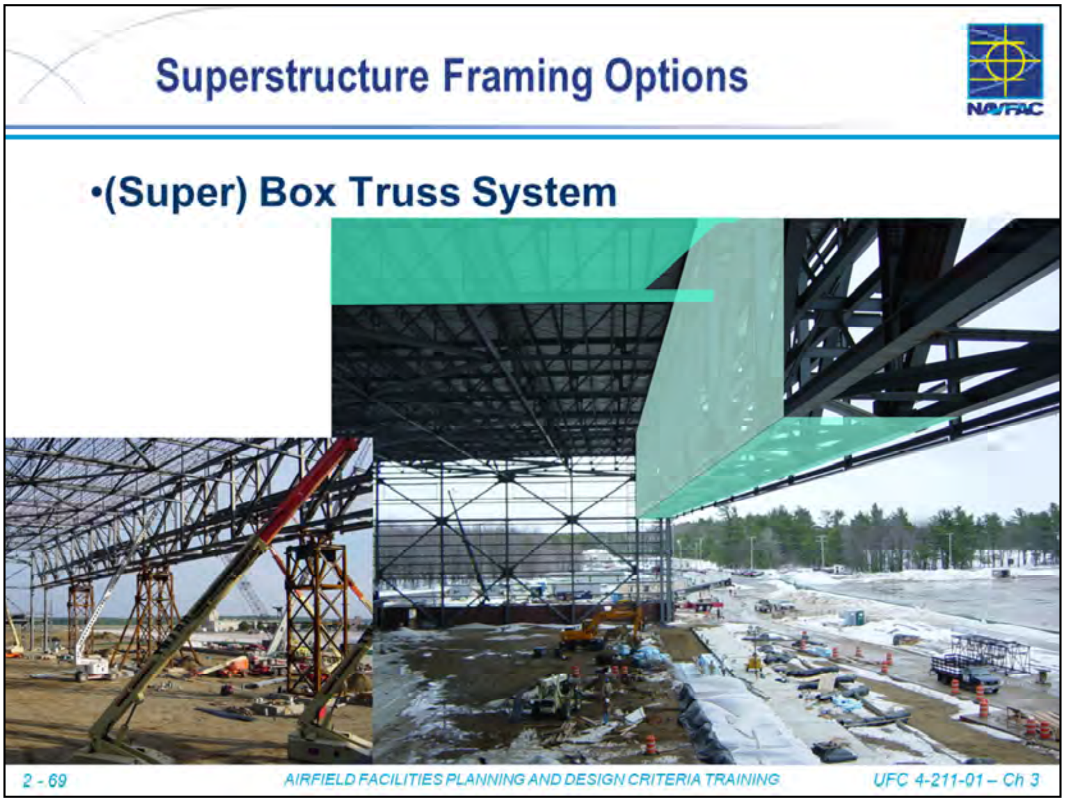
Typical Hangar Door System: Either Horizontal Rolling Steel Doors or Vertical Lift Fabric Doors.

Advantages: Renovations/Modifications are easily accomplished. There is a lot of potential customization here: Trusses may be tapered for a constant bottom chord elevation, they may be constant depth to allow more interior clearance on the hangar door side (for a tall tail) or they can be a combination of the two (as shown above) to both reduce the hangar height and provide more room for a tail (and aircraft jacking).

Limitations: Versus the parallel truss system, this system is used to slope the roof to the back (instead of side to side) and may be used over a square or rectangular bay.

Superstructure Framing Options

- Header Truss System
  - Cost Effective:
    - With Tall/Long spans, Mono-Slope (to rear) Roof, Square or Wide Rectangular, with Bridge Cranes as these all result in regular shaped trusses with repetitive member sizes
    - Typical Hangar Door System: Either Horizontal Rolling Steel Doors or Vertical Lift Fabric Doors
  - Renovations/Modifications are easily accomplished
  - Potential Customizations:
    - Natural shape best fits nose-in aircraft with a tall tail
    - Tapered trusses to lower hangar height or constant bottom chord elevation to maximize interior clearance at hangar door
    - May notch Header Truss to allow jacking tail between trusses



Pros/Cons:

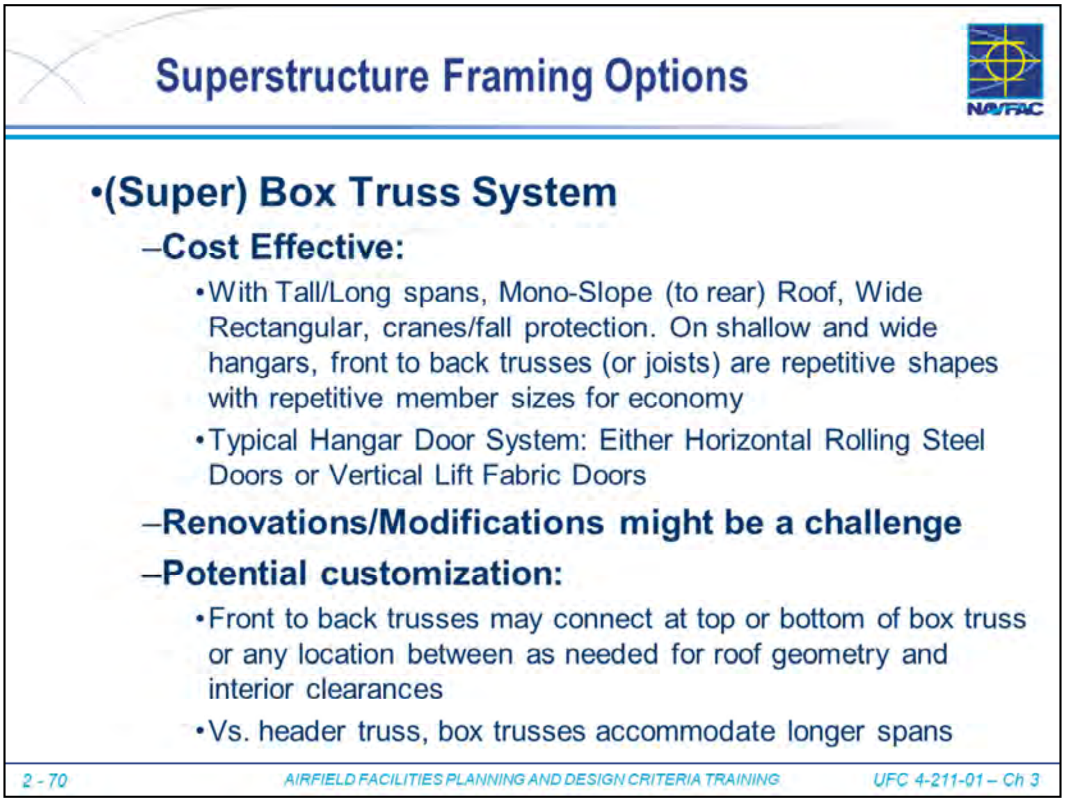
Typical Roof Shapes/Slopes: Typically mono-slope from front (airfield side) down to rear of hangar (land side). Front to back trusses (or joists) are regular shaped trusses with repetitive member sizes for economy.

When (most) Cost Effective: Tall/Long spans, sloped roof, with cranes/fall protection – but especially for the longest spans over the hangar doors and/or high roof live/snow loads.

Typical Hangar Door System: Either Horizontal Rolling Steel Doors or Vertical Lift Fabric Doors.

Advantages: Renovations/Modifications are easily accomplished. Potential customization: Front to back trusses may connect to top of box truss, bottom of box truss or any location between as needed for roof geometry and/or interior clearances.

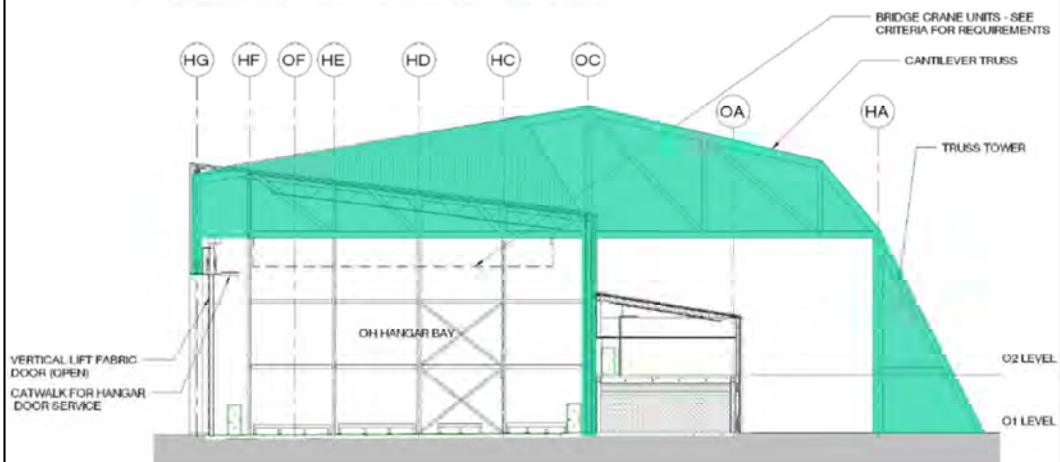
Limitations: Versus the parallel truss system, this system is used to slope the roof to the back (instead of side to side). Versus the header truss system, this system can accommodate longer spans over the hangar door. Steel erection may require more expertise / work.



Steel erection will require more expertise / work (shoring towers?).

Superstructure Framing Options

- Cantilever Truss System



Pros/Cons:

Typical Roof Shapes/Slopes: Boxed/Low Slope from front (airfield side) down to rear of hangar (land side). Cantilever Trusses consist of front to back trusses/towers with repetitive geometry and member sizes for economy.

When (most) Cost Effective: This system may be built with a “limitless” front hangar door opening with cranes/fall protection.

Typical Hangar Door System: Most impressive with Vertical Lift Fabric Doors, but may also be used with pocketless Horizontal Rolling Steel Doors.

Advantages: The above picture says it all - “limitless” front hangar door opening without obstructions. Parallel additions are easily accomplished to extend the hangar.

Limitations/Challenges: Steel erection with deflection control of the cantilever end. Architectural detailing at roof penetrations. Care needs to be taken in detailing and maintaining the exterior steel structural and its anchorage to the foundation as the structure is not stable without these exposed (vulnerable) elements. Structural modifications to roof/steel structural need to be carefully accomplished.

Superstructure Framing Options

- **Cantilever Truss System**
  - **Cost Effective:**
    - When a "limitless" front hangar door opening is desired. Trusses slope roof from front to back and trusses/towers use unitized geometry and member sizes for economy
    - Typical Hangar Door System: Most impressive with Vertical Lift Fabric Doors, also may use pocketless Horizontal Steel Doors
  - **Additions in series to extend are easily accomplished**
  - **Challenges:**
    - Steel erection with deflection control of the cantilever (DL/WL/LL/Temp)
    - Architectural detailing at roof penetrations
    - Detailing and maintaining the exterior steel structural and its anchorage to the foundation as the structure is not stable without these exposed (vulnerable) elements

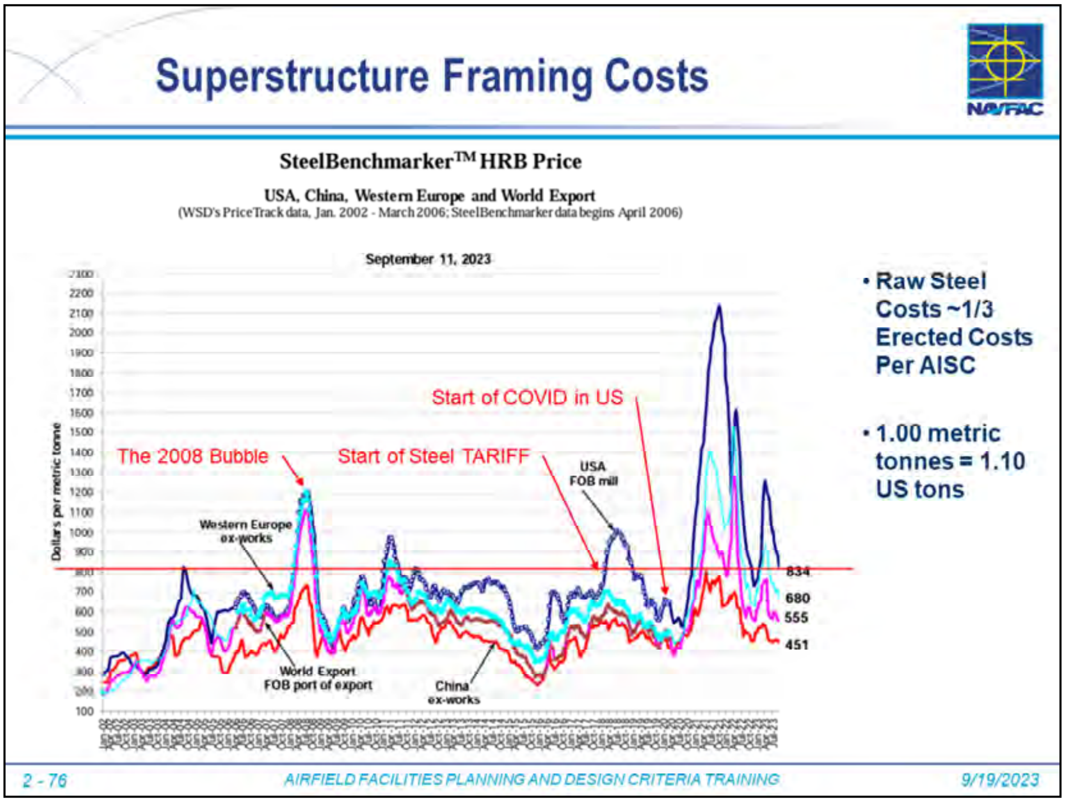
Superstructure Framing Depth/Weights

- **Rules of Thumb**
  - –Beam Span/24 30' span is 30'/24 = 15" deep
  - –Truss Span/11 to 14 300' span is 300'/12 = 27' to 21'
  - –Header Truss Span/9 to 12 300' span is 33' to 25'
- **Structural Frames (no purlins/girts/skin)**
  - –PEMB, Fighter, 4-Position Fighter: 18 psf *
  - –Parallel Truss, C5, Single Position: 23 psf *
  - –Header Truss, C130J, Two Position: 29 psf *
  - –Box Truss, Two 300' spans: 44 psf *
  - –Box Truss, One 537' span: 57 psf *
  - * Varies with wind, seismic, snow, cranes

Superstructure Framing Weights

- **Structural Frame Costs (no purlins/girts/skin)**
  - **PEMB, Fighter, 4-Position Fighter: 18 psf** *
    - 18psf x 13,000sf / 2000 = 117 tons
  - **Parallel Truss, C5, Single Position: 23 psf** *
    - 23psf x 73,000sf / 2000 = 840 tons
  - **Header Truss, C130J, Two Position: 29 psf** *
    - 29psf x 29,000sf / 2000 = 420 tons
  - **Box Truss, Two 300' spans: 44 psf** *
    - 44psf x 178,000sf / 2000 = 3,916 tons
  - **Box Truss, One 537' span: 57 psf** *
    - 57psf x 160,000sf / 2000 = 4,560 tons

*** Varies with wind, seismic, snow, cranes**



This is Hot Rolled Steel (Hangar Structures)

Historically, per AISC, Raw Steel is roughly 1/3 of the cost of steel.

Converting (1.0) metric tonnes to (1.10) US Tons – 834 marks approximately $2300/ton (3*834/1.1)

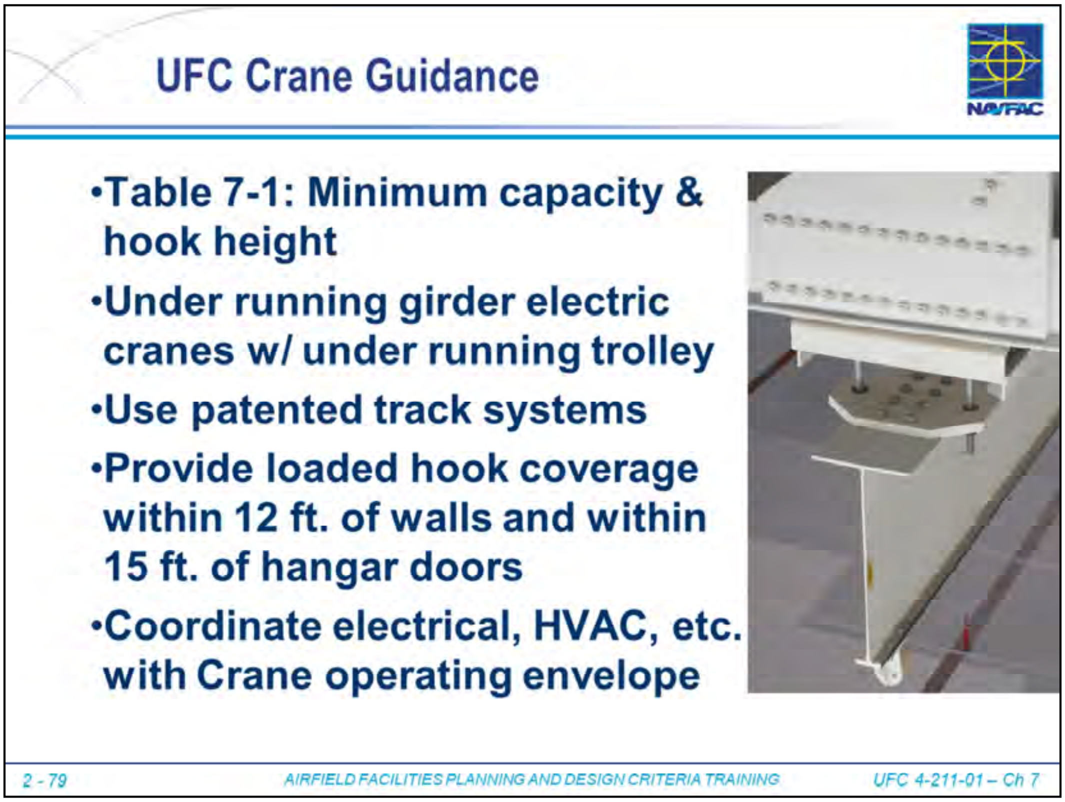
Superstructure Framing Costs

- **Structural Frame Costs (no purlins/girts/skin)**
  - **PEMB, Fighter, 4-Position Fighter: 18 psf** *
    - 117 tons @ $2300/ton = ~$300,000
  - **Parallel Truss, C5, Single Position: 23 psf** *
    - 840 tons @ $2300/ton = ~$2,000,000
  - **Header Truss, C130J, Two Position: 29 psf** *
    - 420 tons @ $2300/ton = $1,000,000
  - **Box Truss, Two 300' spans: 44 psf** *
    - 3,916 tons @ $2300ton = $9,000,000
  - **Box Truss, One 537' span: 57 psf** *
    - 4,560 tons @ $2300/ton = $10,500,000

*** Varies with wind, seismic, snow, cranes & location!**

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)



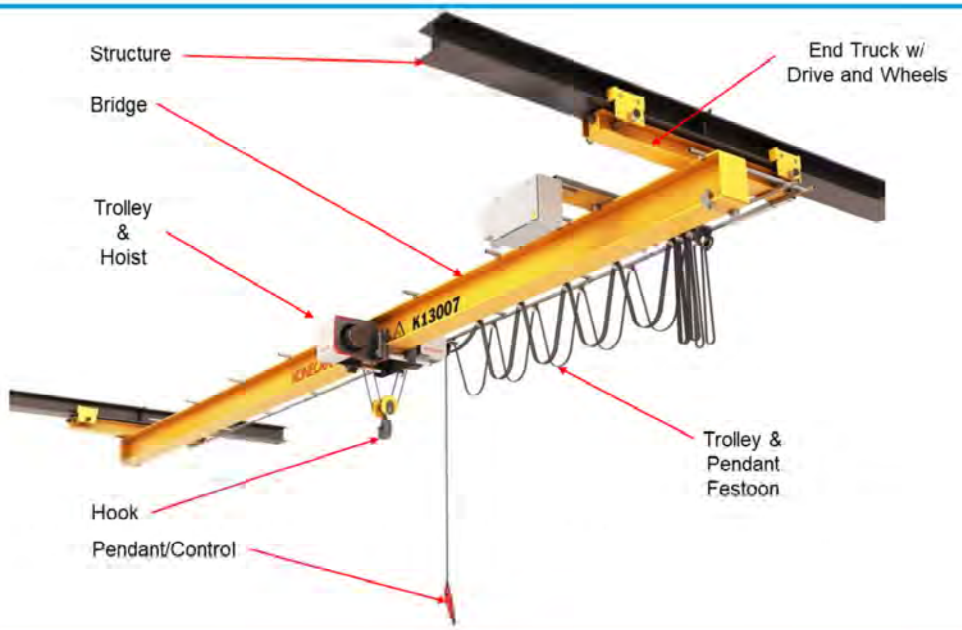
These requirements are from UFC 4-211-01 and are unrelated to the Navy Crane Center.

Navy Crane Center (NCC)

- **Navy Crane Instruction 11450.2**
- **UFGS 41 22 13.55 Bridge Cranes, Under Running, Aircraft Hangar**

- Navy/USMC hangar bridge cranes are considered operating in hazardous environments due to fueled aircraft and due to bridge crane span. **Contact the Navy Crane center for design review involvement**. A **procurement waiver may also be required**. For bridge crane electrical and anti-spark requirements, all hangars are to be designed for fueled aircraft regardless if the aircraft contain fuel or not.
- **NCC may focus on >40 ft. bridge spans**
- **NCC may focus on procurement in (NEC 513) Hazard Zones**

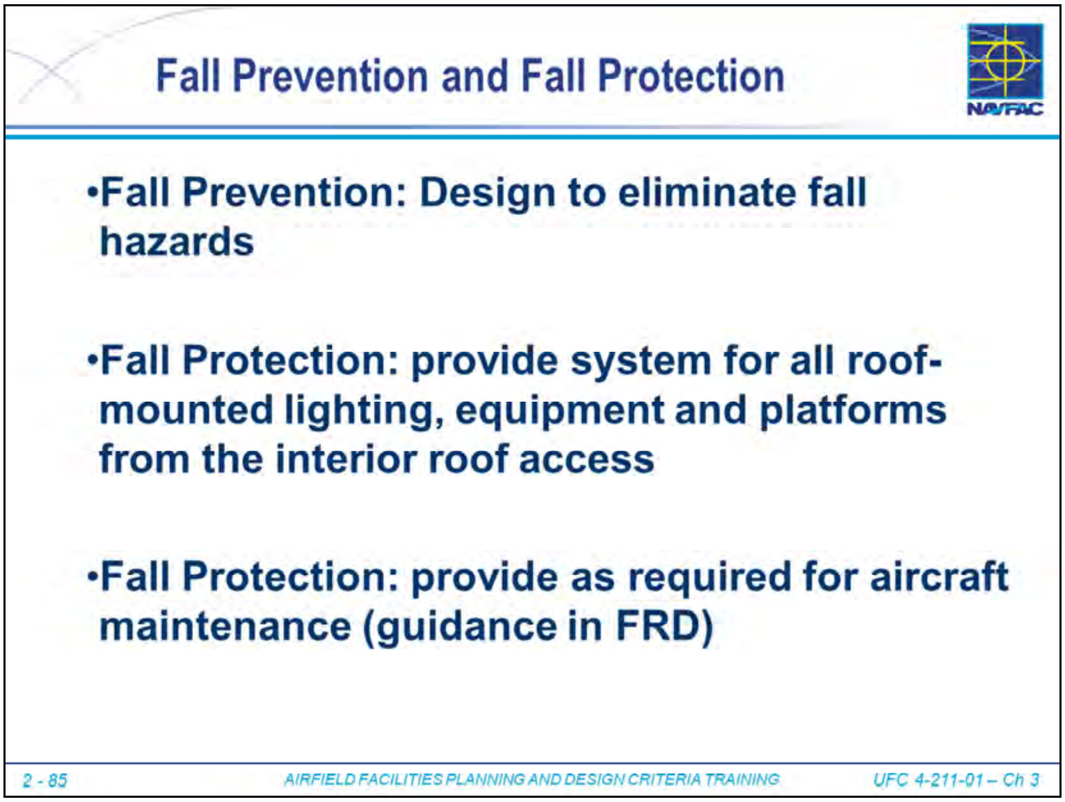
Overhead Crane (hung from structure)



Overhead Crane (hung from structure)

Overhead Equipment (Telescoping Lifts)

Mobile Crane (floor supported equipment)

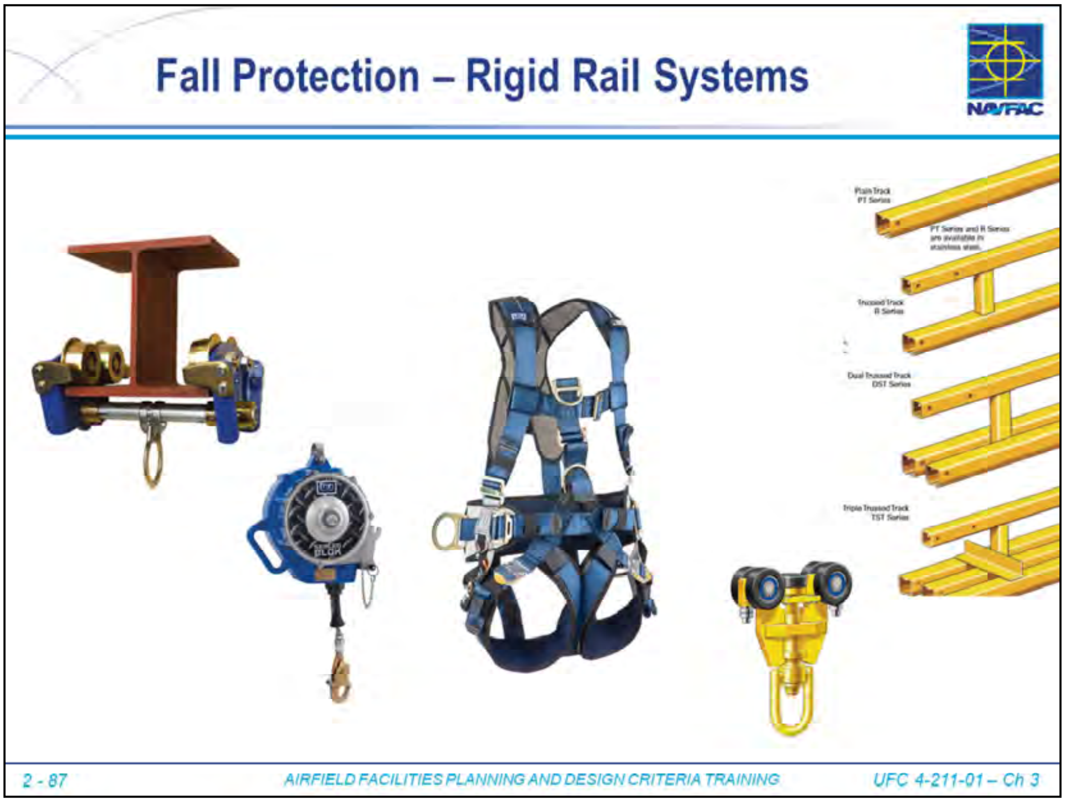


FALL PREVENTION AND PROTECTION SYSTEMS

Design the aircraft maintenance facility to eliminate fall hazards. If fall hazards cannot be eliminated, ensure that a viable fall prevention and protection system is identified by the user and provide where applicable. Provide path and fall protection system for all roof-mounted lighting, equipment and platforms from the interior roof access platform.

These systems can be facility based systems such as horizontal life lines and retractable life lines and non-facility based systems such as aircraft stands/platforms, aircraft safety line attachments, or mobile cranes. Refer to APPENDIX C: BEST PRACTICES, for further discussion.

Fall Protection – Rigid Rail Systems

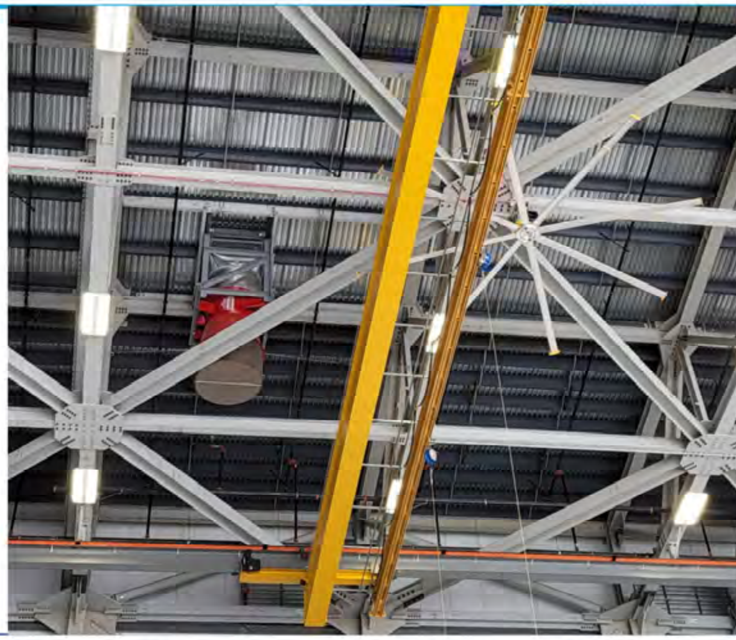


Rigid Rail and Patented Rail – Trolleys for each system

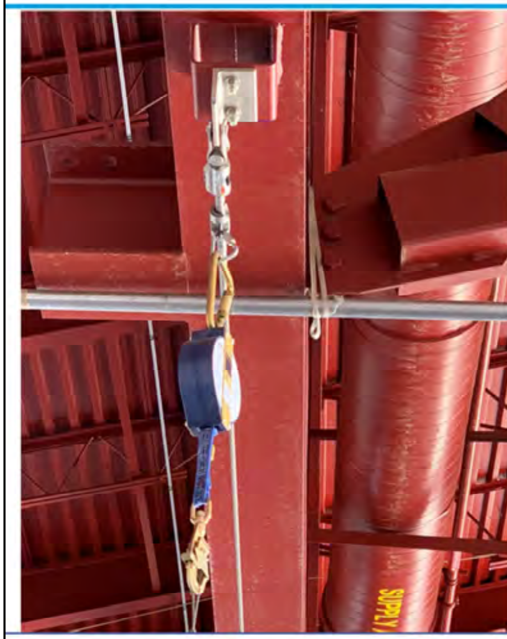
Self Retracting Lifeline (SRL)

Fall Protection Harness

Fall Protection - from Bridge Crane



Fall Protection – Flexible Life Line System



Fall Protection - Mobile Equip/Platforms

Fall Protection - Mobile Stand

Mechanical Design

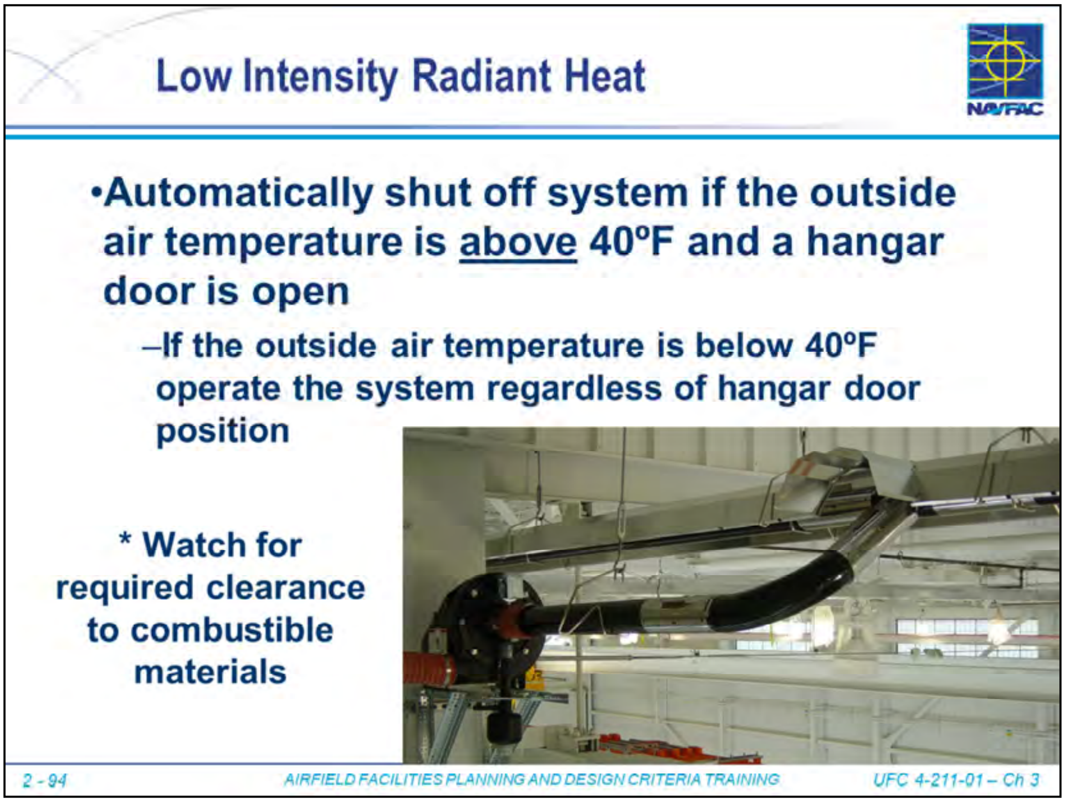
- Building: UFC 1-200-01
- HVAC: UFC 3-410-01
- Sustainability: UFC 1-200-02

- Admin/Office/Shop: 78ºF Cooling / 68ºF Heating
- Hangar Bay: n/a Cooling* / 55ºF Heating

  * Air Conditioning is permitted only when required by the FRD.

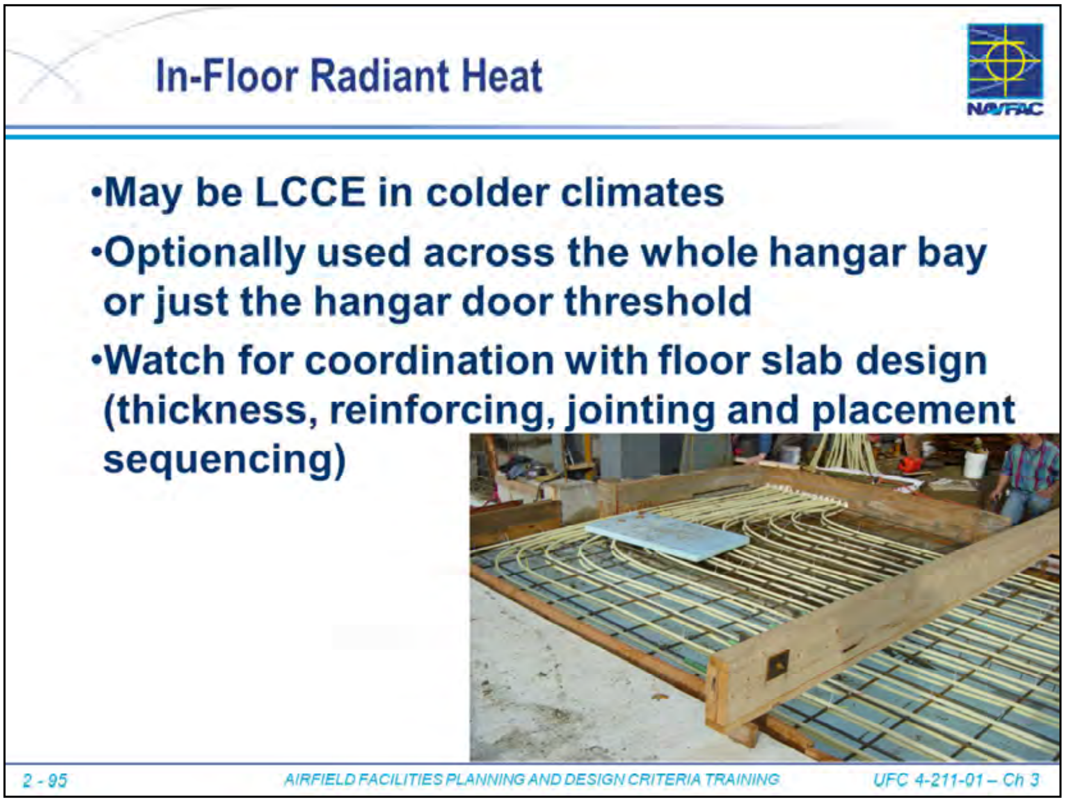
The type of heating system depends on the outdoor design temperatures. The options are overhead radiant heat, in-floor radiant heat, or forced-air heat. Conduct a 40-year life-cycle cost analysis to support selection from the heating system choices. Include an analysis of the anticipated user occupancy schedule. Include these results in the design analysis. If floor-type or forced-air heaters are installed, direct the discharged air to cover the entire floor area to help reduce accumulation of combustible and flammable vapors and arranged to draw warm air from the top of the hangar for distribution at occupied level. Provide floor-type heater fans with not less than six air changes per hour based on an artificial ceiling height of 15 ft. (4.6 m). Refer to 3-5.3: Ventilation for ventilation requirements.

In climates where freezing temperatures occur, protect hangar door tracks or the bottom edges of hangar doors with electric or hot water-glycol snow-melting coils in accordance with NFPA 409. Ensure that non-toxic antifreeze is used, such as propylene glycol, to avoid freezing and environmental spill concerns. Use a sump pump to inject the antifreeze into the system. Provide ratio of antifreeze to water between 30 and 50%, depending on the design temperature, to avoid freezing.



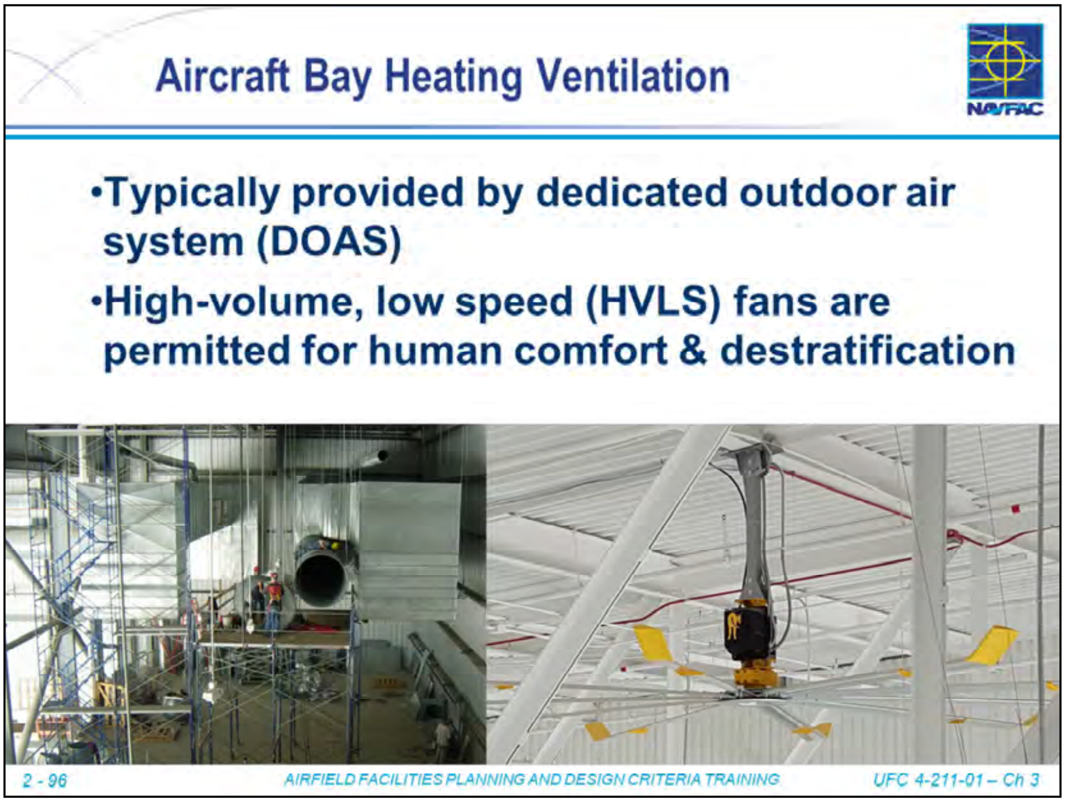
Overhead Radiant Heating: Install gas infrared heaters at the height specified in NFPA 409. Install suspended or elevated heaters not less than 5 ft. (1,524 mm) above the hangar door or lower chord of the roof truss. Use low-intensity tube-type gas infrared radiant heaters. If the outside air temperature is above 40ºF (4.4ºC) and the hangar door is open, automatically shut off the overhead gas-fired, radiant heating system. If the outside air temperature is below 40ºF (4.4ºC) operate the radiant heating system regardless of hangar door position.

For Air Force and Navy: High-intensity type radiant heaters with open flame or glowing elements are not to be installed.



In-Floor Radiant Heating: In-floor, radiant heating systems can be considered in colder climates. They can provide savings on energy and operational costs when compared to conventional heating systems. Refer to 3-4.2.3.4: Aircraft Maintenance Bay - Slab on Ground Floor Heating. Include the efficiency of in-floor, radiant tube systems in the cost analysis of heating systems.

Challenges: Floor slab design (thickness, reinforcing, jointing and placement sequencing), Floor Slab Construction (means and methods). Significant coordination and maintenance issues with in-slab piping. Obtain approval from the base Public Works Department prior to including in LCCA.



Ventilation: Provide ventilation in shop administration spaces in accordance with the latest versions of ASHRAE 62 and UFC 3-410-01. This is typically provided by a dedicated outdoor air system (DOAS), which is separated from the space-cooling function. Include infiltration into ventilation system design.

The use of high-volume, low-speed (HVLS) fans or high velocity focused destratification fans can be considered for installation in hangar bays to provide air mixing and create air movement for comfort at the floor level. These are not a replacement for the exhaust system described below. These fans can redirect heat back down to the occupied level, can improve comfort and efficiency, and provide a homogeneous volume of air to reduce concentration of local vapors. Coordinate the installation of fans with overhead radiant heaters, fall protection, high-expansion foam generators, lights, bird netting, bridge cranes and sprinklers. Coordinate with sprinklers in accordance with the requirements of NFPA 13.

Mechanical Design

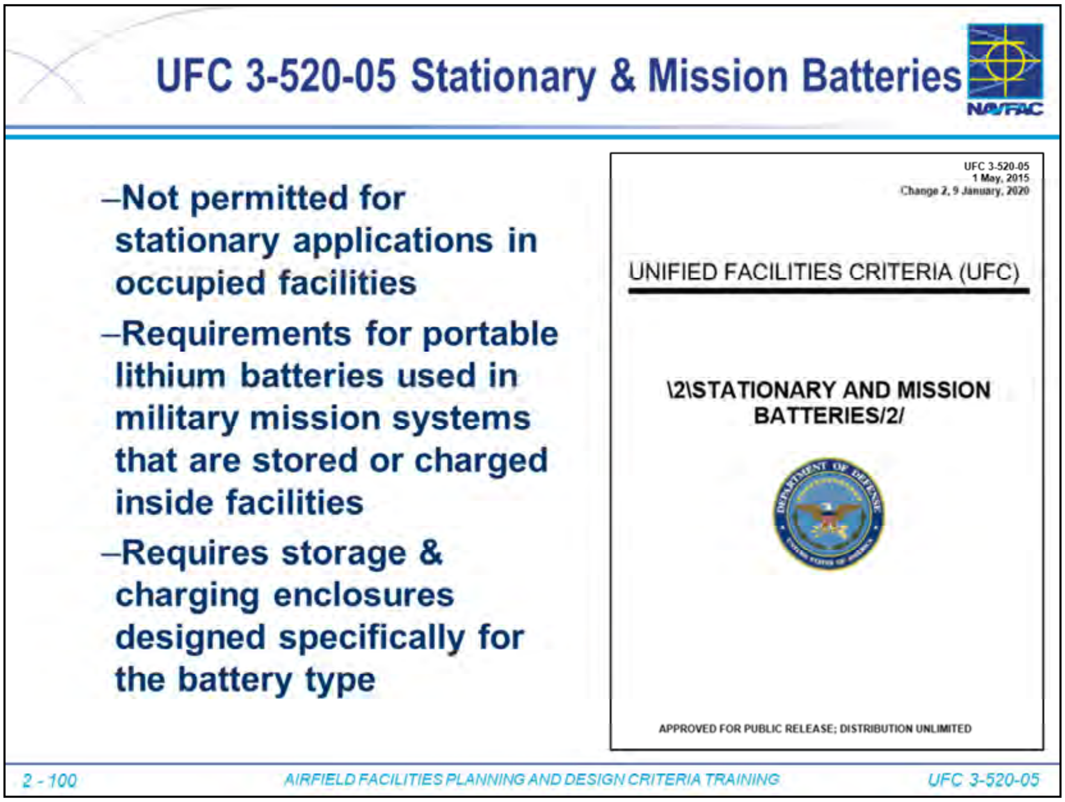
- Provide dedicated units for the Communications Room and Secure Office.
- Provide heating only with a unit heater for the stairs when the climate makes it necessary.

If a battery maintenance shop is required, see UFC 3-520-05 for additional requirements. Lithium-Ion battery maintenance requires significant space and mechanical systems.

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.



Lithium batteries can pose a significant hazard to host U.S. Navy ships, vessels, and platforms when they undergo an acute casualty such as an electrical or mechanical short or overcharge. Batteries may violently vent or rupture, releasing large quantities of combustible, toxic or acidic vapors and aerosols, or incandescent metal or carbon particles which can be at very high temperatures. This can result in a major fire or explosion and release large quantities of toxic and acidic gases with heavy smoke.

Off-gas begins as gases that are generated inside individual cells due to exothermic reactions which begin to occur as a result of internal problems in the battery or external abuses.

The release of these gases is the first stage of a battery failure which can self-propagate until the battery begins to smoke and go into fully developed thermal runaway.

Lithium Ion Batteries - Charging

Charging Tesla Destroyed By Fire Which Spread To Owner's House

The fire reportedly started in the rear of the vehicle, which was burned beyond repair.

Nov 28, 2021 at 5:54am ET

By: **Andrei Nedelea**

Another Tesla has gone up in flames while charging, this time a white Model Y that was plugged in just

Shepherd's Bush tower fire started by charging e-bike battery

21 June 2022

Smoke damage at Queensdale Crescent

A tower block fire in west London, less than a mile (1.6km) from Grenfell Tower, was started by an electric bike battery malfunctioning as it charged.

Lithium Ion Batteries - Damaged

Tesla Model S catches fire three weeks after getting sent to junkyard

Ronan Glon

In what sounds like the automotive equivalent of *The Walking Dead*, a Tesla Model S caught fire three weeks after it was involved in an accident and sent to a junkyard. Firefighters had a difficult time putting out the blaze, and they ended up having to submerge the battery.

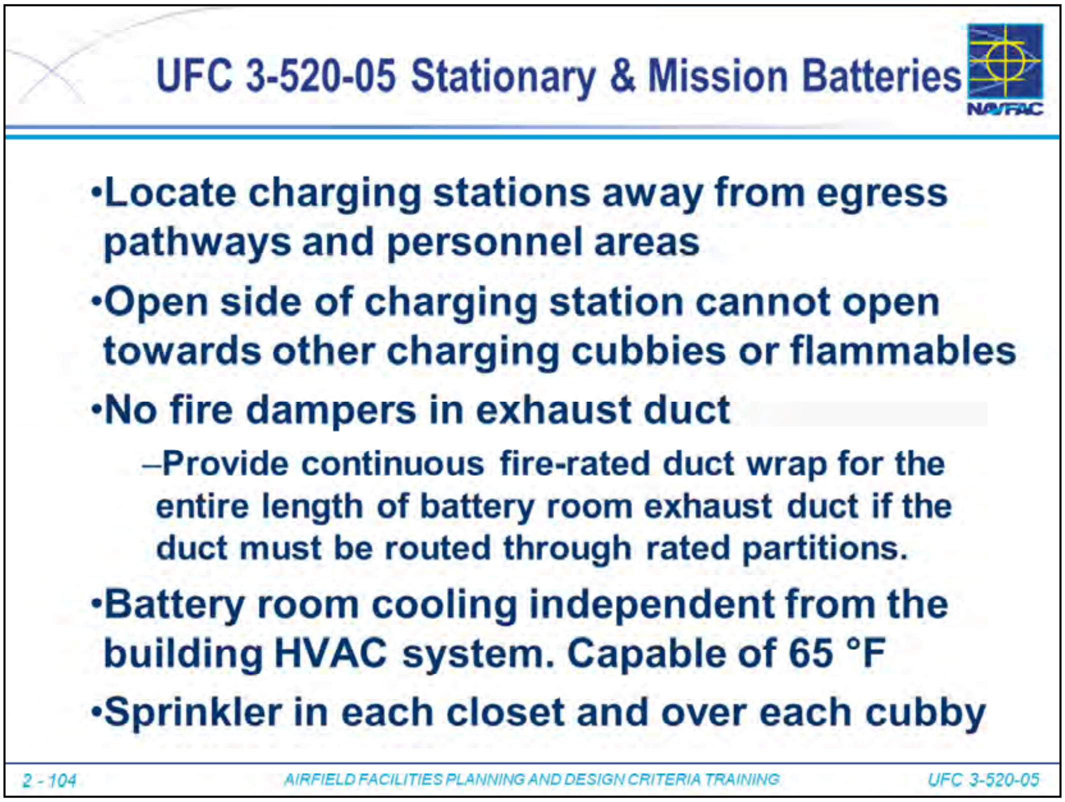
Firefighters: Electric vehicle fires present new challenges

Nancy Loo and Andrew Dorn 2 days ago

(NewsNation) — Although less common than gas-powered vehicle fires, electric vehicle (EV) fires can be extremely difficult to put out and in many cases, require 10 times as much water to extinguish.

NAVSEA S9310-AQ-SAF-010 Lithium Ion Batteries

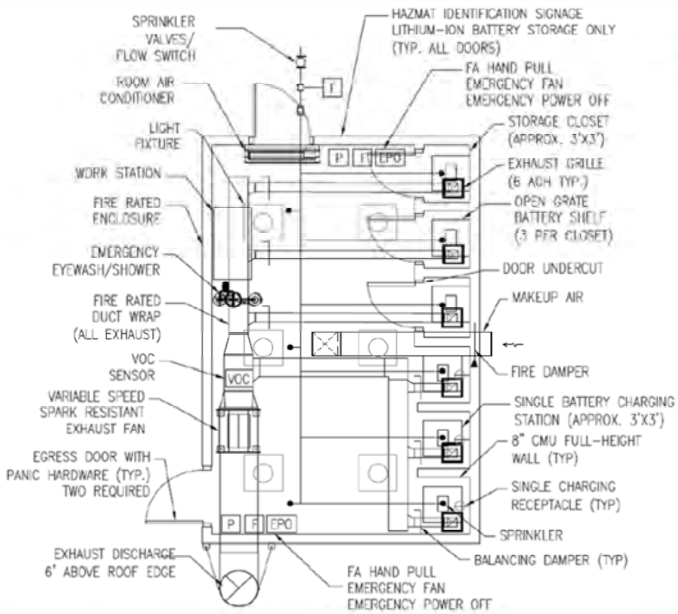
- Exemptions for UL-listed COTS batteries, less than 21 volts & 100 watt-hours
- Emergency exhaust at 12 ACH for closets and cubbies, normal exhaust at 6 ACH
- VOC sensor for early detection and charger shutdown
- Manual charger shutdown switch
- Hazmat signage per NFPA 704



Extend battery room exhaust duct systems directly to the exterior of the building and follow the shortest route to the point of discharge.

Exhaust discharge opening must be at least 6 feet from exterior walls and roofs, 10 feet from operable openings into buildings, and 10 feet above grade.

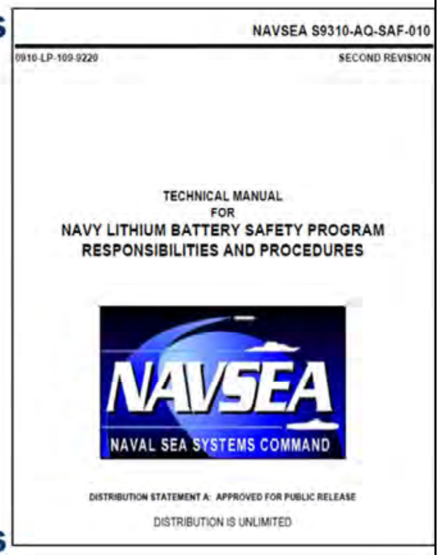
UFC 3-520-05 Stationary & Mission Batteries



- 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**

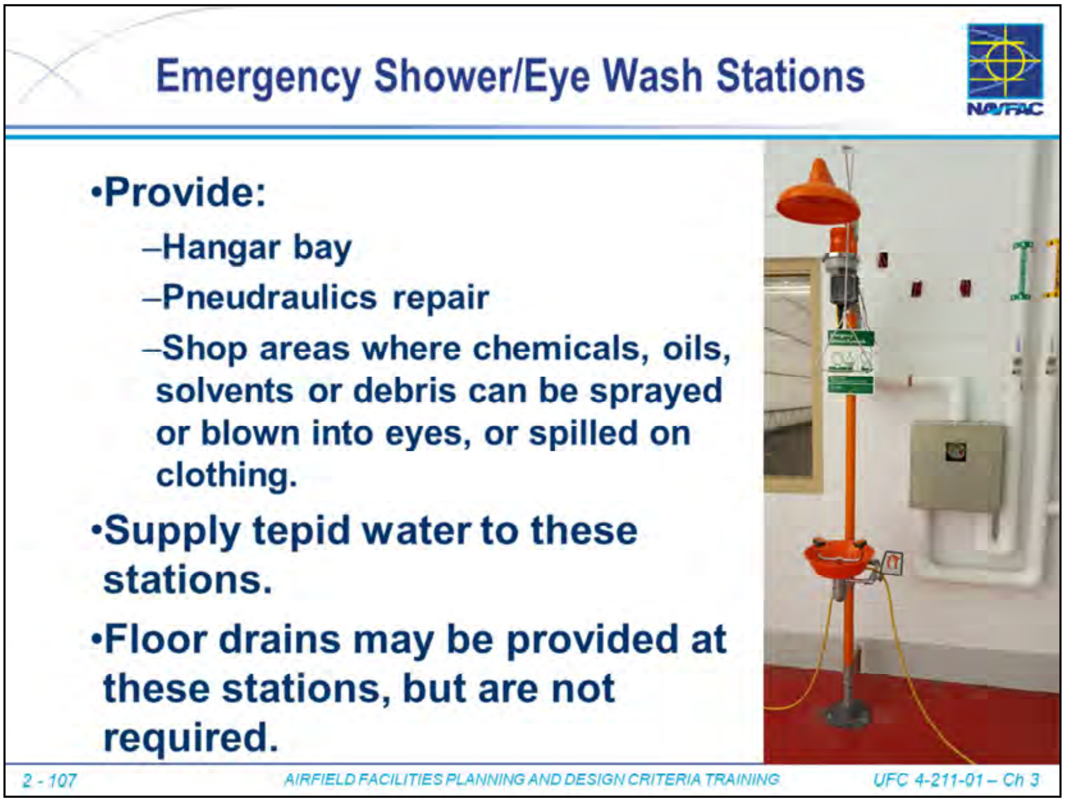

NAVSEA S9310-AQ-SAF-010

0910-LP-109-9220 SECOND REVISION

TECHNICAL MANUAL
FOR
NAVY LITHIUM BATTERY SAFETY PROGRAM
RESPONSIBILITIES AND PROCEDURES

DISTRIBUTION STATEMENT A: APPROVED FOR PUBLIC RELEASE

DISTRIBUTION IS UNLIMITED



Provide emergency showers and eyewashes in accordance with ANSI Z358.1 and OSHA standard 1910.151(c) and UFC 3-420-01.

Floor drains at emergency shower eye wash stations can be provided if desired by the users; however they are not required.

Do not install floor drains adjacent to emergency shower eye wash stations for Air Force hangars (unless approved).

Wall Hydrants & Hose Bibbs - Exterior

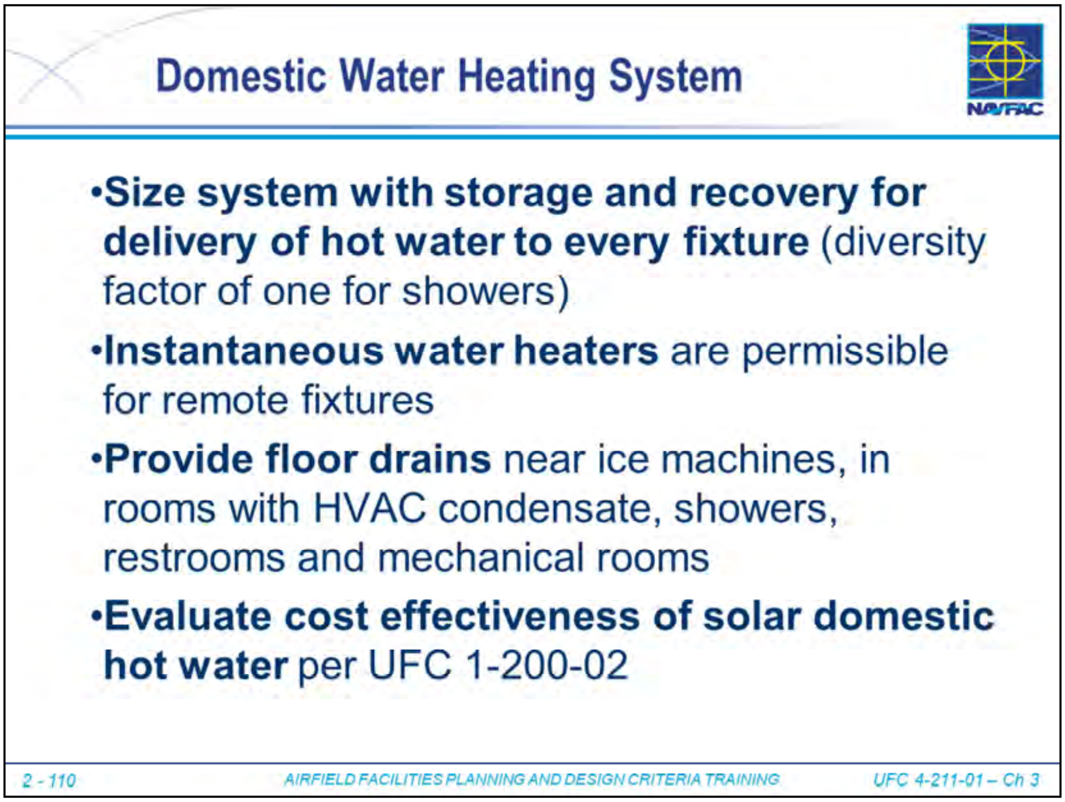
- Provide:
  - Exterior walls with a max spacing of 100 ft.
  - Freeze-proof exterior yard hydrant in mechanical yards containing chillers, condensers, condensing unit, and cooling towers
  - Provide at roof mounted PV and Solar Heating

- All hydrants and hose bibbs shall have a vacuum breaker to prevent back flow

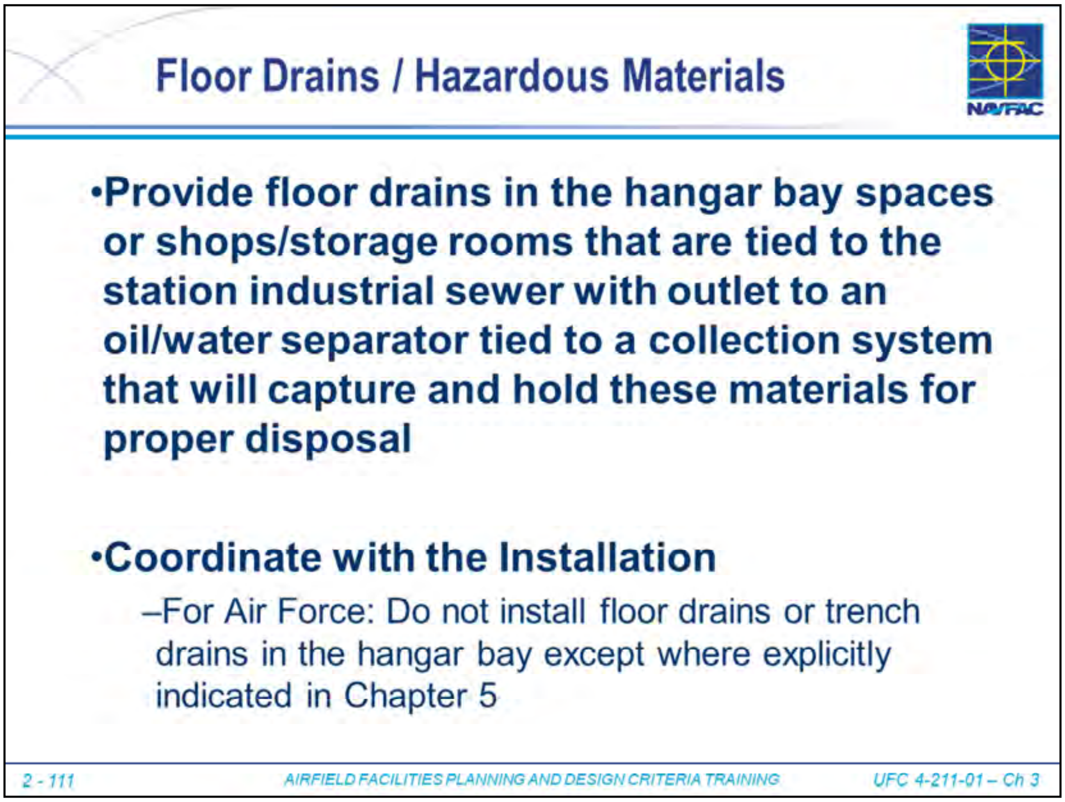
Wall Hydrants & Hose Bibbs - Interior

- 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

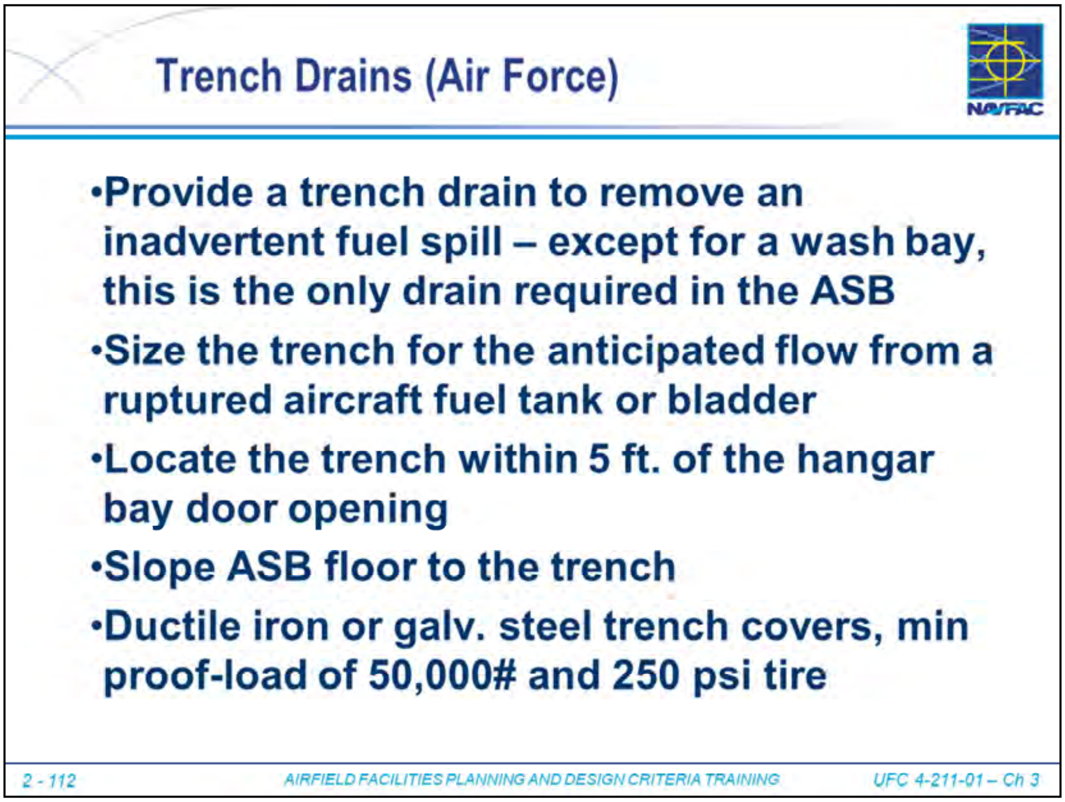


For a Solar Hot Water System Calculator, go to:
https://www.eere.energy.gov/femp/solar_hotwater_system/



Industrial Oil/Water Waste: Since hazardous materials are used in the aircraft maintenance process, 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. Drainage from interior hangar door trench drains may be included in this system. Design in accordance with all applicable environmental codes. Coordination of the collection system is required with the Base or Station to determine the size of the collection system based on the frequency of evacuating it (such as weekly, bi-monthly, monthly), volume of potential liquid spill, and the size of the site where it is to be located.

Design trench drain system for easy cleanout of oil or other residue. Convey waste to an oil/water separator prior to discharge to the sanitary sewer system. Refer to 3-11.3: Trench Drains. **For Air Force**: Do not install floor drains or trench drains in the hangar bay except where explicitly indicated in Chapter 5: Air Force Specific Criteria.



For Air Force: Do not install floor drains or trench drains in the hangar bay except where explicitly indicated in Chapter 5: Air Force Specific Criteria.

Provide a fuel spill capture trench drain in the hangar bay to remove an inadvertent fuel spill from a ruptured aircraft fuel tank/bladder. This is the only drain required in the aircraft servicing area floor. Exception: A fuel spill capture trench drain is not required in a wash bay provided in accordance with this UFC.

Size the trench drain to account for the anticipated flow from a ruptured aircraft fuel tank or bladder.

Locate the trench drain inside the hangar bay, within 5 ft. (1.5 m) of the hangar bay door opening. Do not locate the trench drain near or under the aircraft. Use hangar bay floor sloping to direct the discharge from a rupture aircraft fuel tank/bladder away from the aircraft and towards the hangar bay door opening.

Provide ductile iron or galvanized steel trench covers, manufactured to withstand a minimum proof-load of 50,000 pounds from a tire with a 250 psi pressure or the most critical of the aircraft wheel loads listed in this UFC, whichever is greater.

Compressed Air: Provide compressed air for all hangar bays and shop spaces. Include a refrigerated air dryer in the compressed air systems. In shops, provide wall-mounted compressed air drops, with lubricator on every wall at spacing of every 25 ft. (7.6 m). In hangar bays, provide compressed air drops, with lubricator, along back wall and side walls at spacing of every 50 ft. (15.2 m). Coordinate with users any requirements for compressed air hose reels in shops and hangar bays.

For Navy: Refer to Chapter 7: Navy Specific Criteria, 7-14.5: Functional Data Sheets for Functional Data Sheets for specific requirements. Size air compressor system to accommodate all tool loads including fuel cell evacuation equipment.

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: Provide compressed air for all hangar bays and shop spaces. Include a refrigerated air dryer in the compressed air systems. In shops, provide wall-mounted compressed air drops, with lubricator on every wall at spacing of every 25 ft. (7.6 m). In hangar bays, provide compressed air drops, with lubricator, along back wall and side walls at spacing of every 50 ft. (15.2 m). Coordinate with users any requirements for compressed air hose reels in shops and hangar bays.

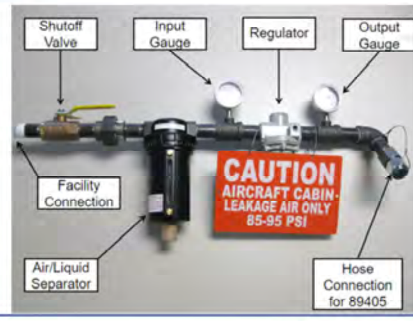
For Navy: Refer to Chapter 7: Navy Specific Criteria, 7-14.5: Functional Data Sheets for Functional Data Sheets for specific requirements. Size air compressor system to accommodate all tool loads including fuel cell evacuation equipment.

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.

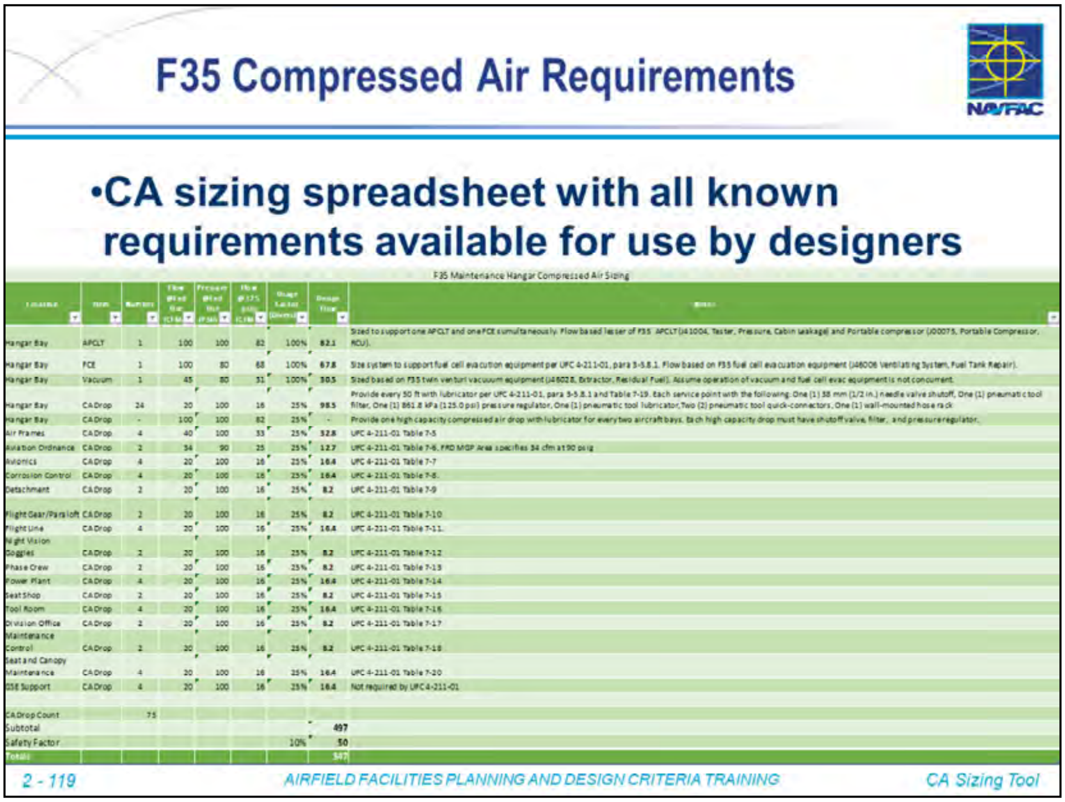
F35 Compressed Air Requirements

- 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**



Hangar Bay	APCLT	1	100	100	82	100%	82.1	Sized to support one APCLT and one FCE simultaneously. Flow based lesser of F35 APCLT (J41004, Tester, Pressure, Cabin leakage) and Portable compressor (J00075, Portable Compressor, RCU).
Hangar Bay	FCE	1	100	80	68	100%	67.8	Size system to support fuel cell evacution equipment per UFC 4-211-01, para 3-5.8.1. Flow based on F35 fuel cell evacuation equipment (J48006 Ventilating System, Fuel Tank Repair).
Hangar Bay	Vacuum	1	45	80	31	100%	30.5	Sized based on F35 twin venturi vacuuum equipment (J46028, Extractor, Residual Fuel). Assume operation of vacuum and fuel cell evac equipment is not concurrent.
Hangar Bay	CA Drop	24	20	100	16	25%	98.5	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
Hangar Bay	CA Drop	-	100	100	82	25%	-	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.
Air Frames	CA Drop	4	40	100	33	25%	32.8	UFC 4-211-01 Table 7-5
Aviation Ordnance	CA Drop	2	34	90	25	25%	12.7	UFC 4-211-01 Table 7-6. FRD MGP Area specifies 34 cfm at 90 psig
Avionics	CA Drop	4	20	100	16	25%	16.4	UFC 4-211-01 Table 7-7
Corrosion Control	CA Drop	4	20	100	16	25%	16.4	UFC 4-211-01 Table 7-8.
Detachment	CA Drop	2	20	100	16	25%	8.2	UFC 4-211-01 Table 7-9
Flight Gear/Parsloft	CA Drop	2	20	100	16	25%	8.2	UFC 4-211-01 Table 7-10
Flight Line	CA Drop	4	20	100	16	25%	16.4	UFC 4-211-01 Table 7-11.
Night Vision Goggles	CA Drop	2	20	100	16	25%	8.2	UFC 4-211-01 Table 7-12
Phase Crew	CA Drop	2	20	100	16	25%	8.2	UFC 4-211-01 Table 7-13
Power Plant	CA Drop	4	20	100	16	25%	16.4	UFC 4-211-01 Table 7-14
Seat Shop	CA Drop	2	20	100	16	25%	8.2	UFC 4-211-01 Table 7-15
Tool Room	CA Drop	4	20	100	16	25%	16.4	UFC 4-211-01 Table 7-16
Division Office	CA Drop	2	20	100	16	25%	8.2	UFC 4-211-01 Table 7-17
Maintenance Control	CA Drop	2	20	100	16	25%	8.2	UFC 4-211-01 Table 7-18
Seat and Canopy Maintenance	CA Drop	4	20	100	16	25%	16.4	UFC 4-211-01 Table 7-20
GSE Support	CA Drop	4	20	100	16	25%	16.4	Not required by UFC 4-211-01
CA Drop Count		75						
Subtotal							497	
Safety Factor						10%	50	
Totals							547	

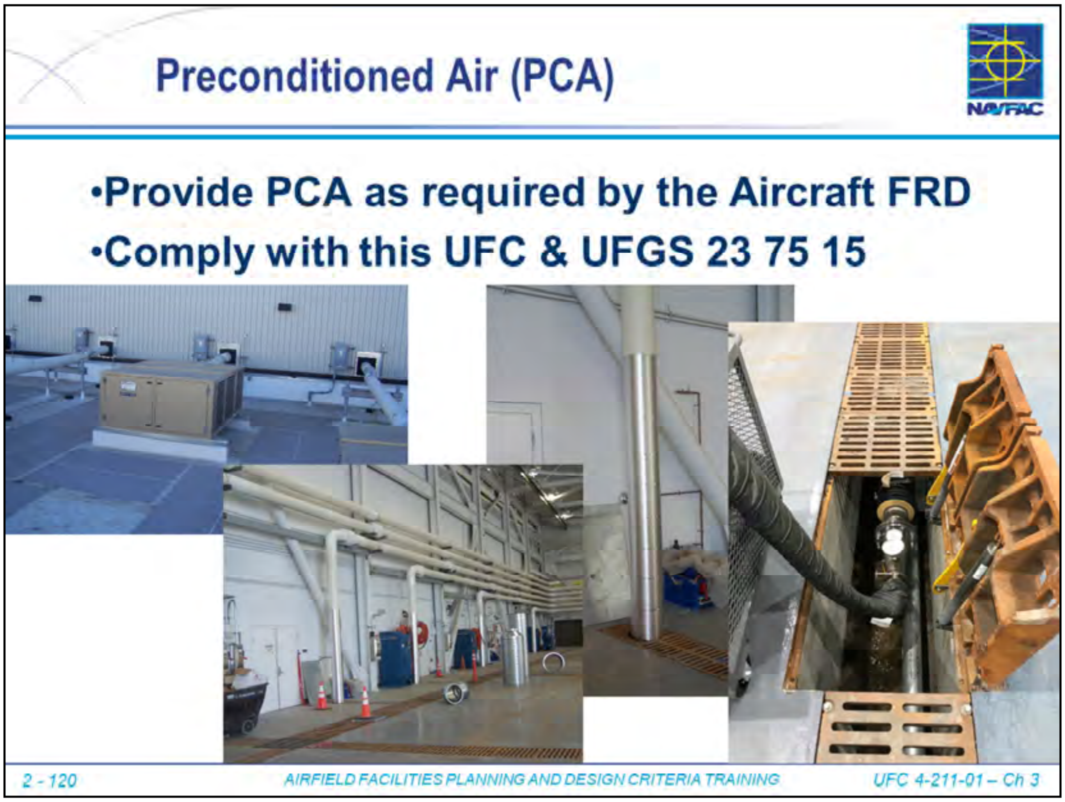
Provide each CA drop with needle valve shutoff, pneumatic tool filter, 125 psi pressure regulator, pneumatic tool lubricator, two pneumatic tool quick-connectors, and a wall-mounted hose rack.

CA Sizing Tool Location:

https://docs.google.com/spreadsheets/d/1L15t7wuoT4J_9NN6Me7-BjAViVVFO8ZUOxHo98sa_AM/edit?usp=sharing

May also be found here:

https://hub.navfac.navy.mil/webcenter/portal/ci/CI+Divisions/Design+(CI4)/Engineering+Communities/Mechanical



Preconditioned Air: Provide preconditioned air (PCA) system in accordance with the requirements of the aircraft. Insulate preconditioned air ductwork installed above ground or underground. Provide each aircraft parking location with a PCA hose connection. Use insulated flexible hose to connect from the PCA pit to the aircraft PCA connection. Install below ground PCA ductwork water tight to prevent water from hangar floor wash down and foam system activations, and fuel spills from damaging the insulation or getting into the duct system. Meter PCA units electrically separately from the rest of the building to not count against facility energy usage goals. Buried duct material is required to be stainless steel. Route buried duct to minimize length from PCA unit to aircraft connection.

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

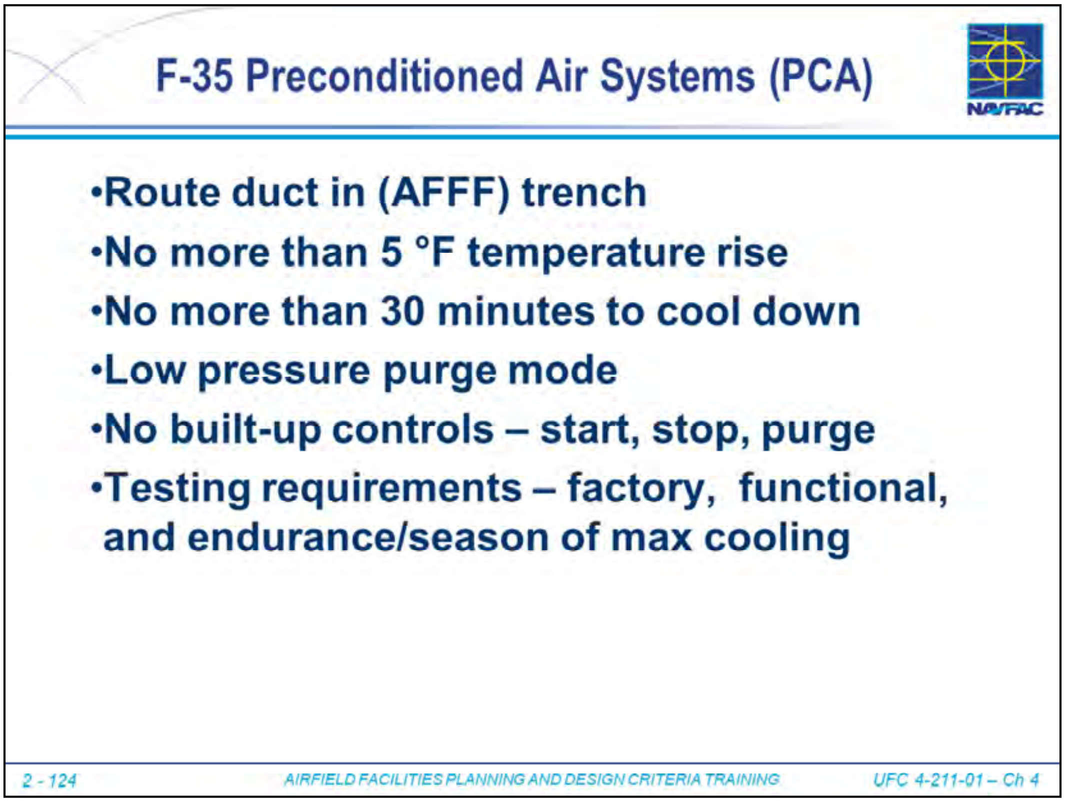
F-35 Preconditioned Air Systems (PCA)

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

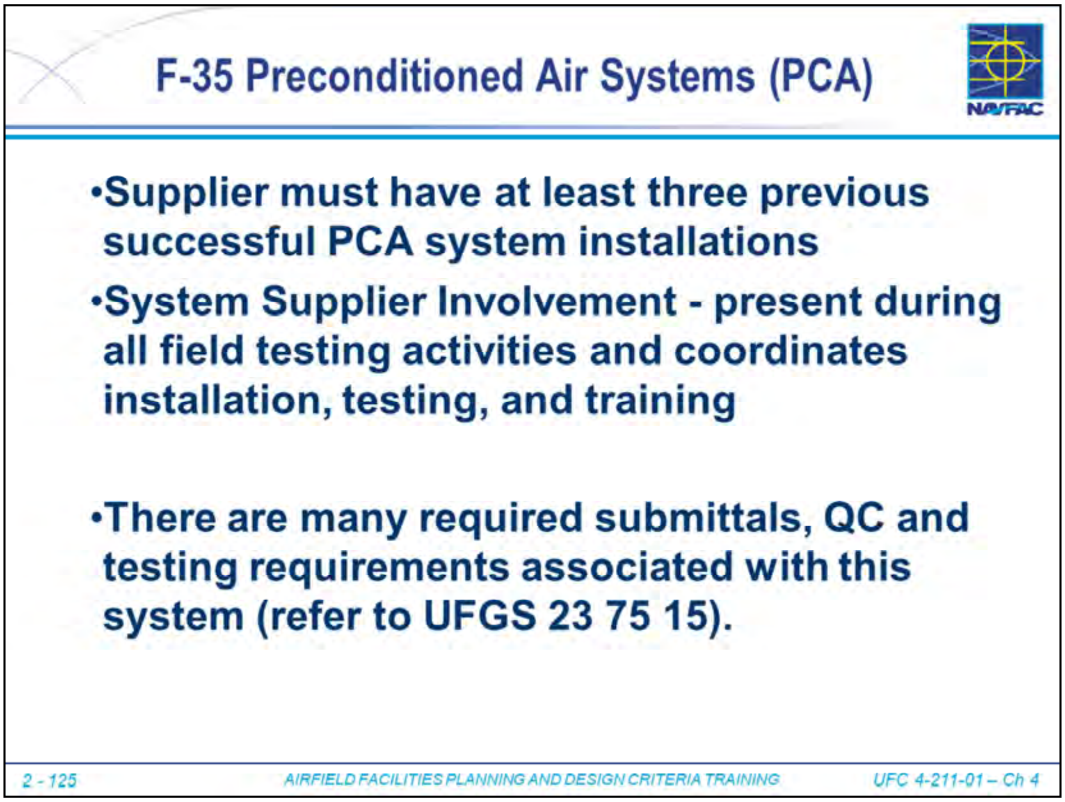
- **Lessons learned previously included in an ITG are included in the recently released UFC 4-211-01 Change 2 and 3**

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



Ensure all ducts subject to foam or water infiltration are sealed and insulation and waterproof jacket installation is complete prior to testing foam fire extinguishing system.



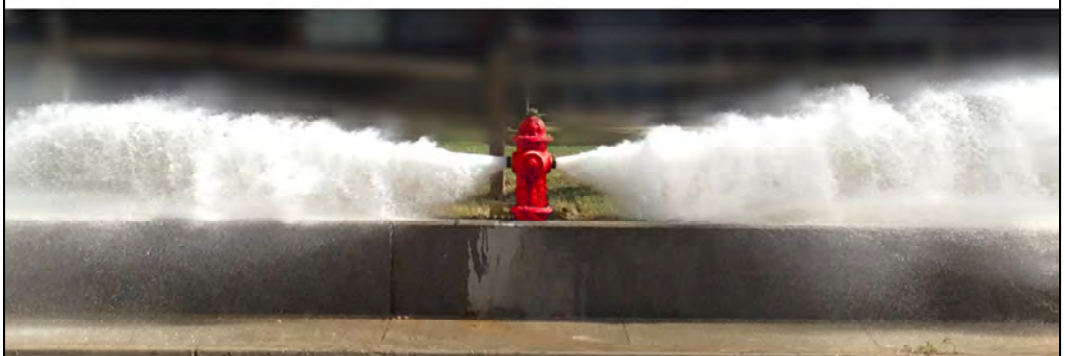
Required Submittals Include: System supplier qualifications, PCA System Detail Drawings and Calculations, Pneumatic Tightness, Tests, Certificate of Completion, Functional Performance Tests, Full-Load Endurance Tests, Training and O&M Manuals

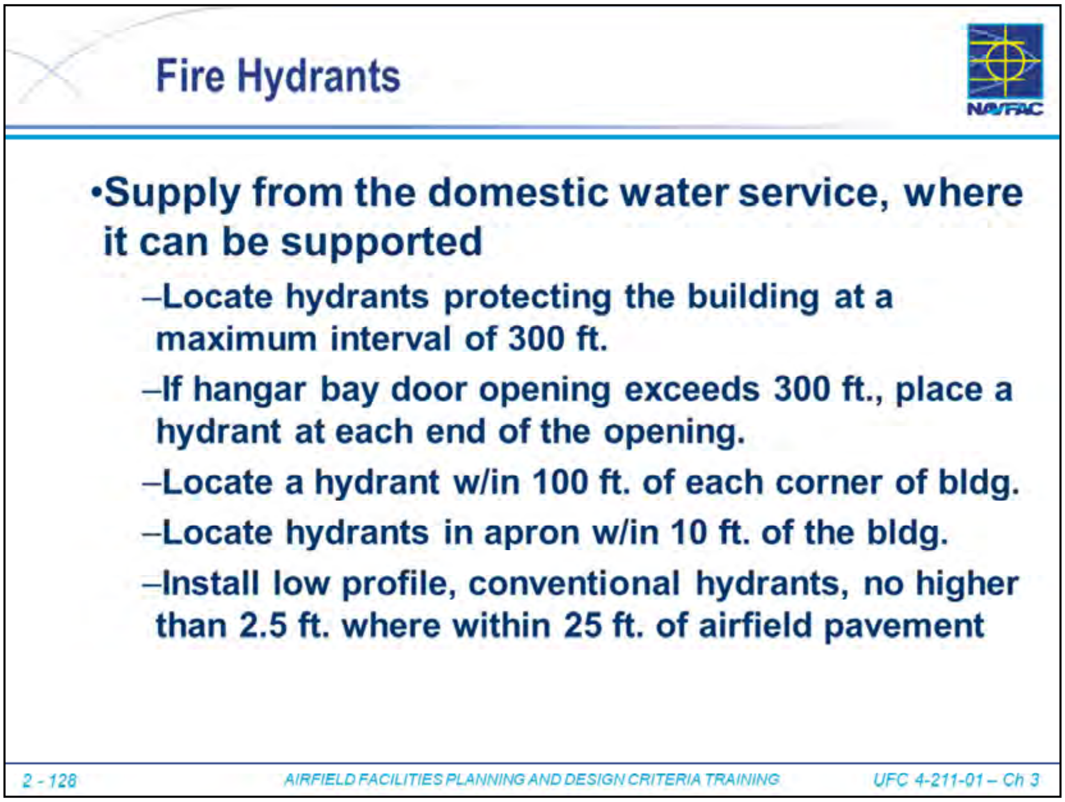
F-35 Preconditioned Air Systems (PCA)

- 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)

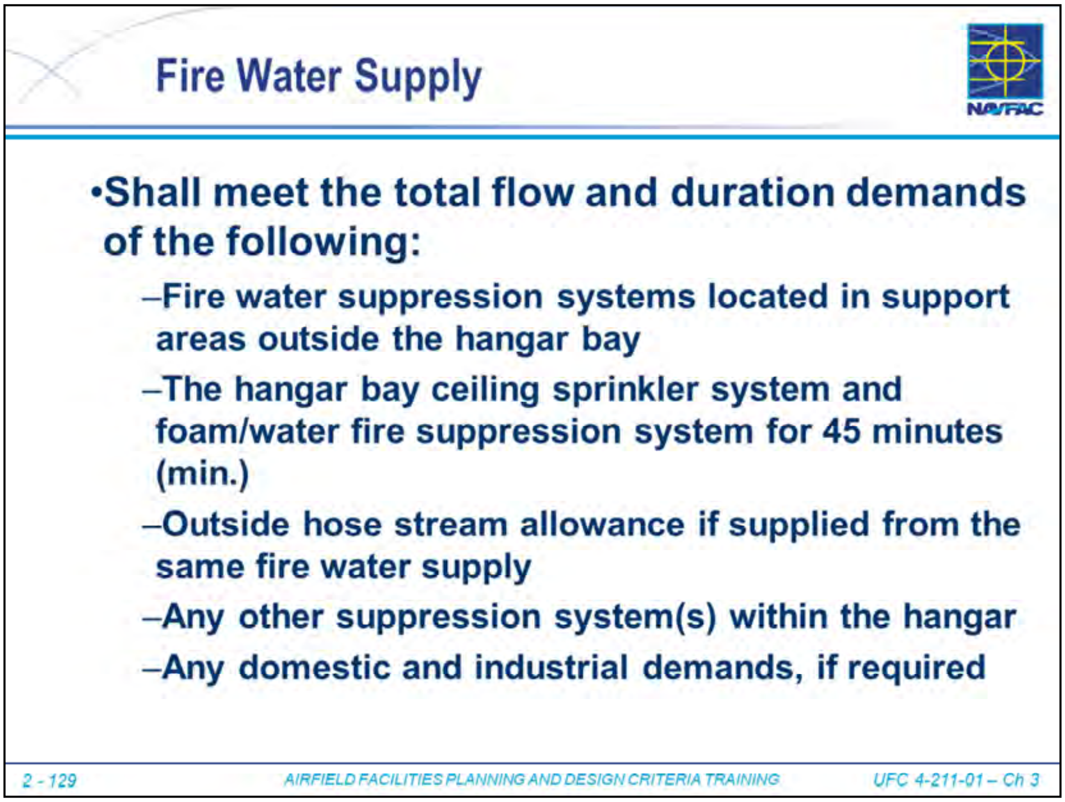




Fire Hydrant Supply: Supply fire hydrants from the domestic water service, where it can be supported.

Fire Hydrant Location: Install hydrants in accordance with UFC 3-600-01, except at modified below:

- Locate hydrants protecting the building at a maximum interval of 300 ft (91 m), unless noted otherwise.
- Hydrants are not permitted in front of the hangar bay door opening. Where the hangar bay door opening exceeds 300 ft. (91.4 m), place a hydrant at each end of the opening.
- Locate at least one hydrant within 100 ft. (30.5 m) of each corner of the building.
- Where the aircraft parking apron pavement abuts the building, locate required hydrants protecting the building in these areas within 10 ft. (3.0 m) of the building.
- Install low profile, conventional hydrants, no higher than 2.5 ft. (700 mm) where within 25 ft. (7.6 m) of airfield pavement.
- Flush-mounted hydrants in the pavement are not permitted.



Fire Water Supply

Design the fire water supply to meet the following fire flow demands for the required duration. When the existing fire water supply cannot meet the flow or duration requirements, modify the system or provide an independent fire water supply to meet the requirements.

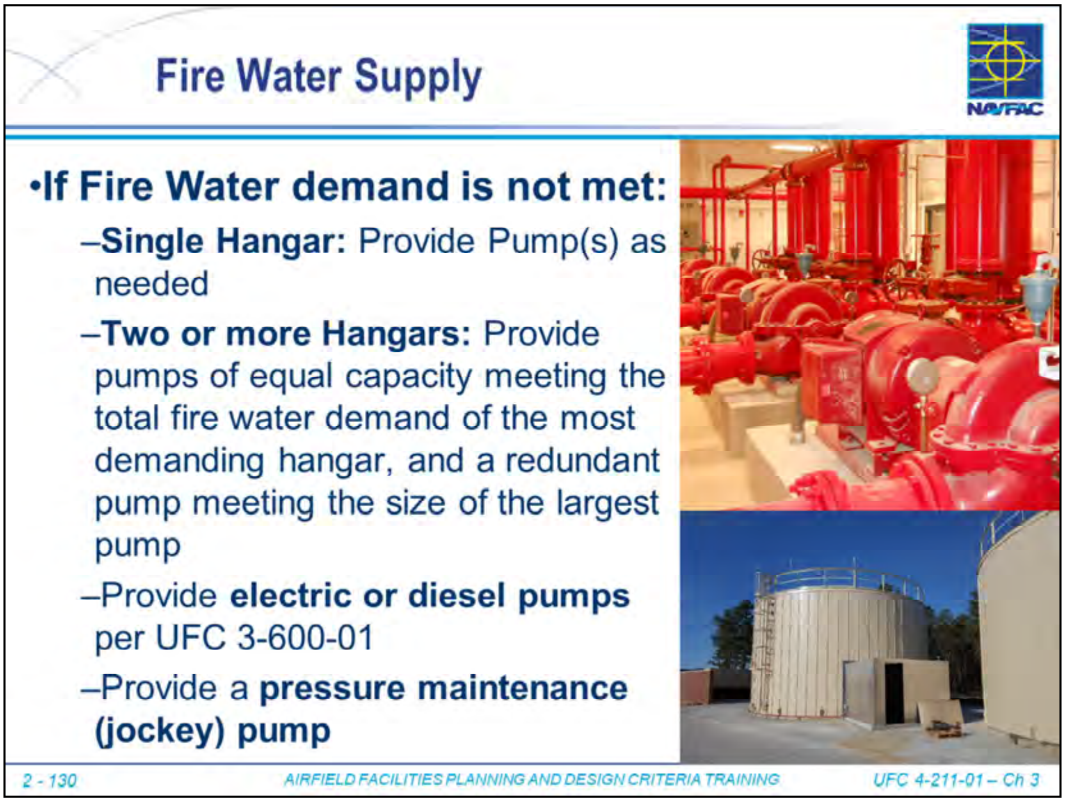
• Evaluate fire water supply for suppression systems located in support areas outside the hangar bay in accordance with UFC 3-600-01.

• For High-Expansion (Hi-Ex) foam and Aqueous Film-Forming Foam (AFFF) Trench Nozzle systems within the hangar bay, provide a fire water supply to support the combined demand of the hangar bay ceiling sprinkler system and foam/water fire suppression system for 45 minutes (min.).

• For other suppression system(s) within the hangar bay, provide additional water supply in accordance with NFPA 409.

• Include the demand of the outside hose stream allowance where supplied from the same fire water supply.

• Include domestic and industrial demands where required by UFC 3-600-01.



Fire and Pressure Maintenance Pumps: Provide electric or diesel fire pumps as required by UFC 3-600-01.

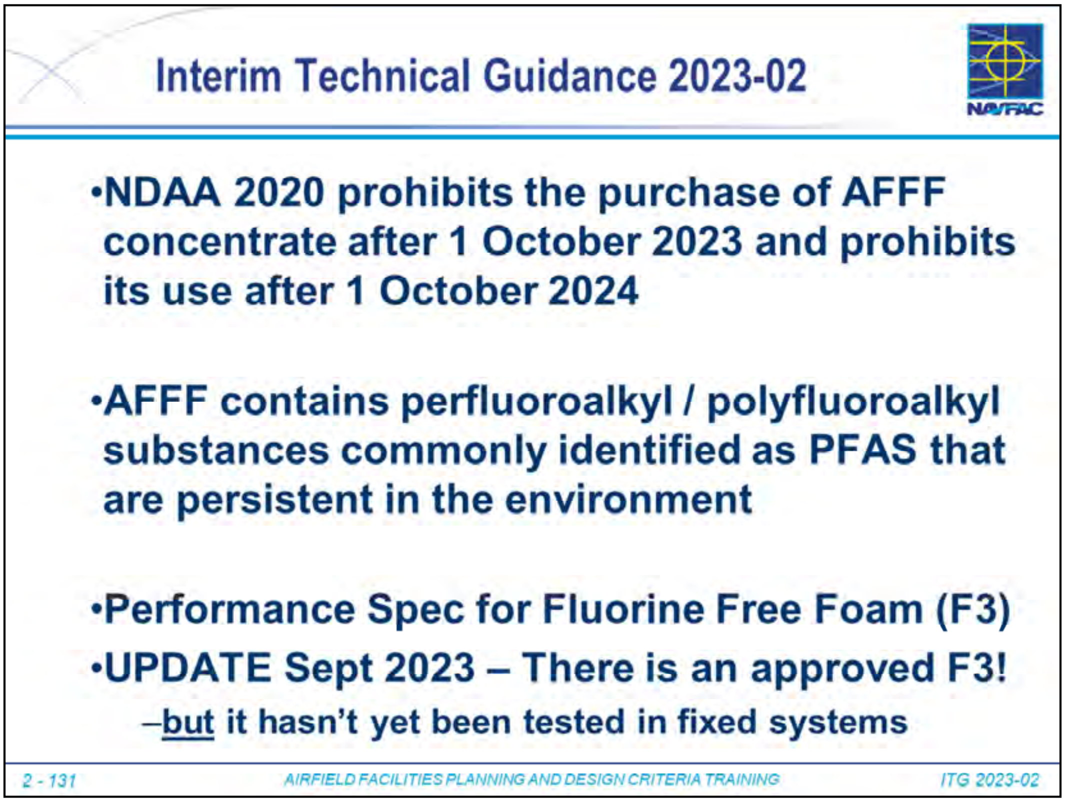
Fire Pump Control

Start the fire pump automatically upon a drop in system pressure in accordance with NFPA 20. Where the drop in system pressure is not significant enough to automatically start the fire pump such as a fire pump installed in parallel with a large domestic water booster pump, provide the fire pump with a remote start signal from the Fire Alarm Control Unit (FACU).

When starting the fire pump, do not exceed ten seconds before the pump is operating at the design pressure.

Pressure Maintenance Pump

Provide a pressure maintenance (jockey) pump to maintain normal operating pressure on the system. Size and automatically operate the pump in accordance with NFPA 20. Provide pump controller with an adjustable timer to prevent short cycling. Operate pump for the minimum run time recommended by the manufacturer.

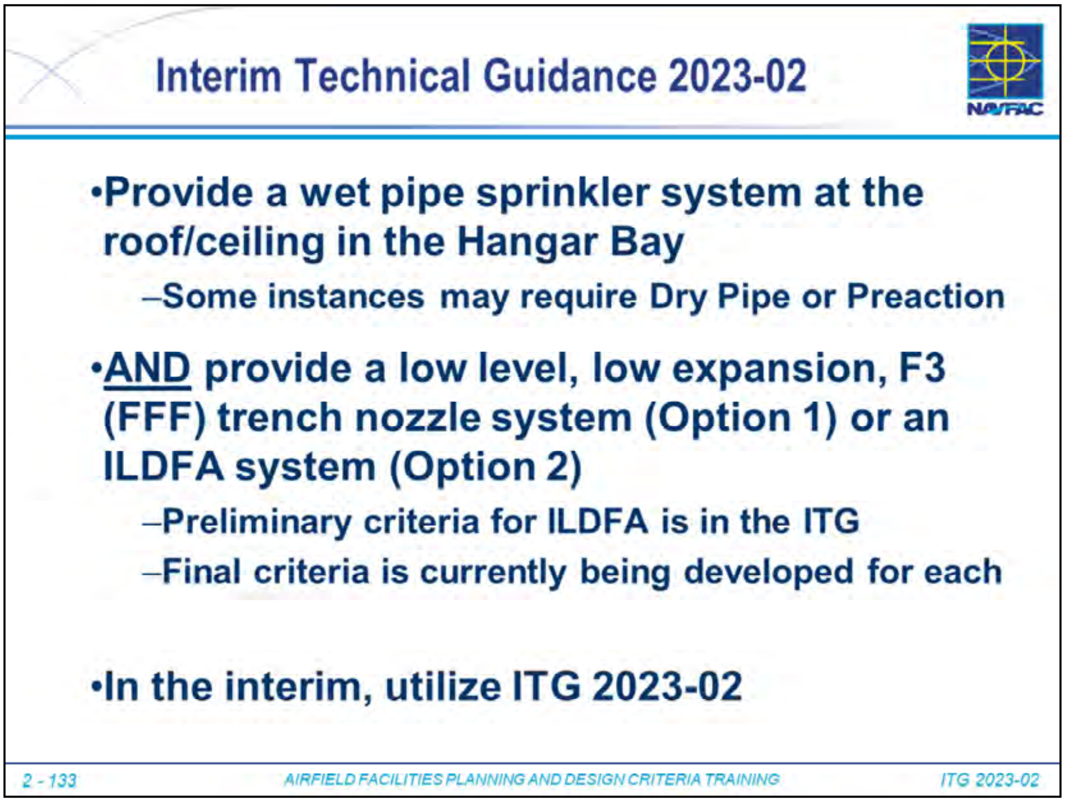


AFFF = Aqueous Film Forming Foam

Refer to the wbdg.org: The ITG has recommendations for existing facilities with AFFF and new facilities in Planning, Design and Construction.

Refer to the wbdg.org: The ITG has recommendations for existing facilities with AFFF and new facilities in Planning, Design and Construction.

NOTE: Criteria is currently being developed for both solutions



Sprinkler Systems

Provide upright quick-response sprinklers at the roof or ceiling level with a temperature rating of 175ºF (79.4ºC).

Where the geographical location of the building has a 0.4% dry bulb temperature greater than 100ºF (37.8ºC) per UFC 3-400-02, provide sprinklers with an intermediate temperature rating of 200ºF (93.3ºC). Design the sprinkler piping such that the majority or all of the system drains back to the riser. Minimize or eliminate the requirement for remote drainage connections in the hangar bay.

Where wet pipe systems are installed in areas with a 99.6% dry bulb temperature of 40ºF (4.4ºC) of less per UFC 3-400-02 Engineering Weather Data, adhere to the following piping installation requirements:

• Locate the inspector’s test connections at the riser. Test stations are not permitted in the hangar bay.

• Where drainage piping is required in the hangar bay, do not route the portion of the drainage piping normally containing water and associated drainage valve more than 5 ft. (1524 mm) below the level of the lowest sprinkler head in the hangar bay. Route the remaining normally empty drainage piping to the building exterior.

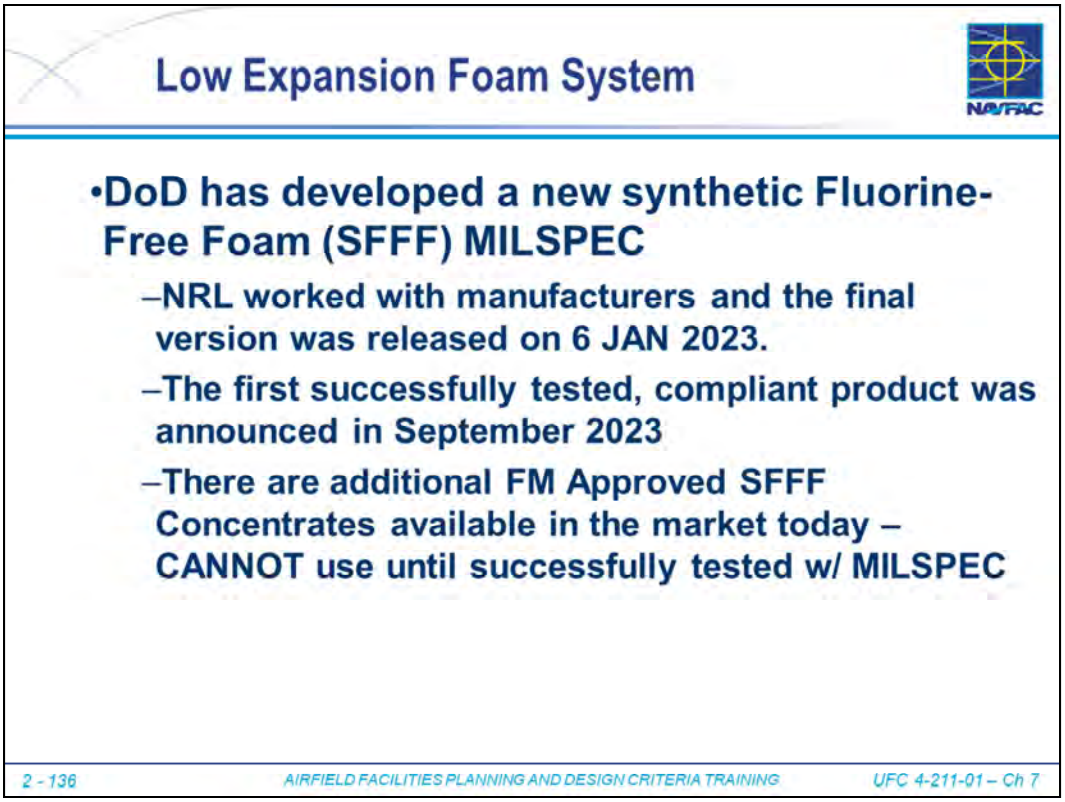
Interim Technical Guidance 2023-02

Planning New Hangar	Design New Hangar	Construction New Hangar
Option 1: Plan for F3 Coordinate for ILDFA	Option 1: Plan for F3 Coordinate for ILDFA	Option 1: Finish AFFF Install Don't purchase, accept AFFF Concentrate At BOD: turn off AFFF treat as Existing Hangar w/ Inoperable AFFF System
Option 2: Plan for ILDFA	Option 2: Plan for ILDFA	Option 2: Modify Contract to Install ILDFA

Interim Technical Guidance 2023-02

NAVFAC

Existing Hgr. w/ AFFF Operational	Existing Hgr. w/ AFFF Inoperable	Existing Hgr. w/ AFFF Inoperable
Option 1: 1. Maintain System with Regular Inspections and Testing 2. Coordinate with CNIC/NAVFAC for F3 prior to 1 OCT 2024	Option 2a: 1. Turn off AFFF – Close, Lock and Tagout Concentrate and water supply to AFFF 2. No fueled Aircraft in Hangar 3. Develop COAs, written procedures, training and signage	Option 2b: 1. Turn off AFFF – Close, Lock and Tagout Concentrate and water supply to AFFF 2. Install surface mounted ILDFA 3. Update written Procedures



https://www.perimeter-solutions.com/en/class-b-foam/3-mil-spec-sfff/

SOLBERG® 3% MIL-SPEC Synthetic Fluorine-Free Foam (SFFF)

Low Expansion Foam System

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

System Details
May Change

Low expansion foam has an expansion ration of 1:20, maximum

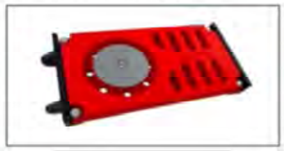
Low Expansion Foam - Technical

VIKING® | **TECHNICAL DATA** | **GRATE NOZZLES MODEL GN202 360°, 180°, AND 90°**

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com
Visit the Viking website for the latest edition of this technical data page www.vikinggroupinc.com

1. GENERAL DESCRIPTION

The Grate Nozzles are designed to protect aircraft hangars and helipads. They are available with a 360°, 180°, or 90° discharge pattern and 26", 20" and 555 mm widths to meet design requirements. The Grate Nozzles are low expansion foam discharge devices that deliver a uniform discharge pattern with a maximum spacing of 50' x 25' (15.2 m x 7.6 m). The nozzles are installed flush with the floor of the protection area within the trench drain. The companion trench drain grate is specially engineered to receive the Grate Nozzle® and serve as a cover for the drain trench.



2. LISTINGS AND APPROVALS

The Grate Nozzle is FM Approved as part of a fire suppression system combining designated foam concentrates, proportioning devices and bladder tanks. Approved system components can be found at www.approvalguide.com.

FM Approved – Low Expansion Foam Systems (FM5130)
Approved with the following foam concentrates:
- Viking USP, 3%

US DOD Acceptance

SFFF [illegible]" refers to this product as being part of a SFFF Foam system that has been tested to recognized standards. Not all configurations are available. Please consult technical data and/or the Approval for usage requirements.

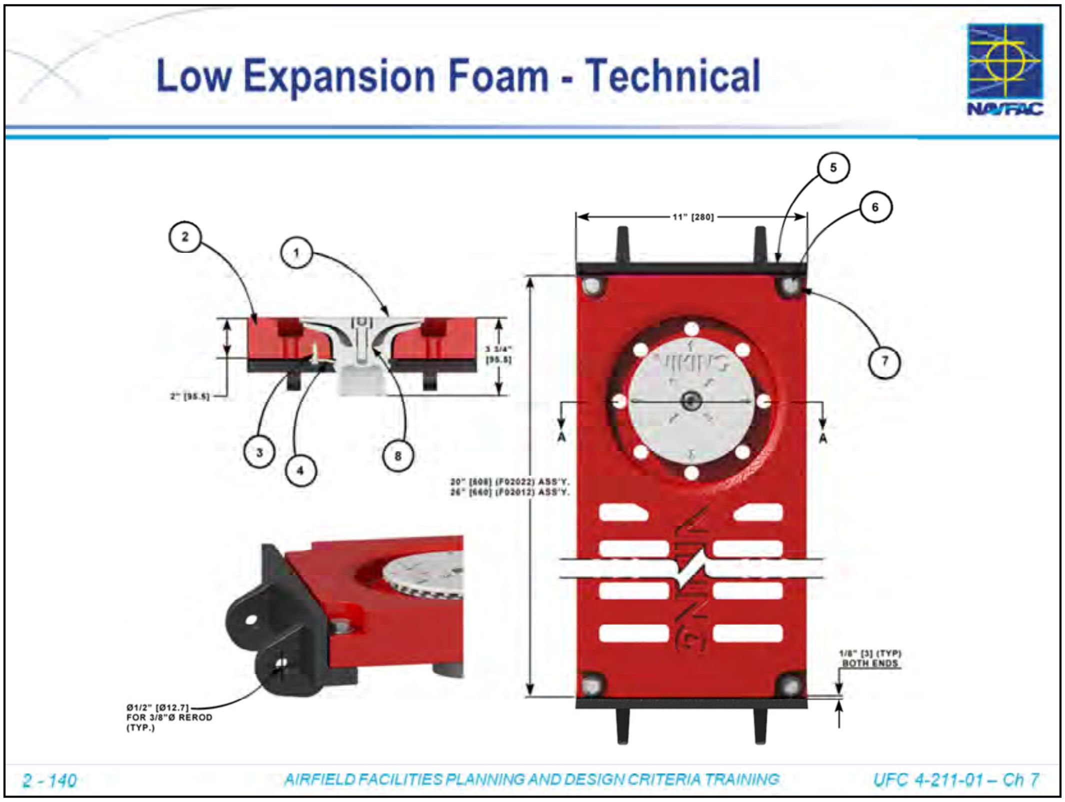
SFFF

3. TECHNICAL DATA

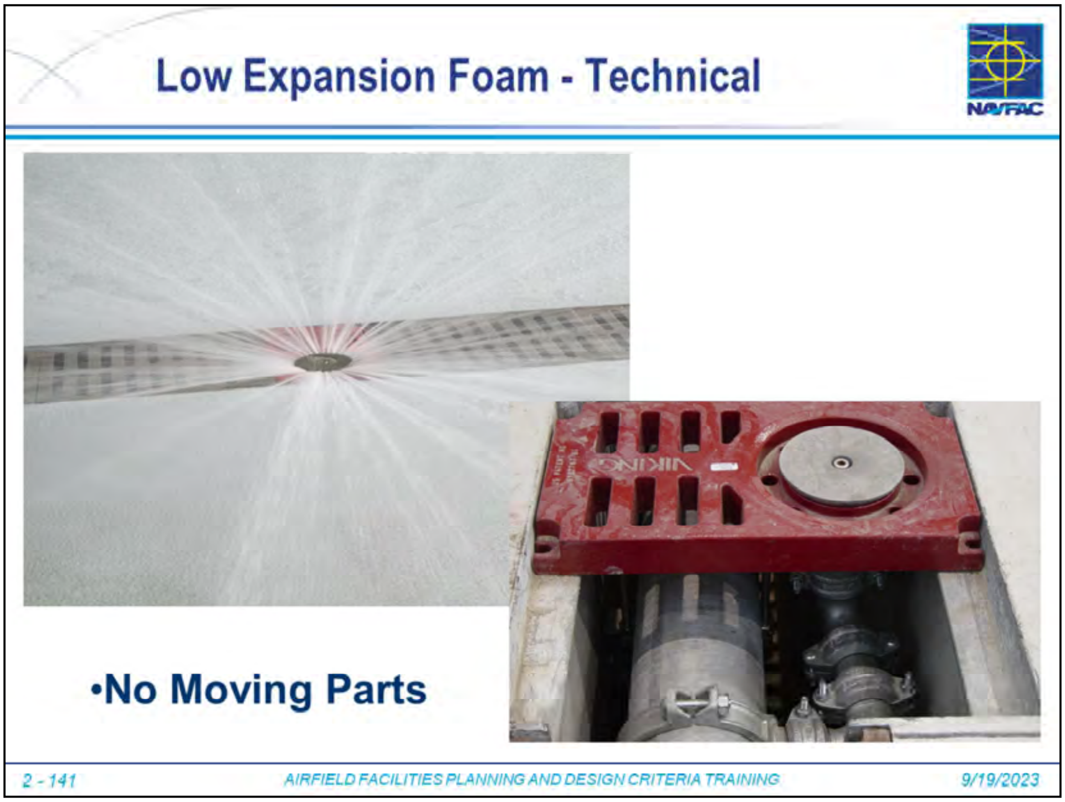
3.1 Features

Grate Nozzle
- Floor level distribution
- 2" grooved inlet for simple installation and removal
- Durable construction
- No moving parts
- Discharge recouping - if a nozzle within a system is obstructed during discharge (by aircraft tires, barrels, hoses, construction materials or other items), flow rates to the other in-line nozzles will increase and recoup the loss.
- Multiple uses including floor washdowns and system flow tests (without foam)
- Maximum 18" height of spray pattern

Trench drain grate
- Acts as a receiver for the Grate Nozzle.
- Slotted design allows drainage into trench drain system.
- Integrates seamlessly into new and existing trench drain grate systems.
- Matches typical trench grate designs.



Use Viking Grate Nozzle™, Models GN 200/360, 200/180, or 200/090 or equal for the low level AFFF system. Use nozzles that are UL listed (GFUT) or FM approved.

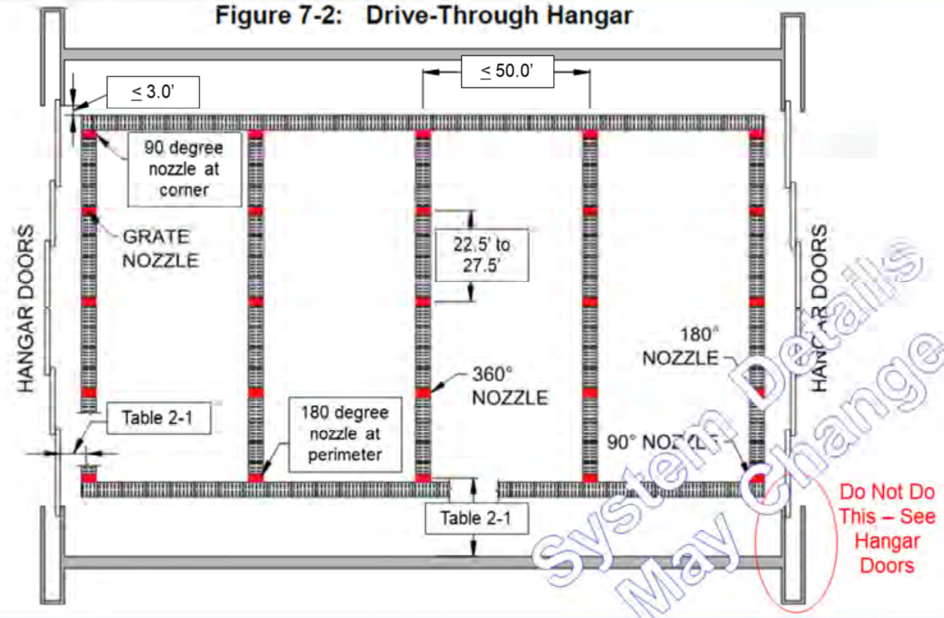


AFFF Trench Nozzle System For Navy: Provide a hydraulically designed low level AFFF trench nozzle system for hangar bays. Refer to Chapter 7: Navy Specific Criteria for additional requirements regarding the trench nozzle system design.

AFFF System Performance: For the AFFF trench nozzle system, provide AFFF foam/water solution at the most remote nozzle within 30 seconds upon foam/water system activation such as from the manual foam releasing station. Maintain the discharge pressure for all nozzles between 40 psig (275 kPa) and 45 psig (310 kPa).

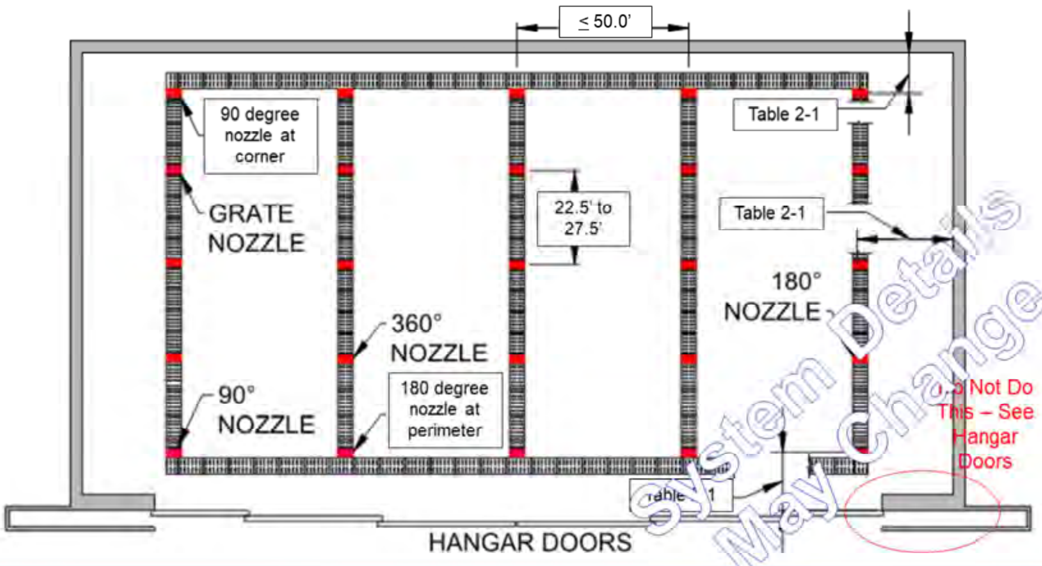
Low Expansion Foam System

Figure 7-2: Drive-Through Hangar



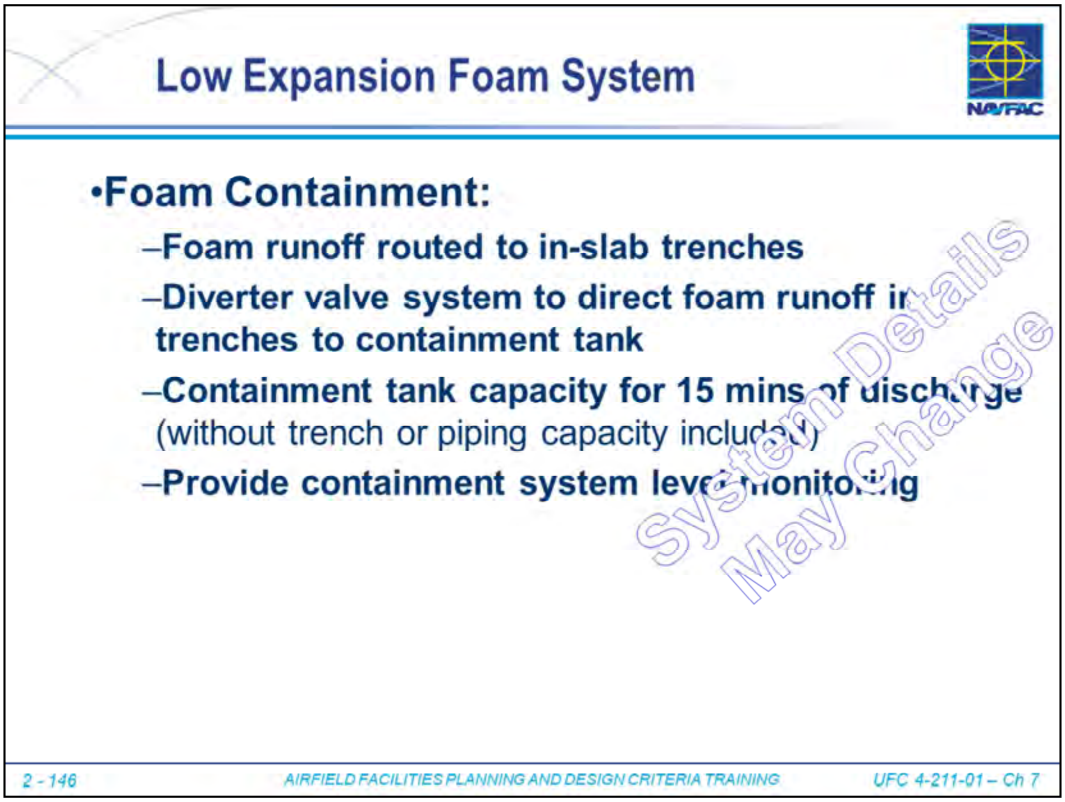
Low Expansion Foam System

Figure 7-3: Pull-In Hangar



Low Expansion Foam System

Low Expansion Foam System



Follow all environmental regulations.

Capacity: Provide capacity to contain 15 minutes of the hydraulically calculated demand from the AFFF system. Design the containment system to accommodate the entire calculated AFFF system effluent discharge volume for the duration noted. Do not use the trenches or piping of the containment system to contain any of the required volume. No allowance is required for the water only sprinkler systems or hose streams.

Containment System Monitoring: Provide the containment system with a remote capacity monitoring panel. Provide monitoring panel with audible and visual (yellow strobe or beacon) alarms. Automatically activate audible and visual alarms when the capacity level exceeds 5%. Provide a silence switch for the audible alarm. Constantly illuminate visual alarms at the panel until the level condition is returned to normal.

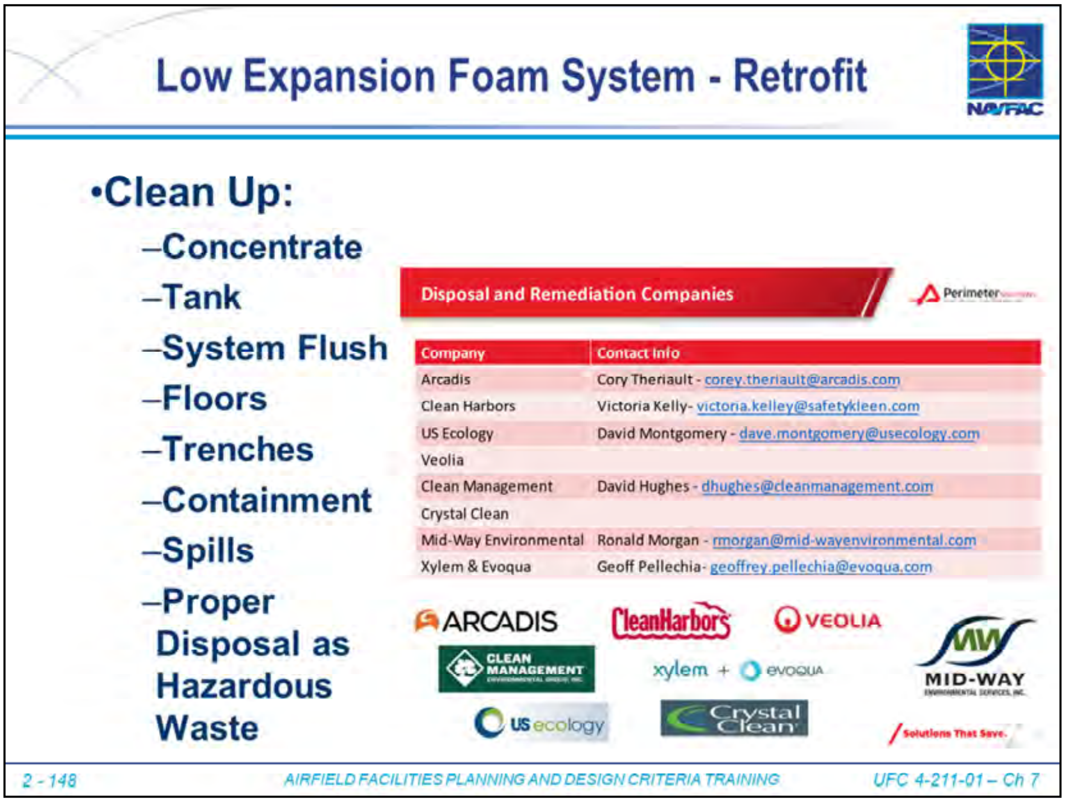
Diverter Valve/System: Provide a system that automatically diverts the floor trench drainage flow to a foam/water containment system upon system activation. Where a containment system uses a diverter valve, provide actuation and monitoring of the valve.

Low Expansion Foam System - Retrofit

- **Currently Evaluating:**
  - **SFFF manufacturers, grates, etc.**
  - **Retrofit & New Design Criteria – TBD**

- **Retrofit to F3 from AFFF (likely includes)**
  - **Flushing, Clean-up, & Disposal**
  - **New Grate Nozzels**
  - **New Eductor (viscosity is different until mixed with water)**
  - **New Pressure Calcs (confirm system/pump capacity and adjust regulating flow control valves as needed)**

System Details May Change



Company	Contact Info
Arcadis	Cory Theriault - corey.theriault@arcadis.com
Clean Harbors	Victoria Kelly- victoria.kelley@safetykleen.com
US Ecology	David Montgomery - dave.montgomery@usecology.com
Veolia	
Clean Management	David Hughes - dhughes@cleanmanagement.com
Crystal Clean	
Mid-Way Environmental	Ronald Morgan - rmorgan@mid-wayenvironmental.com
Xylem & Evoqua	Geoff Pellechia- geoffrey.pellechia@evoqua.com

This is likely an expensive clean up and disposal.

ILDFA = Ignitable Liquid Drainage Flooring Assemblies

Concerns –

Only one manufacturer (design standards require 3 manufacturers or sole-source justification)

No currently published design or performance standards – which makes it difficult for additional manufacturers to compete

Some maintainers have expressed concern about working on the elevated metal floor with a dimpled surface

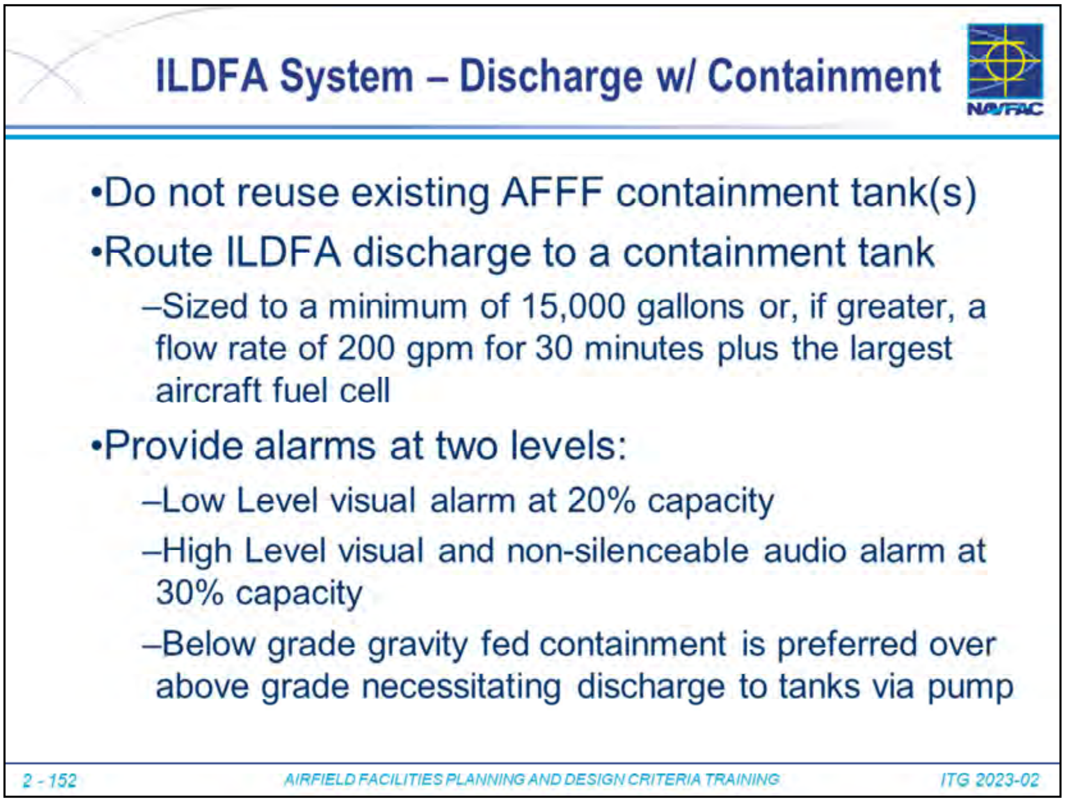
Concern over what other chemicals are spilled into this system and what may happen if they don’t flow (and thus clog the system)

Some concern over elevated floors or attempting to recess hangar floors

The distance from the walls may exceed those “Table 2-1: Minimum Aircraft Maintenance Bay Clearances” in reference (e) by 5 feet if the ILDFA still covers a 16 ft to 18 ft radius drawn from the outer edge of any potential area containing fuel in the aircraft, such as fuel tanks and engines.

ILDFA System – Optical Flame Detectors

- Individually addressed, tied to FA system, but not tied to a releasing service fire alarm control unit
- Provide around the perimeter of the hangar bay, such that all portions of the hangar bay are within the range and cone-of-vision of at least one detector
  - Exception: Area within 5 ft. of the perimeter wall
- Prevent cone-of-vision beyond the hangar doors, and heat sources such as radiant heaters
- Install per manufacturer's recommendations



ILDFA must continue to operate once containment tank is full. Arrange containment system to prevent ILDFA discharge from backing up into the hangar bay or hangar bay trenches once containment tank is full.

ILDFA System – Discharge No Containment

- Direct ILDFA drainage outflow to an oil water separator (OWS)
- Outflow must be gravity fed to an OWS rated for a minimum of 400 gm. Provide OWS with a higher capacity when necessary

ILDFA System

- Install only with Qualified contractors under direct supervision and QC of the ILDFA manufacturer
- Recess the slab to provide ILDFA system flush with adjacent slab surfaces
- Provide HMI (Human Machine Interface) Screen located on the control panel
  - Utilize a glare resistant screen.

ILDFA System

- Pump serving the ILDFA system
  - –Consist of one minimum 20 HP Listed centrifugal fire pump with a listed fire pump controller
  - –Fire pump (and controller) listing agency must be the same as for the ILDFA system
  - –Pump skid enclosure must consist of a bollard structure (and panels to fully enclose the pump and pump controller) to protect it from damage from tugs, etc.

ILDFA System – Grounding

- Connect ILDFA to the facility grounding and bonding in accordance with UFC 3-575-01
  - Provide AC Grounding points, integrated in the ILDFA

ILDFA System – Protection

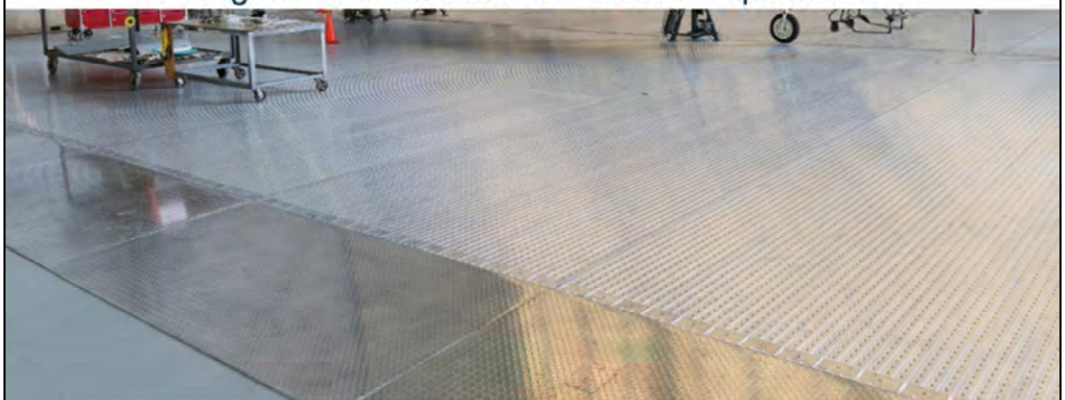
- Provide Galvanic Protection for Aluminum ILDFA
  - Protect from contact with other metals
  - Protect from concrete slab w/ 5-coat Epoxy Coating
- Protect all in-trench cabling inside fireproof conduit
- House solenoid valves in a separate sub-grade enclosure mounted adjacent to the trench

ILDFA System – Retrofits

- Survey slab to ensure no utilities will be impacted by trench cutting (or anchoring)
- Provide ILDFA Manufacturer with a survey of actual trench depth, length, width, etc.
- Specify applicable mortar for backfilling of trenches (do not specify quick setting cement)

ILDFA System – Retrofits

- Ramps/Transition Plates
  - Matte finish metal to prevent glare
  - Meet same structural requirements as the ILDFA
  - Designed and installed for thermal expansion



Fire Protection Design – Air Force

- Provide a wet pipe sprinkler system at the roof/ceiling in the Hangar Bay
  - Some instances may require Dry Pipe or Preaction
- Air Force: ~~provide an overhead High-Expansion (HEF, Hi-Ex) foam system~~
  - Note: HEF, Hi-Ex does not have PFAS

SAF/IE Sundown Policy for Foam Fire Suppression Systems

- Air Force Sundown Policy (with ongoing modifications) cites Chemicals and Inadvertent Activations (one every two months) resulting in damage to aircraft and facilities, injuries and loss of life.

2 - 161 AIRFIELD FACILITIES PLANNING AND DESIGN CRITERIA TRAINING 9/19/2023

Policy also notes no aircraft have been saved by a foam system in the DoD.

ILDFA = Ignitable Liquid Drainage Flooring Assemblies

High expansion foam has an expansion ration of 1:200 to 1:1000

NAVFAC managed projects of Air Force projects may use HEF, as may projects in Japan.

Hi-Ex Foam Generators: Provide hydraulically (water) powered or electrically powered foam generators.

Hi-Ex Foam Generator Location: Locate Hi-Ex generators to discharge within close proximity, but not directly upon the aircraft or surrounding maintenance platforms. When mounting generators in the horizontal position, take into account the throw pattern of the Hi-Ex foam discharge. Do not locate the generator where the Hi-Ex foam discharge is obstructed by items such as structural members, lighting fixtures, or bird screen or in areas that obstruct the use of service equipment such as the crane travel path.

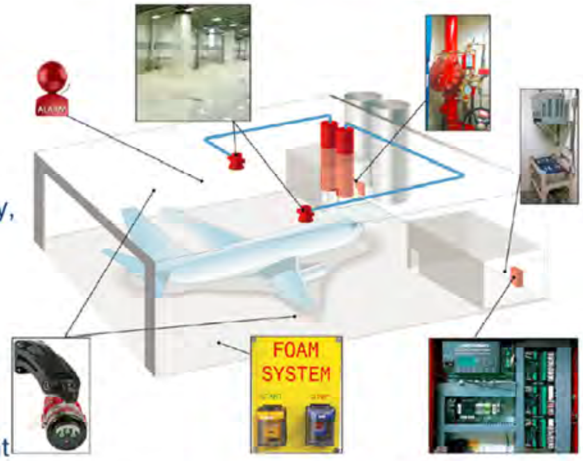
Do not provide generators in locations where the developing foam blanket will block exits from the hangar bay within the first minute of discharge. Blocked exits are defined as an exit that is obstructed by a foam blanket exceeding 5 ft. (1.5 m) in depth. In small hangar bays where the entire floor may be covered with foam within the first minute, provide generator locations so exits are one of the last areas blocked.

Air Force Tier 1 – High Expansion Foam

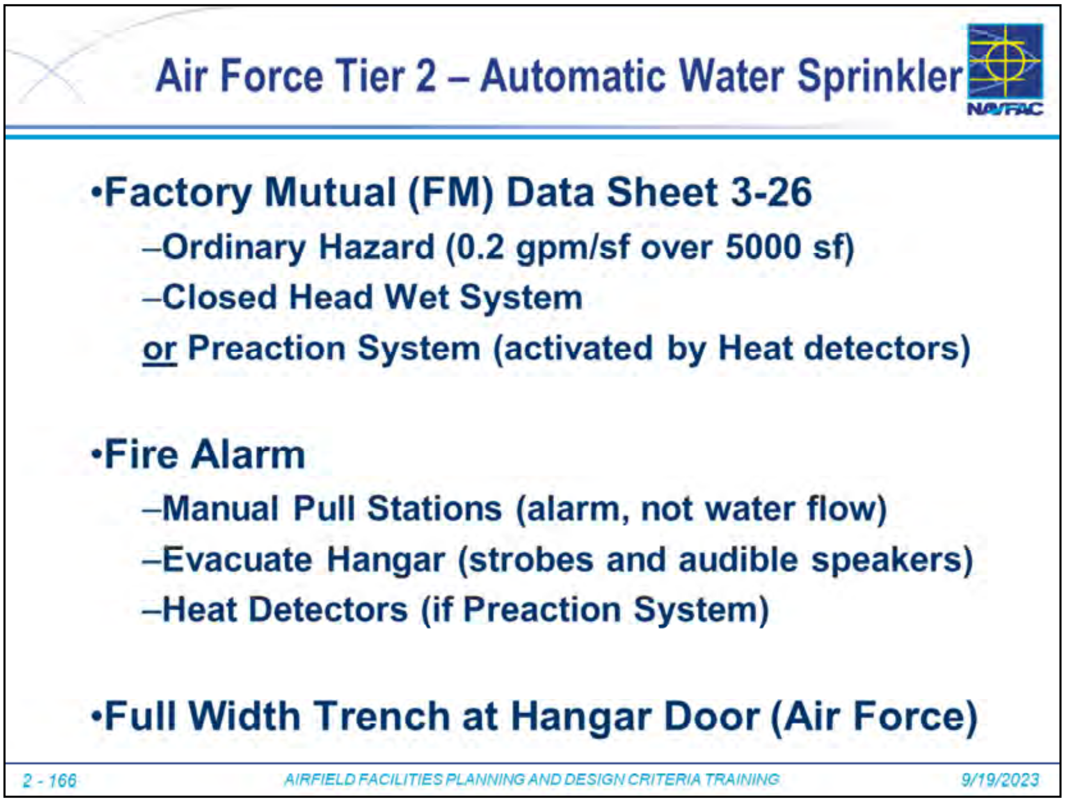
- Foam Controls: Proprietary Foam Control Panel and Flame Detection
- Triple IR Flame Detectors - Crosszoned
- First Detector – Prealarm
- Second detector in Same Hangar Bay, Activates HEF Zone

- OR -

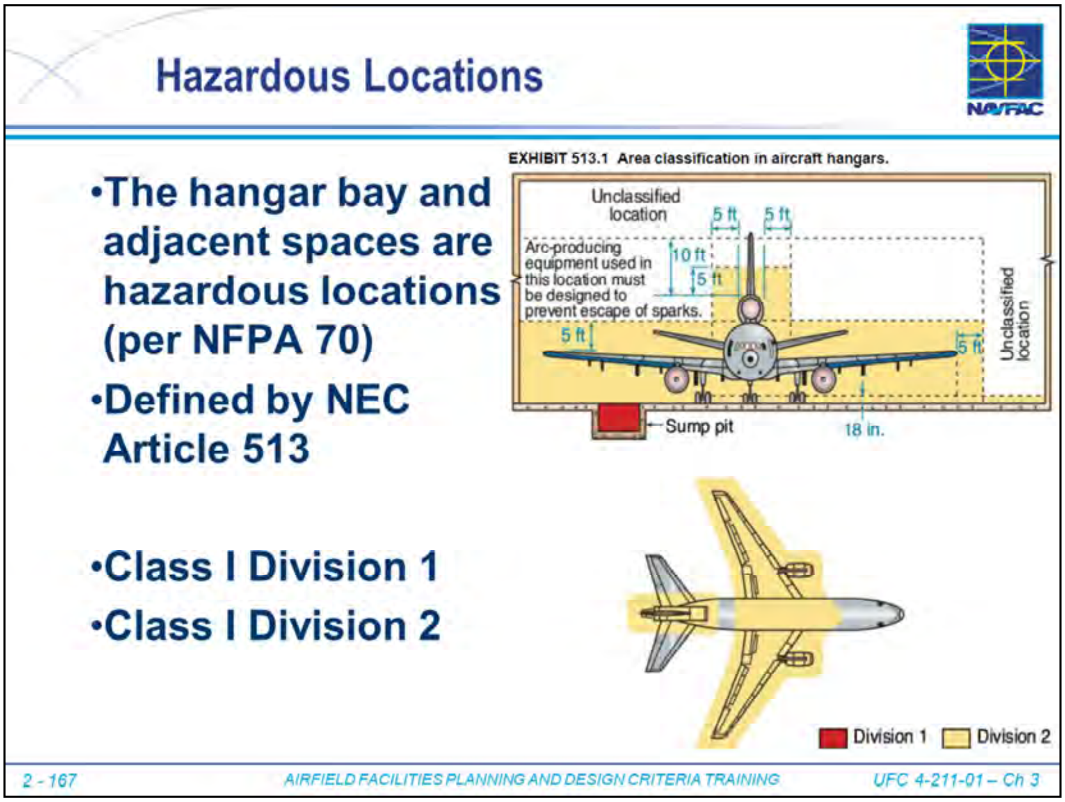
- Foam Manual Pull – Activates HEF Zone Per Hangar Bay – located at Hangar Exits, dual action stations w/ clear covers & sirens
- Abort Switch at Foam Pulls to Prevent or Stop Foam Flow, Even After System Activation (must press and hold)
- Blue Beacons Signal Foam Discharge



Air Force Tier 1 – High Expansion Foam

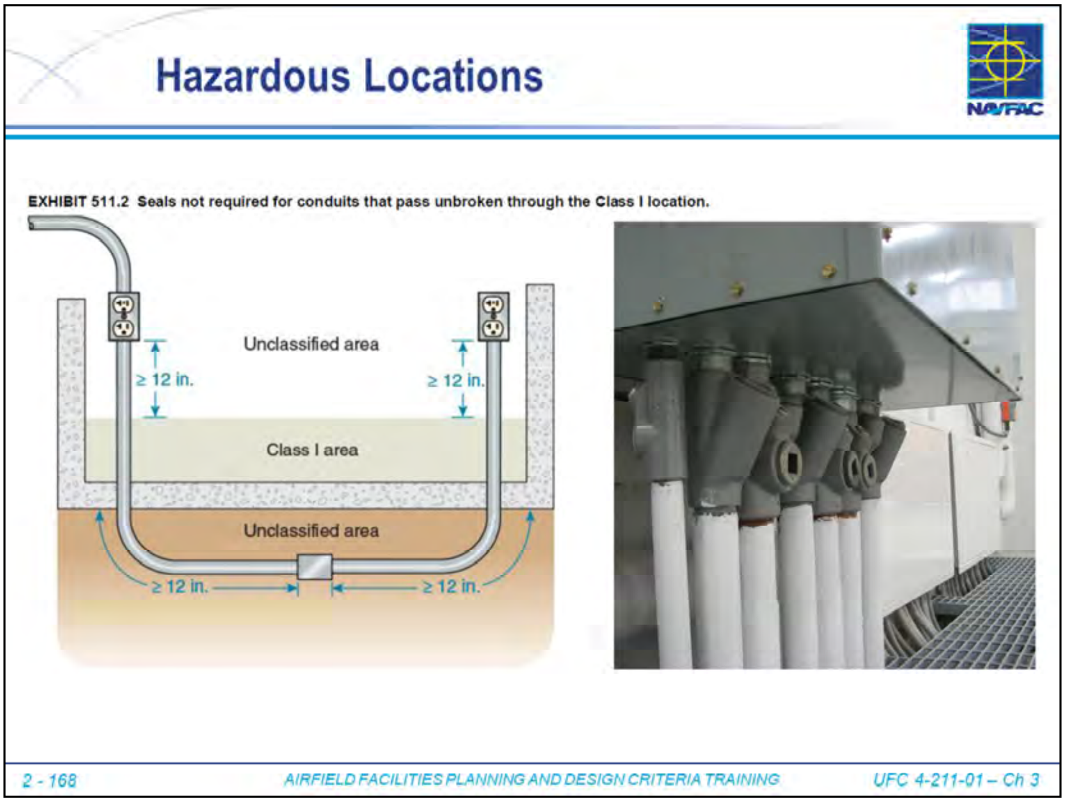


The difference between a wet system and the pre-action system is that in the pre-action system, the pipes are filled with compressed air and the sprinkler heads are all closed, and water is held back from the piping by a pre-action valve. This way the system is considered a dry system until activated when it becomes a wet system.



Hazardous (Classified) Locations

Design hazardous (classified) locations including the hangar bay and adjacent spaces in accordance with NFPA 70 requirements for hazardous locations. At a minimum, classify adjacent spaces that are not suitably cutoff as Class I Division 2 up to 18 inches (460 mm) above the floor of the hangar bay adjacent to the space.



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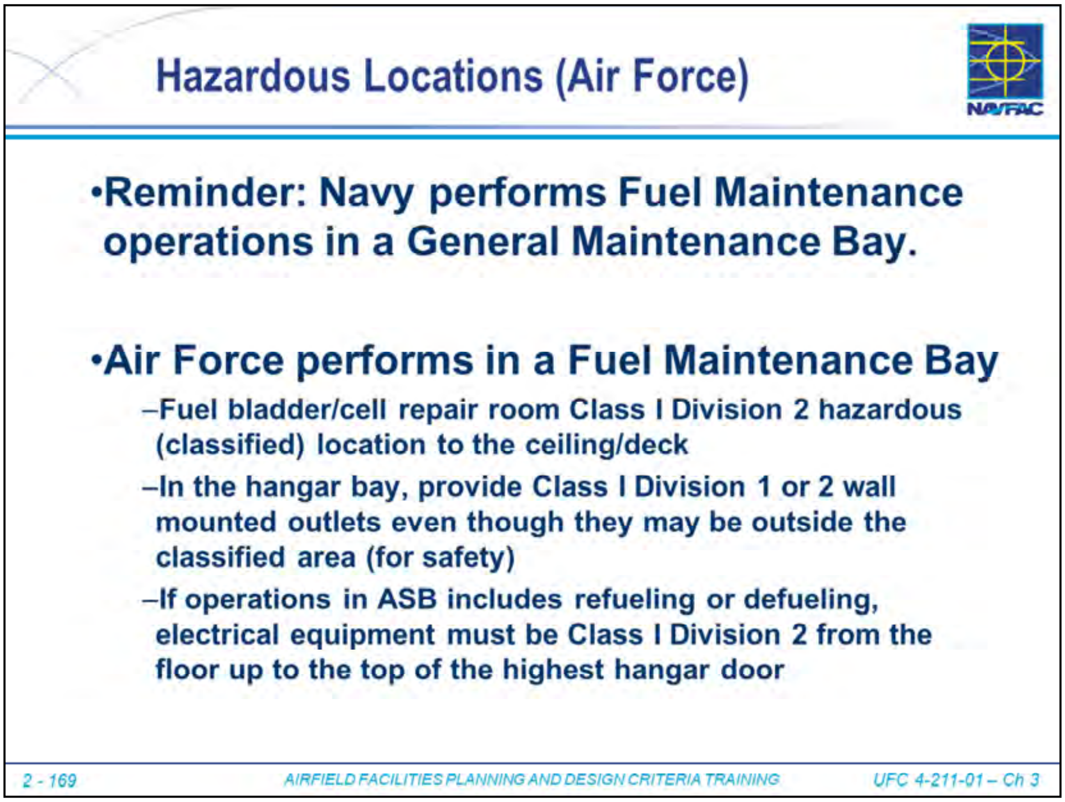

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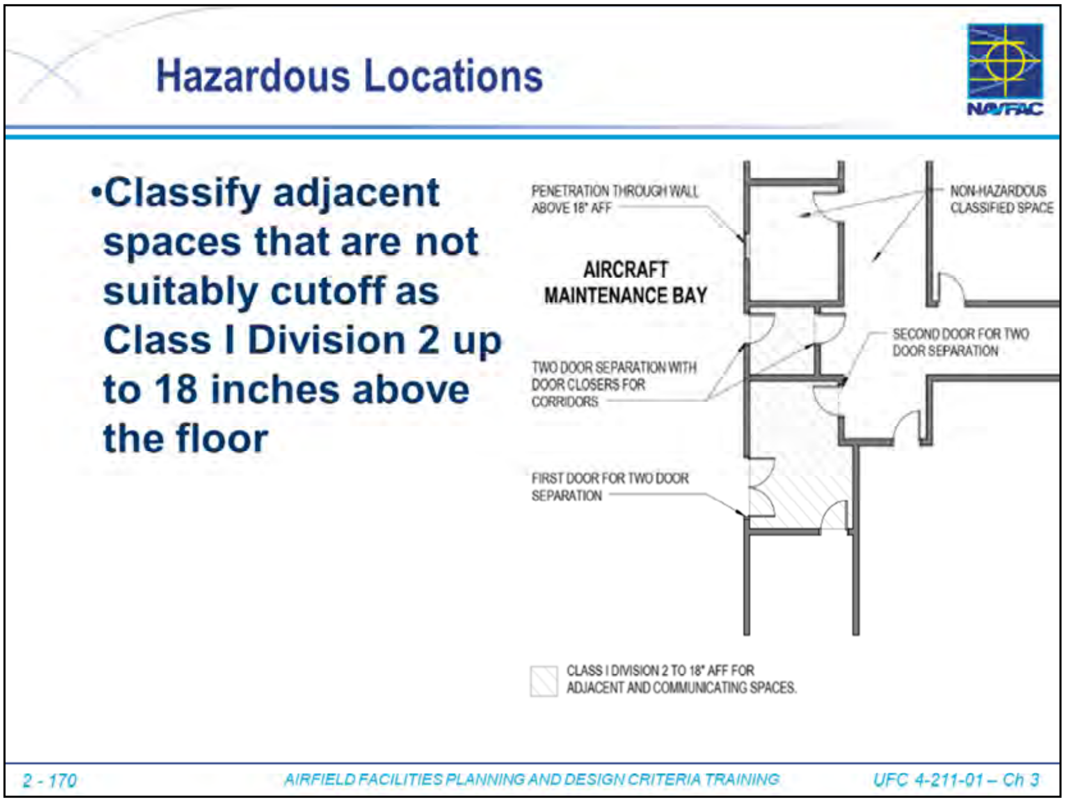


Hazardous (Classified) Locations

If a space is adjacent and communicates with a hazardous location, the term "suitably cutoff" in NFPA 70 is defined as either of the following conditions as shown in Figure 3-12: Adjacent Space Electrical Hazardous Classifications:

• Two normally closed (self-closing) doors in series with a minimum separation of 5 ft. (1.5 m). Classify the space between these doors as Class I Division 2 up to 18 inches (460 mm) above the floor of the hangar bay adjacent to the space.

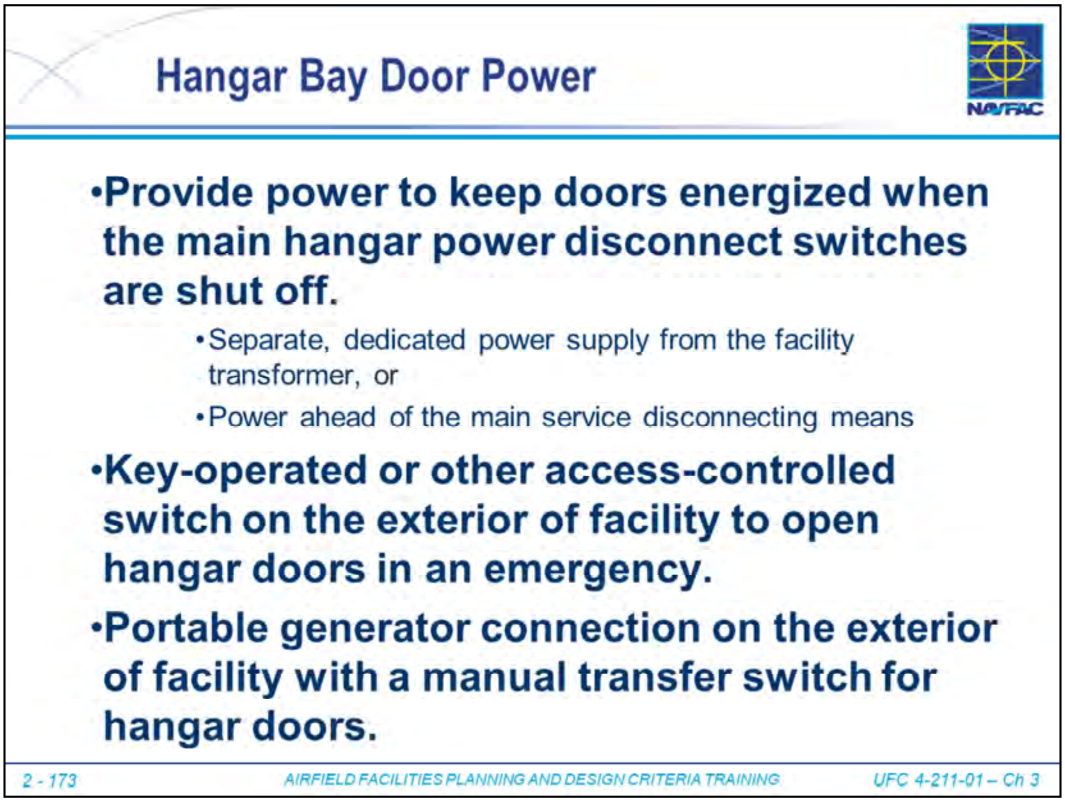
• A wall that has sealed openings up to a minimum of 18 inches (460 mm) above the floor of the hangar bay adjacent to the space. This condition is not permitted where the hazardous classification of hangar bay adjacent to the space is greater than 18 inches (460 mm).

Hazardous Locations

- This does not meet the definition of suitably cutoff

Hazardous Locations

- Both devices (and their power supply/chord) must be at least 18 inches above the floor to meet Class I Division 2 in this hangar



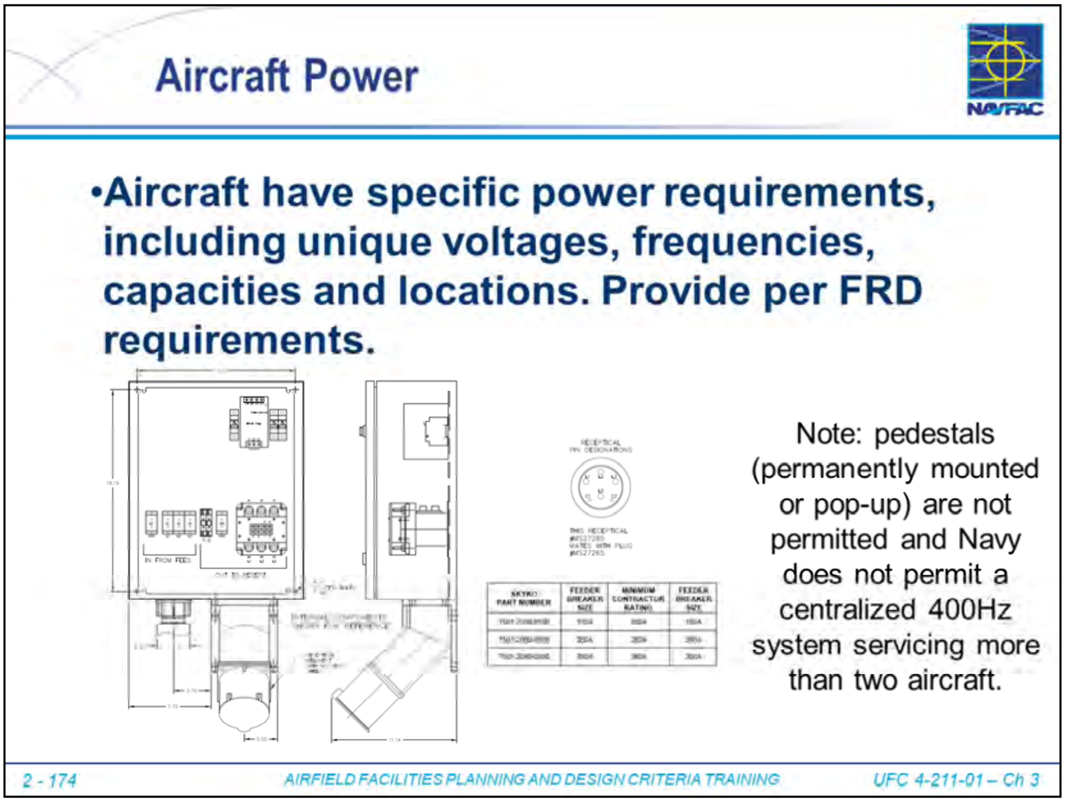
Hangar Bay Door Power

Provide a separate and dedicated power supply from the facility transformer or ahead of the main service disconnecting means. Provide power to the hangar bay door such that the door remains energized when the main disconnect switches for general hangar power are shut off.

Provide a key-operated or other access-controlled switch on the exterior of the facility to open the hangar bay door in the event of an emergency.

Hangar Bay Door Portable Generator Connection: As a minimum, provide a portable generator connection on the exterior of the building with a manual transfer switch for hangar bay doors.

Vertical Lift Fabric Doors: Design the power source for vertical lift fabric doors to have the capability of being operated by an emergency generator or an Aerospace Ground Equipment (AGE) power cart during power outages. At a minimum, size the service to allow operation of one door panel at a time.



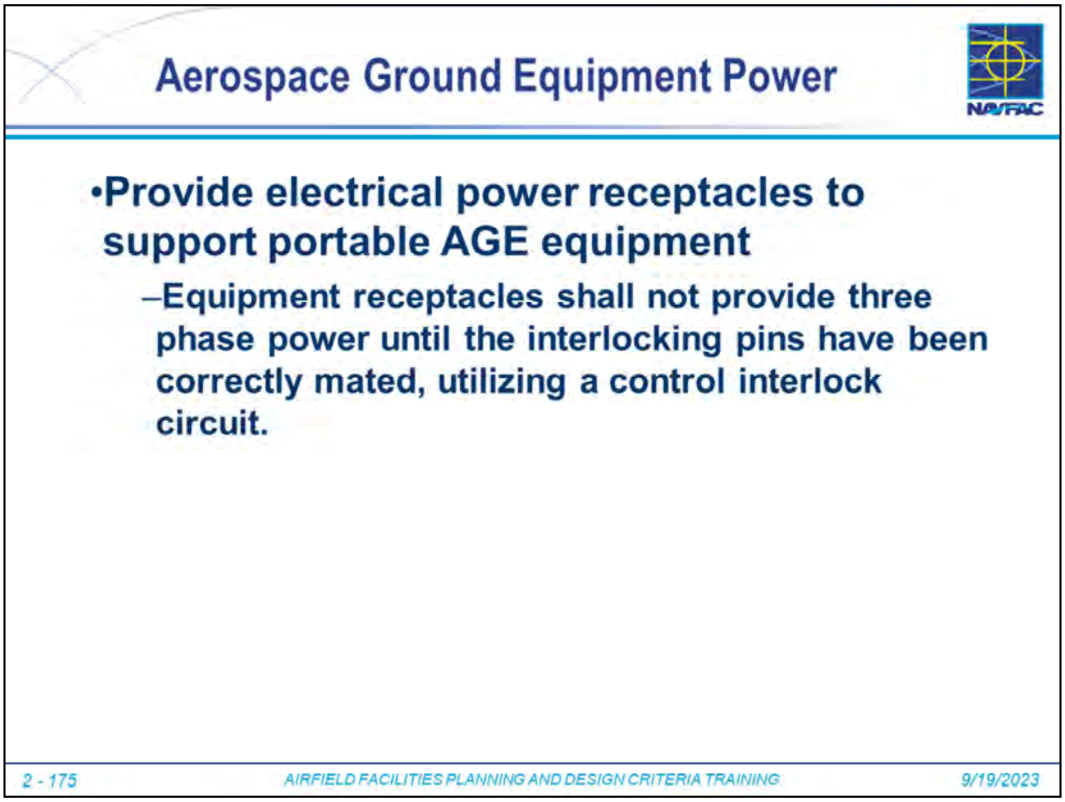
Aircraft Power Systems: Aircraft have specific power requirements, including unique voltages, frequencies, and capacities. Review the requirements of the aircraft being maintained in the hangar bay to determine the appropriate special power systems required. Provide the appropriate aircraft power systems in voltage, frequency, and capacity to service the aircraft being maintained.

Aircraft 400 Hertz (Hz) Service, Aircraft 28 Volts Direct Current (VDC) Service, Aircraft 270VDC Service

Note: Change 2 includes new power requirements for the Triton Type IV Hangars.

UFC prohibits pedestals, and we understand NAVFAC may add prohibition of pits. FYI NAVFAC managed projects of Air Force hangars may contain in-slab pits.

Distribute aircraft power from permanently-mounted equipment located on the wall.



It has been shown that specific AGE plugs, such as 480VAC 60 Hz Hydraulic Mule 200-300 amp equipment, can be inserted into AGE supporting receptacles 180 degrees out of rotation causing a personnel safety and equipment risk. Electrical circuit control interlocking is required to reduce this risk.

Power

- Design Power Distribution in accordance with UFC 3-555-01
- 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**

Comment: UFC 3-575-01 para. 2-3.3 (detail)

Provide LED obstruction lights where the users and airfield manager can verify that night vision goggles (NVG) or vision enhancement systems are not used.

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 to have 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)
  - ACS – access control system
  - IDS – intrusion detection system

F35 Preconditioned Air (PCA) System Technical Oversight

NAVFAC Atlantic, DC43

Agenda Items

- PCA System History and Lessons Learned
- Technical Authority (TA) and Warrant Holder (TWH) Policy
- Current UFC Design Criteria
- Critical Design Review Issues
- UFGS Equipment, System, and Testing Requirements
- Construction Submittal Reviews
- Acceptance Testing

All referenced documents posted on DCME webpage:
https://hub.navfac.navy.mil/webcenter/faces/oracle/webcenter/page/scopedMD/s42a90a51_7a8d_496e_ac68_f103d7ef63a6/Page317.jspx

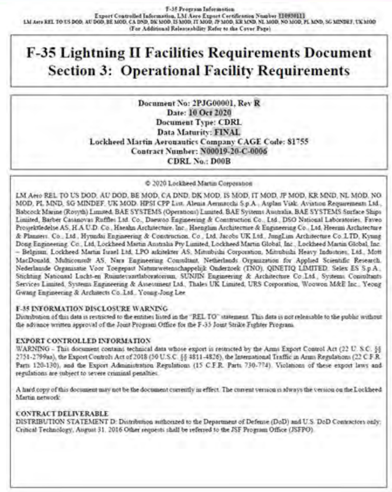
F35 Facilities Requirements Document

Lockheed Martin Joint Strike Fighter Facilities Requirements Document (FRD Rev. R as of Oct 2020) specifications:

- Flow rate - 46.6 lbs (21.14 kg) per minute
- Temperature - 35°F - 55°F (1.67°C - 12.78°C)
- Pressure - 5.25 psi (-0.25 / 0.50 psi)
- Allowable moisture content - 0 – 55 grains per pound of dry air (measured/supplied) with no condensed moisture (droplets) exiting the duct
- Allowable dust - up to 0.02 grams of dust with a maximum particle size of 50 microns per each pound of air

Note: 46.6 lbs/min is equivalent to approximately 440 cfm

Contact George Malamos, Aviation Facilities Criteria Manager, george.malamos@navy.mil for latest FRD


F-35 Program Information
Export Controlled Information, LM Aero Export Certification Number [illegible]
LM Aero REL TO US DOD, AU DOD, BE MOD, CA DND, DK MOD, IS MOD, IT MOD, JP MOD, KR MND, NL MOD, NO MOD, PL MND, SG MINDEF, UK MOD
(For Additional Releasability Refer to the Cover Page)

F-35 Lightning II Facilities Requirements Document
Section 3: Operational Facility Requirements

Document No: 2PJG00001, Rev R
Date: 10 Oct 2020
Document Type: CDRL
Data Maturity: FINAL
Lockheed Martin Aeronautics Company CAGE Code: 81755
Contract Number: N00019-20-C-0006
CDRL No.: D00B

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LM Aero REL TO US DOD, AU DOD, BE MOD, CA DND, DK MOD, IS MOD, IT MOD, JP MOD, KR MND, NL MOD, NO MOD, PL MND, SG MINDEF, UK MOD. HPSI CPP List: Alenia Aermacchi S.p.A., Asplan Viak, Aviation Requirements Ltd., Babcock Marine (Rosyth) Limited, BAE SYSTEMS (Operations) Limited, BAE Systems Australia, BAE SYSTEMS Surface Ships Limited, Barber Casanovas Ruffles Ltd. Co., Daewoo Engineering & Construction Co., Ltd., DSO National Laboratories, Faveo Prosjektledelse AS, H.A.U.D. Co., Haeahn Architecture, Inc., Haenglim Architecture & Engineering Co., Ltd, Heerim Architecture & Planners. Co., Ltd., Hyundai Engineering & Construction. Co., Ltd, Jacobs UK Ltd., JungLim Architecture Co.LTD, Kyung Dong Engineering. Co., Ltd, Lockheed Martin Australia Pty Limited, Lockheed Martin Global, Inc., Lockheed Martin Global, Inc. – Belgium, Lockheed Martin Israel Ltd, LPO arkitekter AS, Mitsubishi Corporation, Mitsubishi Heavy Industries, Ltd., Mott MacDonald, Multiconsult AS, Nara Engineering Consultant, Netherlands Organization for Applied Scientific Research, Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek (TNO), QINETIQ LIMITED, Selex ES S.p.A., Stichting Nationaal Lucht-en Ruimtevaartlaboratorium, SUNJIN Engineering & Architecture Co.Ltd., Systems Consultants Services Limited, Systems Engineering & Assessment Ltd., Thales UK Limited, URS Corporation, Woowon M&E Inc., Yeong Gwang Engineering & Architects Co.Ltd., Young-Jong Lee

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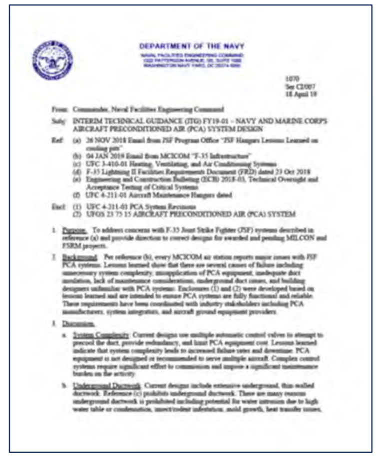
PCA History and Lessons Learned

Project Number	P-447	P-460	P-454	P-545S	P-545N	P-465	P-995	P-328	P-430	P-803	P-378
Lessons Learned	Heat losses in underground duct	Heat losses in underground duct	No valves in common header	Improper unit locations/spacing	Improper unit locations/spacing	Control system failures	Pop-up pedestal failures	Built-up control system failures	Need system performance testing req'mts		Buried duct failures
PCA System Features:											
PCAS Units Ratio (Units to Aircraft)	3 to 5	3 to 5	5 to 7	3 to 5	3 to 5	4 to 6	3 to 5	4 to 4	1 to 1	3 to 3	7 to 7
Automatic Valves (Y/N)	Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y
Duct Insulation (Y/N)	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Unit Outdoor Clearances (Y/N)	N	N	Y	N	N	Y	Y	Y	Y	Y	Y
Underground Ductwork (Y/N)	Y	Y	Y	Y	Y	Y	N	N	N	Y	N
Cooling Pits (Qty)	5	5	7	5	5	6	5	2	0	3	4
Duct Material (Poly/SS)	HDPE	HDPE	HDPE	SS	SS	SS	SS	SS	SS	SS	SS
Pop-Up Pedestals (Y/N)	N	N	N	N	N	N	Y	N	N	N	N
Hatch Safety Features (Y/N)	N	N	Y	Y	Y	Y	Y	Y	N/A	Y	Y
Currently Functional (Y/N)	N	N	N	N	N	Y	60%	50%	Y	N	N/A
Blast Cool (Y/N)	N	N	N	Y	Y	Y	Y	Y	N	N	Y
Other Issues	Note 4	Note 4	Note 5	Note 3			Note 8	Note 6			Note 7
Prior Projects Lessons Learned (Y/N)	N	N	N	N	N	N	Notes 11 and 13	Note 11	Y	Note 13	Note 11

- ➢PCA system is an industrial process cooling system with tight control requirements
- ➢Typical HVAC requirements and design criteria do not apply

ITG FY19-01 - PCA System Design

- USN and MCICOM installations with PCA systems report major issues
- Lessons learned show several causes of failure:
  - System complexity due to multiple cooling units connected together
  - Underground ductwork and utility pits
  - Lack of quality control requirements
  - No UFGS requirements
- ITG developed based on lessons learned to ensure systems are fully functional and reliable
- Superseded by UFC 4-211-01 and UFGS 23 75 15



DEPARTMENT OF THE NAVY

From: Commander, Naval Facilities Engineering Command

Subj: INTERIM TECHNICAL GUIDANCE (ITG) FY19-01 - NAVY AND MARINE CORPS AIRCRAFT PRECONDITIONED AIR (PCA) SYSTEM DESIGN

Ref: (a) 26 NOV 2018 Email from JSF Program Office "JSF Hangars Lessons Learned on cooling pits"
(b) 04 JAN 2019 Email from MCICOM "F-35 Infrastructure"
(c) UFC 3-410-01 Heating, Ventilating, and Air Conditioning Systems
(d) F-35 Lightning II Facilities Requirements Document (FRD) dated 23 Oct 2018
(e) Engineering and Construction Bulletin (ECB) 2018-03, Technical Oversight and Acceptance Testing of Critical Systems
(f) UFC 4-211-01 Aircraft Maintenance Hangars dated

Encl: (1) UFC 4-211-01 PCA System Revisions
(2) UFGS 23 75 15 AIRCRAFT PRECONDITIONED AIR (PCA) SYSTEM

http://www.wbdg.org/ffc/navy-navfac/interim-technical-guidance-itg/2019-01

NAVFACINST 5400.7B - Technical Authority (TA) Policy

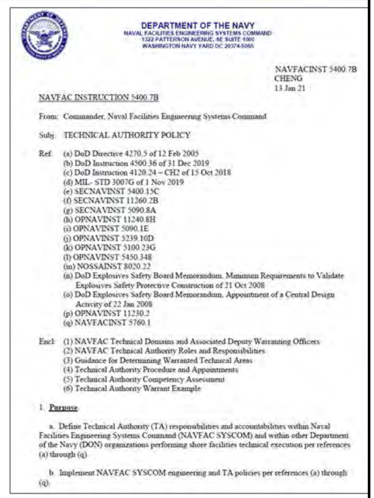
Technical Authority (TA) – Responsibilities and accountabilities within Naval Facilities Engineering Systems Command (NAVFAC SYSCOM)

- TA ensures that actions associated within each of the technical domains (TDs) are technically sound, compliant, safe, and cost-efficient

Technical Essentials (TE) – Technical skills and standards that ensure products and services are technically sound, compliant, safe, and cost-efficient

- TE include criteria, codes and standards, policies, instructions, business processes, tools, community management, credentials, training, and technical competencies

NAVFACINST 5400.7B implements engineering and TA policies, promulgates TA construct including roles, responsibilities, processes, and procedure, and delineates TDs, technical leadership, and technical responsibilities


DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND
1322 PATTERSON AVENUE, SE SUITE 1000
WASHINGTON NAVY YARD DC 20374-5065

NAVFACINST 5400.7B
CHENG
13 Jan 21

NAVFAC INSTRUCTION 5400.7B

From: Commander, Naval Facilities Engineering Systems Command

Subj: TECHNICAL AUTHORITY POLICY

Ref: (a) DoD Directive 4270.5 of 12 Feb 2005
(b) DoD Instruction 4500.36 of 31 Dec 2019
(c) DoD Instruction 4120.24 – CH2 of 15 Oct 2018
(d) MIL- STD 3007G of 1 Nov 2019
(e) SECNAVINST 5400.15C
(f) SECNAVINST 11260.2B
(g) SECNAVINST 5090.8A
(h) OPNAVINST 11240.8H
(i) OPNAVINST 5090.1E
(j) OPNAVINST 5239.10D
(k) OPNAVINST 5100.23G
(l) OPNAVINST 5450.348
(m) NOSSAINST 8020.22
(n) DoD Explosives Safety Board Memorandum, Minimum Requirements to Validate Explosives Safety Protective Construction of 21 Oct 2008
(o) DoD Explosives Safety Board Memorandum, Appointment of a Central Design Activity of 22 Jan 2008
(p) OPNAVINST 11230.2
(q) NAVFACINST 5760.1

Encl: (1) NAVFAC Technical Domains and Associated Deputy Warranting Officers
(2) NAVFAC Technical Authority Roles and Responsibilities
(3) Guidance for Determining Warranted Technical Areas
(4) Technical Authority Procedure and Appointments
(5) Technical Authority Competency Assessment
(6) Technical Authority Warrant Example

1. Purpose.

a. Define Technical Authority (TA) responsibilities and accountabilities within Naval Facilities Engineering Systems Command (NAVFAC SYSCOM) and within other Department of the Navy (DON) organizations performing shore facilities technical execution per references (a) through (q).

b. Implement NAVFAC SYSCOM engineering and TA policies per references (a) through (q).

Technical Authority Construct

TA Establishment (TAE) – Authority and responsibility to establish, monitor, approve, and deviate from TE within established TDs

- Technical Warrant Holder (TWH), under Deputy Warranting Officer (DWO) and Chief Engineer (CHENG), executes this function

TA Assurance (TAA) – The responsibility and accountability to assure that products and services are delivered according to the TE

- Project or Service Technical Staff (PTS) and PTS Authority (PTA), under the authority of the Command, executes this function

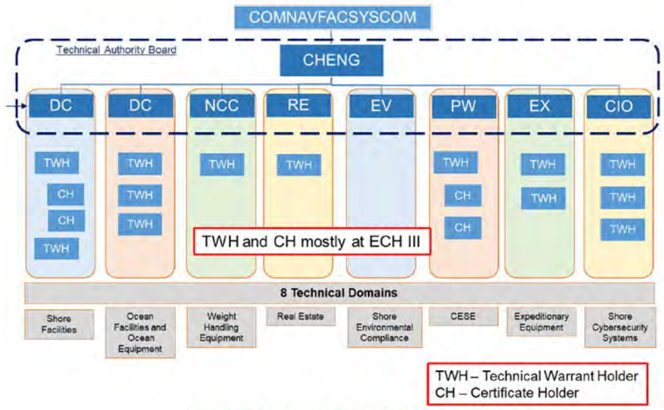


Figure 1: NAVFAC SYSCOM TA Construct

Roles and Responsibilities

Technical Warrant Holder (TWH)

- Final TA in defined subject matter and produces TEs
- TWH is also termed "Chief Mechanical Engineer" for mechanical engineering Shore Facility TD

Certificate Holder (CH)

- Individual selected, based on qualifications, who is warranted to evaluate and make recommendations on certification of specific products, processes, assets, and systems in a warranted technical area

Authority Having Jurisdiction (AHJ)

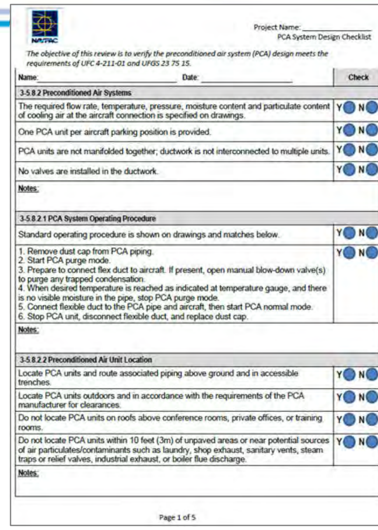
- Designated authority charged with administering and enforcing TE, usually FEC Chief Engineer
- AHJ renders interpretations/clarifications of the criteria and application
- Interpretations/clarifications must comply with the intent and purpose of the criteria and not have the effect of waiving or exempting requirements

A warranted certificate holder is required at each FEC for F35 preconditioned air systems. Need recommendation from FEC for SME/CH assignment

PCA System Certificate Holder Responsibilities

- Review RFP packages and design submittals for compliance with technical requirements
- Review critical PCA system submittals
- Inspect construction and witness testing of PCA systems
- Recommend final system acceptance to construction manager and TWH

PCA Design Review Checklist:
https://hub.navfac.navy.mil/webcenter/content/conn/WebCenterSpaces-ucm/uuid/dDocName:ID_3441429



Project Name: ____________
PCA System Design Checklist

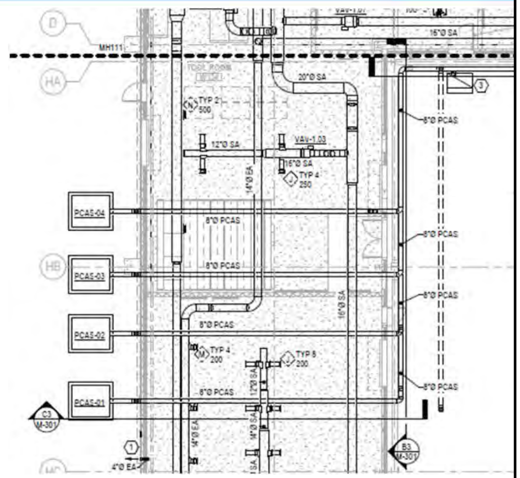
The objective of this review is to verify the preconditioned air system (PCA) design meets the requirements of UFC 4-211-01 and UFGS 23 75 15.

Name: ____________ Date: ____________	Check
3-5.8.2 Preconditioned Air Systems	
The required flow rate, temperature, pressure, moisture content and particulate content of cooling air at the aircraft connection is specified on drawings.	Y N
One PCA unit per aircraft parking position is provided.	Y N
PCA units are not manifolded together; ductwork is not interconnected to multiple units.	Y N
No valves are installed in the ductwork.	Y N
Notes:	
3-5.8.2.1 PCA System Operating Procedure	
Standard operating procedure is shown on drawings and matches below.	Y N
1. Remove dust cap from PCA piping. 2. Start PCA purge mode. 3. Prepare to connect flex duct to aircraft. If present, open manual blow-down valve(s) to purge any trapped condensation. 4. When desired temperature is reached as indicated at temperature gauge, and there is no visible moisture in the pipe, stop PCA purge mode. 5. Connect flexible duct to the PCA pipe and aircraft, then start PCA normal mode. 6. Stop PCA unit, disconnect flexible duct, and replace dust cap.	Y N
Notes:	
3-5.8.2.2 Preconditioned Air Unit Location	
Locate PCA units and route associated piping above ground and in accessible trenches.	Y N
Locate PCA units outdoors and in accordance with the requirements of the PCA manufacturer for clearances.	Y N
Do not locate PCA units on roofs above conference rooms, private offices, or training rooms.	Y N
Do not locate PCA units within 10 feet (3m) of unpaved areas or near potential sources of air particulates/contaminants such as laundry, shop exhaust, sanitary vents, steam traps or relief valves, industrial exhaust, or boiler flue discharge.	Y N
Notes:	

Page 1 of 5

System Configuration

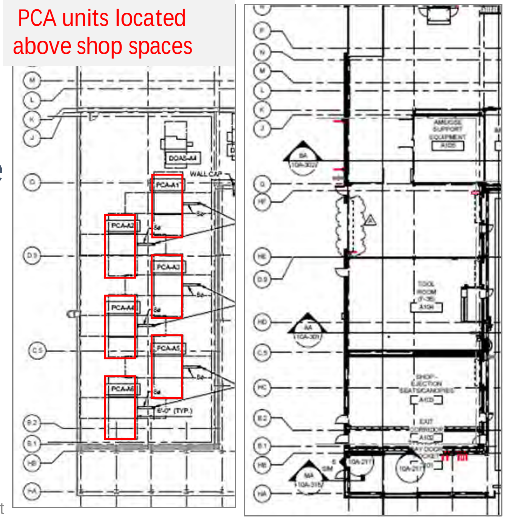
- One PCA unit per aircraft parking position and ductwork not shared between units
- PCA units not manifolded together
- No valves in piping between the PCA unit and aircraft
- All piping above ground and accessible
- Pressure/temperature test ports are provided in the piping immediately downstream of each PCA unit.
- Mechanical (non-gas), lift-assisted, hinged access cover with safety locking device at each duct connection point - <u>No underground utility pits</u>



Location of Equipment

- Locate PCA units outdoors
- Provide manufacturer's required clearances at least 4 feet
- Do not locate PCA units above conference rooms, offices, or training rooms
- Do not locate PCA units within 10 feet (3m) of unpaved areas or near sources of air contaminants such as laundry, shop exhaust, sanitary vents, steam traps or relief valves, industrial exhaust, or boiler flue discharge

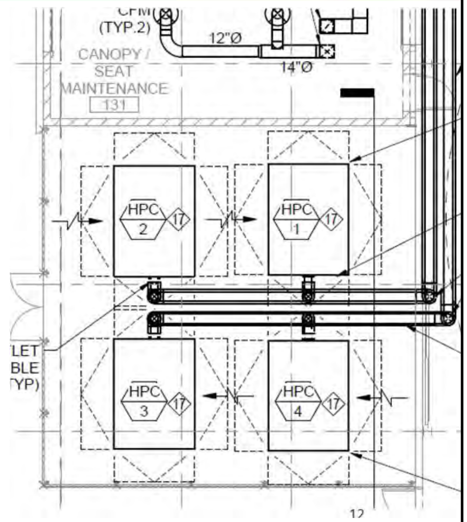
PCA units located above shop spaces



F35 PCA System Technical Oversight

ATFP Unobstructed Space

- Equipment located within the fenced flight line area is considered secured
- If necessary, secure units with chain link fence only
- Do not install solid wall enclosures, grates, screens, expanded louvers, or any other impediments to airflow around or above PCA equipment
- Equipment may be located within the unobstructed area as defined by UFC 4-010-01 as long as the equipment provides no opportunity for concealment of explosive devices with heights of 6 inches (150 mm) or greater, or the equipment is secured to prevent concealment of the devices



PCA Unit Sizing Calculations

- Size PCA units for the greatest enthalpy condition when comparing the 0.4% dry-bulb and mean coincident wet-bulb (DB/MCWB) and the 0.4% humidity ratio and mean coincident dry-bulb (HR/MCDB) design conditions using weather data prescribed by UFC 3-400-02
- Unitary PCA equipment is typically designed for worst-case geographical locations and various commercial aircraft
- Units must modulate over a wide load and range of outdoor conditions
- Total capacity typically 12-15 tons with sensible heat ratio around 65%

PCA Unit Psychrometric Calculations

MCAS Cherry Point Example:

Note: Fan heat adds 70 °F before the cooling coil

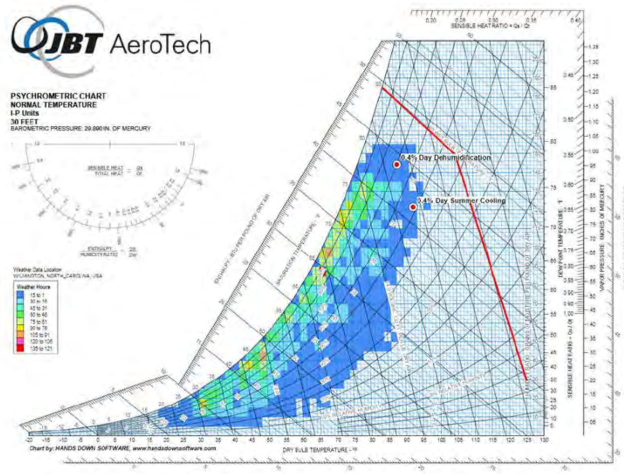
1% HR & MCDB = 149 gr/lb, 85 °F db

Sensible load = 1.08(450 cfm)(85+70-35 °F)= 58 Mbh

Latent Load = 0.68(450 cfm)(149-30 gr/lb)= 36 Mbh

Total Capacity = (58 + 36)/12 = 7.8 tons

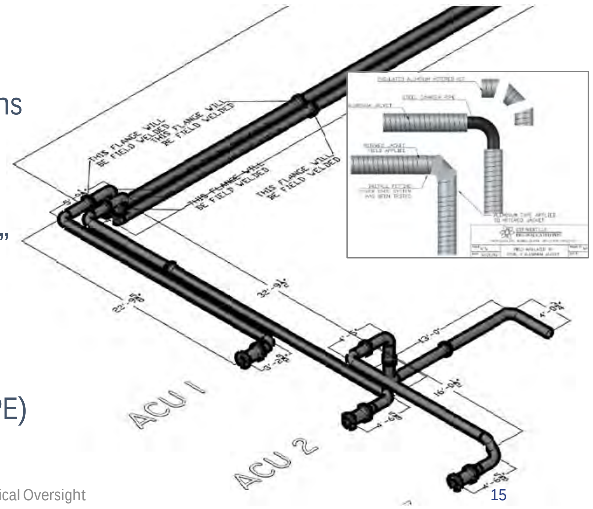
SHR = 58/(58+36) = 62%



Cherry Point, North Carolina - Local Psychrometric Chart

PCA System Piping/Ductwork

- Welded stainless steel piping suitable for pressures up to 15 psig
- Expansion joints required for long straight runs
- Piping supports allow and control thermal expansion
- Bolted and gasketed flanged joints within 18" of hangar floor and in the trench to preclude the need for hot work in hazardous locations
- Factory applied insulation with water-tight aluminum or high density polyurethane (HDPE) jacket



PCA Piping and Insulation Calculations

- Air distribution piping sized using 1,300 ft/min (6.6 m/s) minimum velocity
- PCA duct for F-35 should be 6" dia. or smaller
- Insulation calculations show less than 5 °F temperature rise between PCA discharge and the aircraft connection at the end of the flex duct
- Calculations must include heat gain in pipe, fittings, and flex duct at 1% dry bulb conditions
- Calculations must show less than 30 minutes for system cool-down from ambient conditions

2017 ASHRAE Handbook—Fundamentals

$$t_{drop} \text{ or } t_{gain} = 0.2\left(\frac{qPL}{VC_p\rho A}\right) \quad (3)$$

then, for warm air ducts,

$$t_{exit} = t_{enter} - t_{drop} \quad (4)$$

and for cold air ducts,

$$t_{exit} = t_{enter} - t_{gain} \quad (5)$$

where

t_{drop} = temperature loss for warm air ducts, °F
t_{enter} = entering air temperature, °F
t_{gain} = temperature rise for cool air ducts, °F
t_{exit} = exit temperature for either warm or cool air ducts, °F
q = heat loss through duct wall, Btu/h·ft²
P = duct perimeter, in.
L = length of duct run, ft
V = air velocity in duct, ft/min
C_p = specific heat of air, Btu/lb_m·°F
ρ = density of air, 0.075 lb/ft³
A = area of duct, in²
0.2 = conversion factor for length, time units

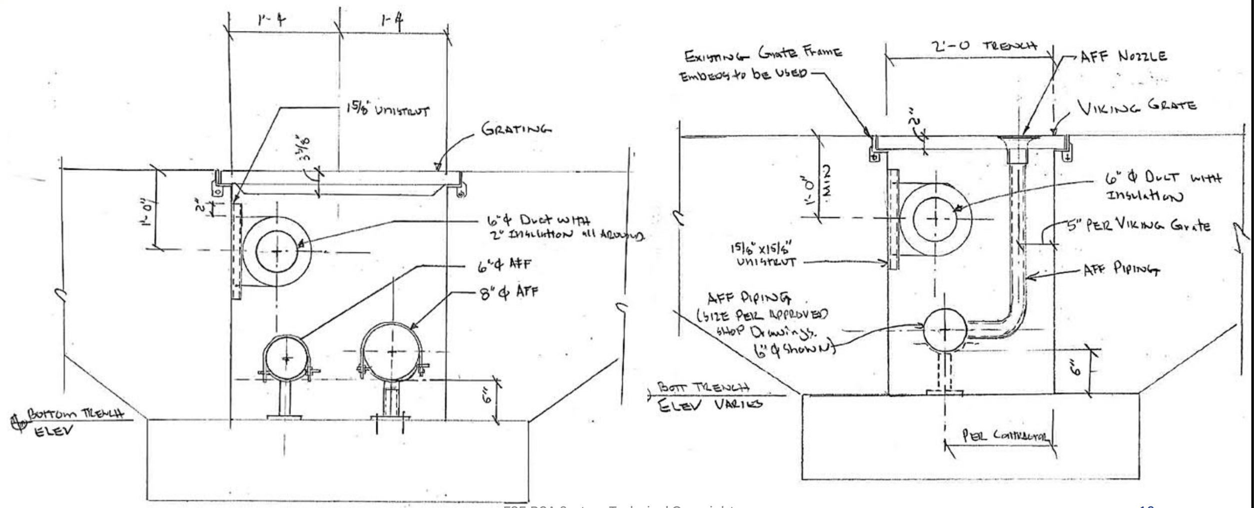
Duct Temperature Rise Calculator:
https://hub.navfac.navy.mil/webcenter/content/conn/WebCenterSpaces-ucm/uuid/dDocName:ID_3447027

PCA Pipe Routing

- Piping must be coordinated with AFFF piping and any other trench utilities
- Drawings must include trench cross-section view or details showing coordination between disciplines
- PCA pipe must be continuously sloped to the flexible duct connection point
- PCA pipe must be routed outside of the crane operating envelope per UFC 4-211-01
- Pipe must not create a tripping hazard or obstruction in the main circulation aisle between the aircraft and shops
- PCA pipe must be supported and elevated minimum 6 inches (150 mm) off the bottom of the trench

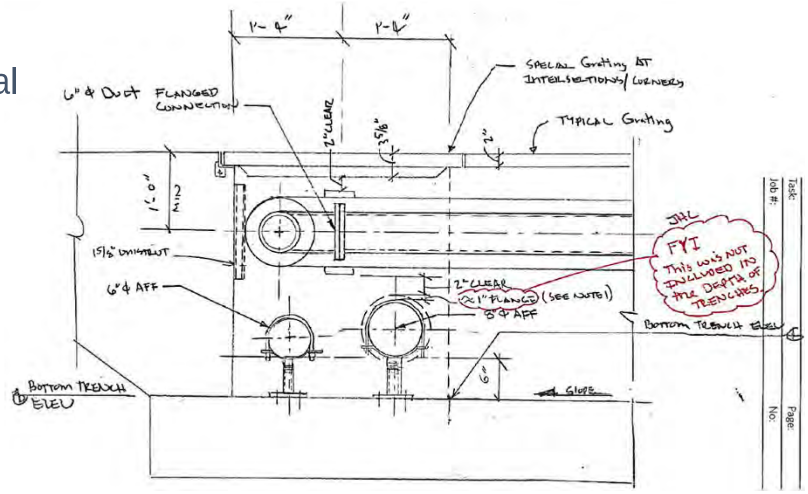
Typical AFFF Trench Piping

Trench Coordination Details



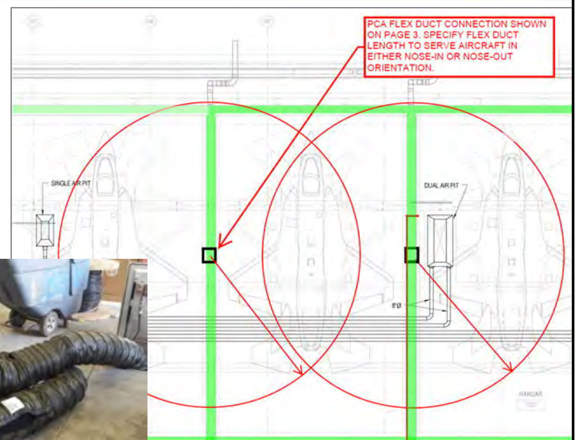
PCA Duct Crossing AFFF Piping

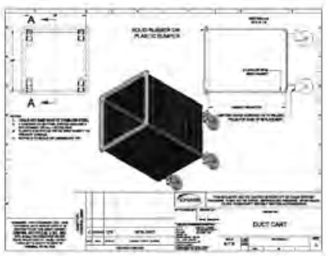
- Where PCA duct crosses AFFF piping is most critical point for determining depth of trenches throughout the entire hangar
- Design must include sections at this crossing with dimensions
- PCA duct must be on top



Flexible Duct Selection

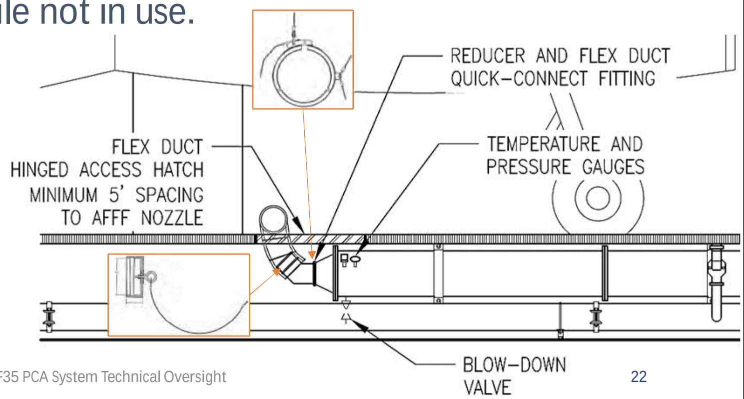
- Insulated flexible hose with a mobile basket or reel
- Length of hose is typically at least 45’ but depends on specific application
- Verify hose length is sufficient for both nose-in and nose-out





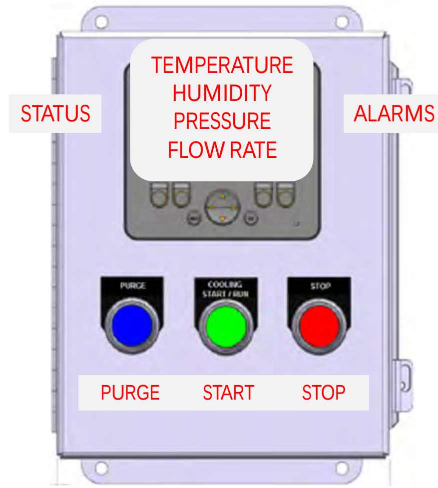
Flexible Duct Accessories

- Mechanical (digital or analog) temperature and pressure gauges provided in the PCA pipe immediately upstream of the flexible duct connection point.
- Water tight, soft rubber cover with lanyard provided to protect the flexible duct connection opening while not in use.
- Quick-connect fitting at connection between PCA piping and flex duct
- 45° or 90° hard fittings to prevent kinking of flex hose
- Manual blow-down valve at low point



Remote Control Panel

- One remote control panel per PCA unit provided along the hangar back wall at each aircraft location
- Additional features are not necessary or permitted as they may conflict with the standard operating procedure (SOP).



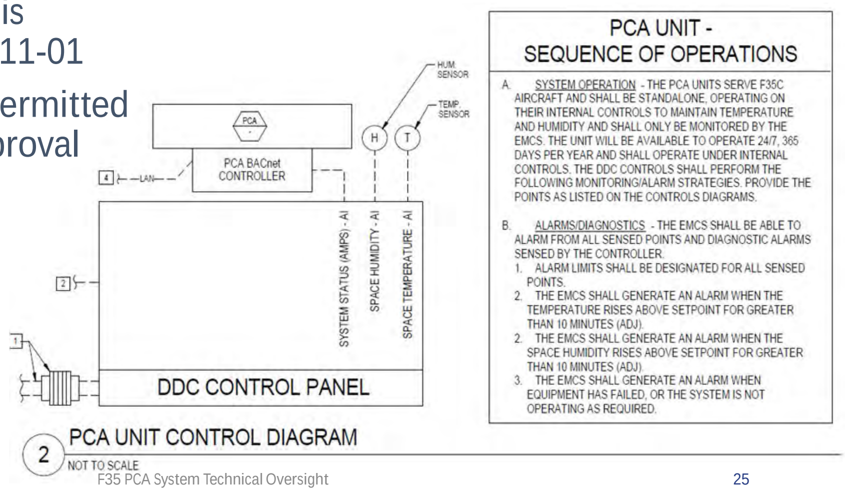
Standard Operating Procedure

Standard operating procedure must be shown on drawings and posted at each remote control panel

1. Remove dust cap from PCA piping.
2. Start PCA purge mode.
3. Prepare to connect flex duct to aircraft. If present, open manual blow-down valve(s) to purge any trapped condensation.
4. When desired temperature is reached as indicated at temperature gauge, and there is no visible moisture in the pipe, stop PCA purge mode.
5. Connect flexible duct to the PCA pipe and aircraft, then start PCA normal mode.
6. Stop PCA unit, disconnect flexible duct, and replace dust cap.

DDC Monitoring

- No DDC connection is required by UFC 2-411-01
- DDC monitoring is permitted with installation approval

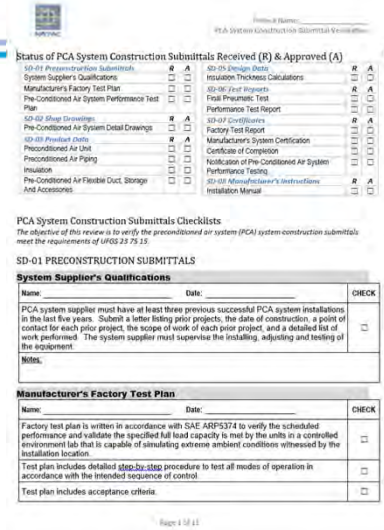


Specification 23 75 15 Review

- UFGS 23 75 15 is included in the specification package with all applicable tests and submittals
- PCA system is not required to be included in 01 91 00.15 20 systems to be commissioned
- If PCA system is included in commissioned systems, commissioning must not replace or modify UFGS 23 75 15 testing requirements
- Use design review checklist to verify all submittals are included
- Add PCA system submittals to section 01 33 00 “Submittals Reserved for NAVFAC Approval”

Construction Submittals

- Review all 23 75 15 submittals against the project specifications and PCA Construction Submittal Checklist
- Track progress of submittals
- Can be used to communicate status of prerequisite testing submittal requirements to contractor and CM



Status of PCA System Construction Submittals Received (R) & Approved (A)

SD-01 Preconstruction Submittals	R	A	*SD-05 Design Data*	R	A
System Supplier's Qualifications	☐	☐	Insulation Thickness Calculations	☐	☐
Manufacturer's Factory Test Plan	☐	☐	*SD-06 Test Reports*	R	A
Pre-Conditioned Air System Performance Test Plan	☐	☐	Final Pneumatic Test	☐	☐
			Performance Test Report	☐	☐
SD-02 Shop Drawings	R	A	*SD-07 Certificates*	R	A
Pre-Conditioned Air System Detail Drawings	☐	☐	Factory Test Report	☐	☐
SD-03 Product Data	R	A	Manufacturer's System Certification	☐	☐
Preconditioned Air Unit	☐	☐	Certificate of Completion	☐	☐
Preconditioned Air Piping	☐	☐	Notification of Pre-Conditioned Air System Performance Testing	☐	☐
Insulation	☐	☐	*SD-08 Manufacturer's Instructions*	R	A
Pre-Conditioned Air Flexible Duct, Storage And Accessories	☐	☐	Installation Manual	☐	☐

PCA System Construction Submittals Checklists

The objective of this review is to verify the preconditioned air system (PCA) system construction submittals meet the requirements of UFGS 23 75 15.

SD-01 PRECONSTRUCTION SUBMITTALS

System Supplier's Qualifications

Name: ______ Date: ______	CHECK
PCA system supplier must have at least three previous successful PCA system installations in the last five years. Submit a letter listing prior projects, the date of construction, a point of contact for each prior project, the scope of work of each prior project, and a detailed list of work performed. The system supplier must supervise the installing, adjusting and testing of the equipment.	☐
Notes:	

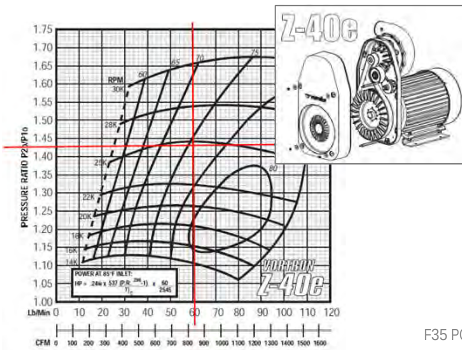
Manufacturer's Factory Test Plan

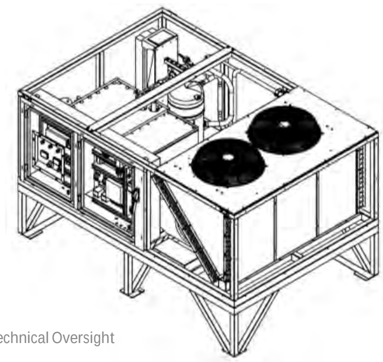
Name: ______ Date: ______	CHECK
Factory test plan is written in accordance with SAE ARP5374 to verify the scheduled performance and validate the specified full load capacity is met by the units in a controlled environment lab that is capable of simulating extreme ambient conditions witnessed by the installation location.	☐
Test plan includes detailed step-by-step procedure to test all modes of operation in accordance with the intended sequence of control.	☐
Test plan includes acceptance criteria.	☐

Construction Submittal Review Checklist:
https://hub.navfac.navy.mil/webcenter/content/conn/WebCenterSpaces-ucm/uuid/dDocName:ID_3445494

Design Data & Product Data Submittal

- Packaged pre-conditioned air unit with structural base designed for 100% fresh air
- High pressure centrifugal fan with high efficiency particulate air filter
- Verify filter size/efficiency for dusty environments
- Verify condenser air discharge location matches drawings for spacing and arrangement





Shop Drawings Submittal

Calculations and detail drawings stamped by a licensed professional engineer showing:

- Equipment layout, assembly and installation details and electrical connection diagrams
- Piping layout showing all supports, hangers, and hanger details
- Trench sizes and access hatch points prior to concrete foundation construction
- Step-by-step operating procedures with detail drawings.
- Calculations demonstrating the equipment selection meets the performance requirements at design conditions
- If minimum operating temperature is less than the minimum aircraft delivery temperature, verify whether PCA unit needs heating capability
- Recommended spare parts listing for each assembly or component.

Pre-Testing Submittals

- Final Pneumatic Test
- Factory Test Report
- PCA System Performance Test Plan
- Manufacturer's System Certification
- Notification of PCA System Performance Testing
- Certificate of Completion

Project Name: P464
PCA System Construction Submittal Verification

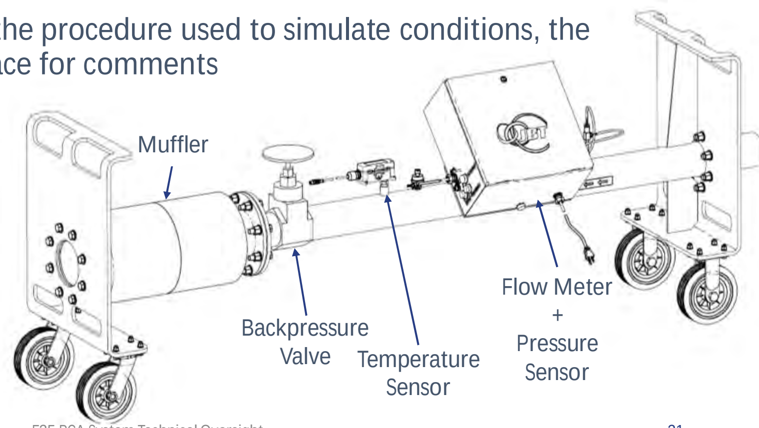
Status of PCA System Construction Submittals Received (R) & Approved (A)

SD-01 Preconstruction Submittals	*R*	*A*
System Supplier's Qualifications	☒	☒
Manufacturer's Factory Test Plan	☒	☒
Pre-Conditioned Air System Performance Test Plan	☒	☒
SD-02 Shop Drawings	*R*	*A*
Pre-Conditioned Air System Detail Drawings	☒	☒
SD-03 Product Data	*R*	*A*
Preconditioned Air Unit	☒	☒
Preconditioned Air Piping	☒	☒
Insulation	☒	☒
Pre-Conditioned Air Flexible Duct, Storage And Accessories	☒	☒

SD-05 Design Data	*R*	*A*
Insulation Thickness Calculations	☒	☒
SD-06 Test Reports	*R*	*A*
Final Pneumatic Test	☒	☒
Performance Test Report	☐	☐
SD-07 Certificates	*R*	*A*
Factory Test Report	☒	☒
Manufacturer's System Certification	☒	☒
Certificate of Completion	☒	☒
Notification of Pre-Conditioned Air System Performance Testing	☒	☒
SD-08 Manufacturer's Instructions	*R*	*A*
Installation Manual	☐	☐

Performance Test Plan

- Detailed step-by-step procedures for all modes of operation and safeties to verify functional performance of the complete system
- Each test step must include the procedure used to simulate conditions, the expected responses, and space for comments
- Test also checks calibration of sensors
- Test plan must include list of participants and equipment needed
- Product data for test bullet if not previously submitted



Performance Test Plan – Endurance Test

- Endurance test form to record performance variables at 15-minute intervals over 4 hours when ambient outdoor conditions are within 10-percent of the design maximum enthalpy conditions
- Performance variables must be measured at aircraft connection point under the same test set-up as the functional tests
- Record temperature, pressure, and airflow at both PCA unit and test rig
- Record ambient temperature and humidity

Table 1 – Steady state airflow performance

Time (min.)	Ambient Temp. (°F)	Ambient RH%	Temp. at Test Rig (°F)	Press. at Test Rig (psig)	Airflow at Test Rig (lb/min)	Temp at Unit (°F)	Press. at Unit (psig)	Flow at Unit (lb/min) see Table 2
+15								
+30								
+45								
+60								
+75								
+90								
+105								
+120								

Performance Test Plan – Combined Test

- All the units could be operating at once when all the aircraft positions are being used in the hangar
- Testing should be performed for a combined system test to verify don't have a overheating situation with all the units operating
- While one unit is running for endurance testing and outdoor temperature is near daily maximum, run all adjacent units in purge mode for two hours
- Test is successful if all units continuously provide 55 F air (measured at the end of the duct) during the combined test period, subject to any initial cool-down that may be necessary

Pneumatic Tightness Tests

Soap Spray Test: Pressurize to 15 psig prior to insulating joints. Apply soapsuds, then visually inspect the entire run of piping, including the bottom surfaces, for leaks. If leaks are discovered, repair the leaks accordingly and retest

Pressure Drop Test: Pressurize the system to 15 psig and isolate the source of pressure. No leakage is permitted at the end of one hour as indicated by a drop in system pressure. Test must be witnessed by government personnel, and a final pneumatic test report submitted for approval by the quality control manager (QCM). If any test section fails tightness testing, repair or replace all defective materials and/or workmanship.

Manufacturer's System Certification

- Factory-trained representative must verify on-site the PCA equipment installation compliance with manufacturer's recommendations
- Manufacturer's representative must check each unit for refrigerant leaks
- Manufacturer's representative must test controls through every cycle of operation, verify safeties, make necessary adjustments, and balance systems prior to scheduling acceptance testing of completed systems
- Controllers must be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.
- Submit manufacturer's system certification at least 30 calendar days in advance of the scheduled acceptance test date

Testing Notice and Certificate of Completion

- The Contractor must notify the Contracting Officer at least 30 calendar days' notice prior to scheduling acceptance testing
- Notification must include PCA System Certificate of Completion including all quality control documentation, preliminary test reports, pneumatic test reports, weld inspection reports and NDE testing reports
- Contractor Quality Control Manager must certify that all required checks, inspections, and preliminary tests have been successfully completed
- If partial performance testing is necessary because outdoor conditions are not within the required range, include the anticipated endurance test dates in the Notification of PCA Performance Testing

PCA System Inspections and Testing

- Conduct an end-to-end inspection of the system to ensure installation complies with the contract documents and criteria
- Certificate Holder must make final acceptance recommendation to TWH
- Testing typically begins with functional testing and calibration checks in the morning, then endurance testing in the afternoon

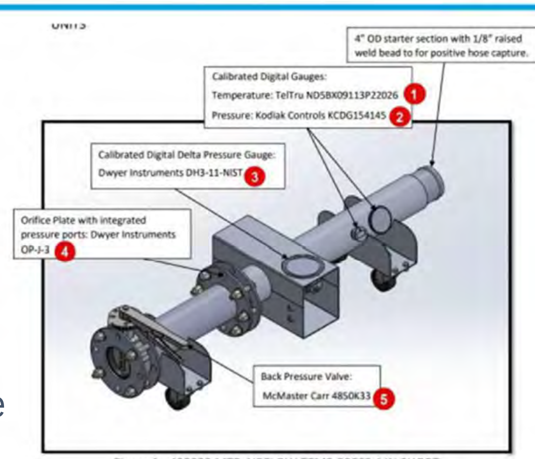


Figure 1 - 400222 MTR,AIRFLOW,TEMP,PRESS,4 IN,SHORT

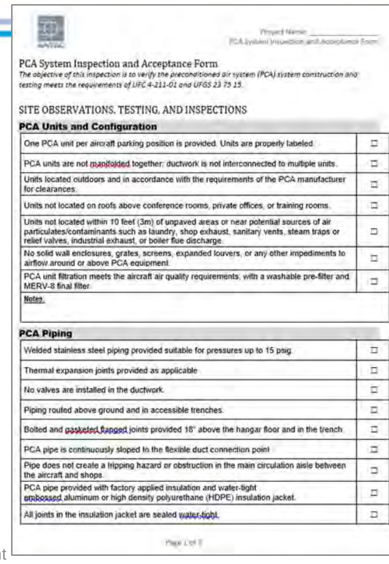
Final Acceptance Recommendation

Prior to final acceptance recommendation:

- Performance Test Report submitted and approved
- Training completed
- O&M Manuals submitted

Complete the PCA System Inspection and Acceptance Form and submit to Chief Mechanical Engineer

PCA System Inspection and Acceptance Form:
https://hub.navfac.navy.mil/webcenter/content/conn/WebCenterSpaces-ucm/uuid/dDocName:ID_3447281



PCA System Inspection and Acceptance Form

The objective of this inspection is to verify the preconditioned air system (PCA) system construction and testing meets the requirements of UFC 4-211-01 and UFGS 23 75 15.

SITE OBSERVATIONS, TESTING, AND INSPECTIONS

PCA Units and Configuration

One PCA unit per aircraft parking position is provided. Units are properly labeled.	☐
PCA units are not manifolded together; ductwork is not interconnected to multiple units.	☐
Units located outdoors and in accordance with the requirements of the PCA manufacturer for clearances.	☐
Units not located on roofs above conference rooms, private offices, or training rooms.	☐
Units not located within 10 feet (3m) of unpaved areas or near potential sources of air particulates/contaminants such as laundry, shop exhaust, sanitary vents, steam traps or relief valves, industrial exhaust, or boiler flue discharge.	☐
No solid wall enclosures, grates, screens, expanded louvers, or any other impediments to airflow around or above PCA equipment.	☐
PCA unit filtration meets the aircraft air quality requirements, with a washable pre-filter and MERV-8 final filter.	☐
Notes:	

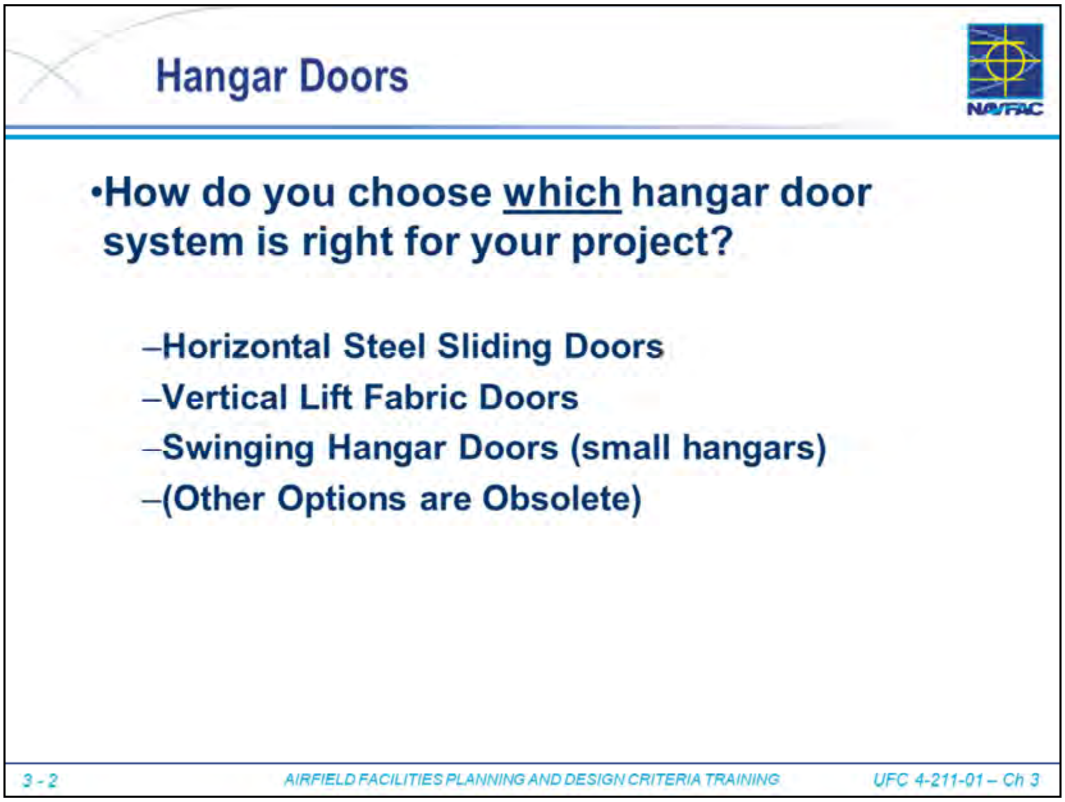
PCA Piping

Welded stainless steel piping provided suitable for pressures up to 15 psig.	☐
Thermal expansion joints provided as applicable.	☐
No valves are installed in the ductwork.	☐
Piping routed above ground and in accessible trenches.	☐
Bolted and gasketed flanged joints provided 18" above the hangar floor and in the trench.	☐
PCA pipe is continuously sloped to the flexible duct connection point.	☐
Pipe does not create a tripping hazard or obstruction in the main circulation aisle between the aircraft and shops.	☐
PCA pipe provided with factory applied insulation and water-tight embossed aluminum or high density polyurethane (HDPE) insulation jacket.	☐
All joints in the insulation jacket are sealed water-tight.	☐

Section 3a – Hangar Door Design

Aircraft Hangars & Other Airfield Structures

9/18/2023



HANGAR DOORS

Provide either a vertical lift fabric door system or horizontal sliding hangar doors. Coordinate with the user to provide type of hangar door and controls required for maintenance operations. **Refer to C-10: HANGAR DOOR for guidance on best practices for hangar door selection and design.**

Hangar doors are to be fully operational when subjected to wind pressures up to a minimum of 15 psf. Include signage noting operational wind speed at which doors should be closed and secured with wind lock activation. Consider the full deflection range and wind uplift to design the interface between the superstructure and the door systems.

Horizontal Sliding Steel Hangar Doors

Hangar doors are to be a series of insulated, horizontal sliding leaves with protected, preformed metal or sheet-steel siding. Support each sliding door on hardened steel wheels rolling on continuously supported recessed rails with guide rails at the top of the doors. Hangar doors are to be of hot-rolled steel construction and designed and built to the same standards as the main Aircraft Maintenance Bay superstructure. Provide hot-rolled steel tension and compression bracing members. Hangar door frames will not depend on the metal or steel siding to provide diaphragm actions. Provide insulation values equal to the minimum values required for the exterior walls of the Aircraft Maintenance Bay. Provide waterproof weather stripping at all door system joints.

In the hangar door rail support foundation, provide for surface drainage with intermediate drainage, at a maximum spacing of 10 ft. (3.0 m). In cold climates provide a door track heating system.

Horizontal Steel Sliding Doors

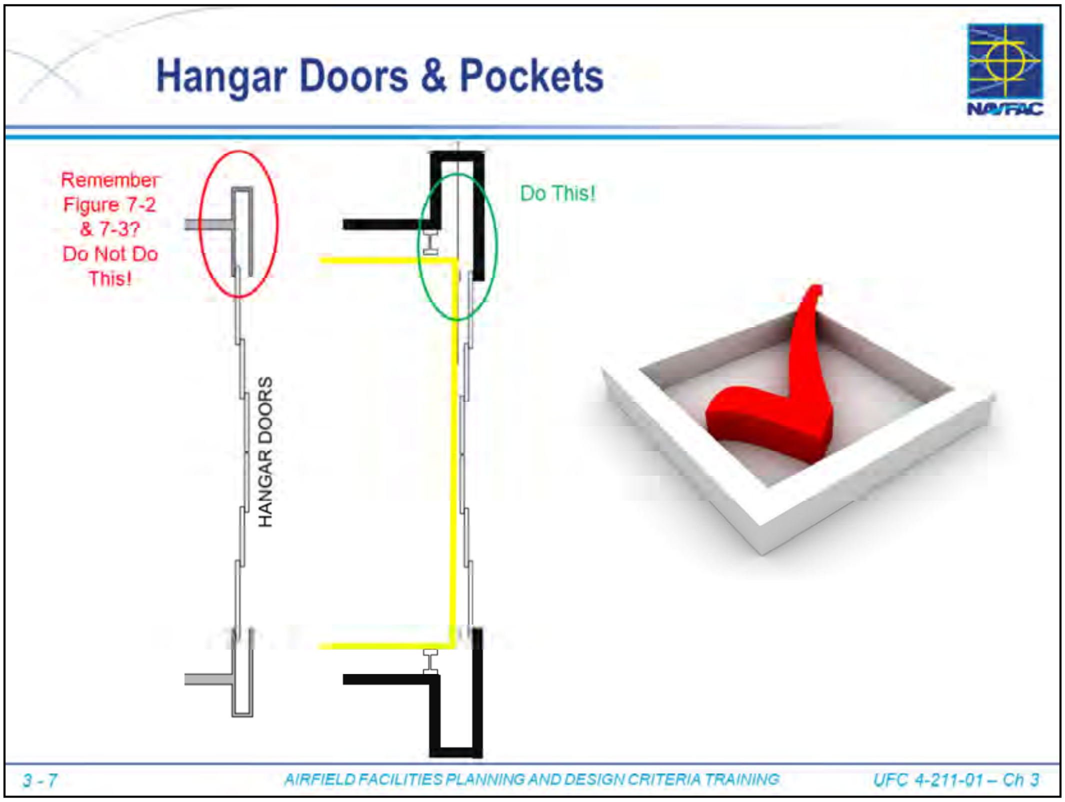
Horizontal Steel Sliding Doors

- 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)



On Left (on right every one of these error is correct):

Door rails are exterior and exposed to elements, water, ice and debris

Door pockets will collect trash, leaves and are a potential AT/FP or security risk

Door pocket structure and interior exposed to weather

Door pocket lid/ceiling is very difficult to detail and will be difficult at best to complete the air barrier and provide continuous insulation where it ties into the hangar bay

Door pockets are not safe (crush and pinch concerns both inside and outside)

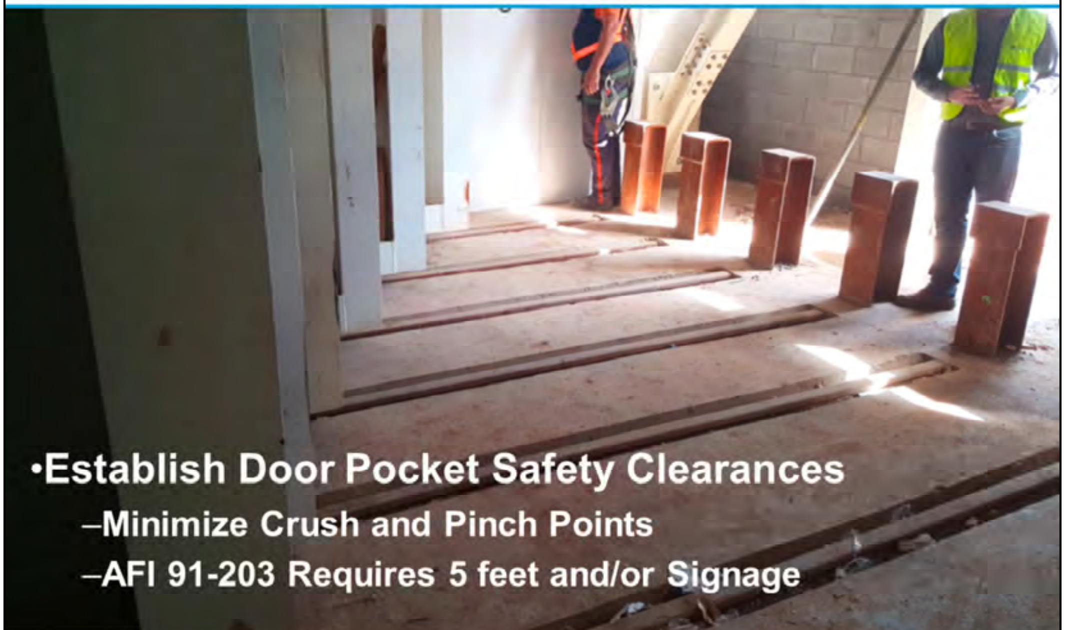
Door pockets are too narrow and do not have an area to avoid doors

Door pockets are not deep enough and block more than the permitted 3’ of hangar width

(safest) Door operation button location on the outside instead of inside

Interior “wing wall” is not a necessary cost and is a pinch point

Hangar Doors & Pockets



- Establish Door Pocket Safety Clearances
  - Minimize Crush and Pinch Points
  - AFI 91-203 Requires 5 feet and/or Signage

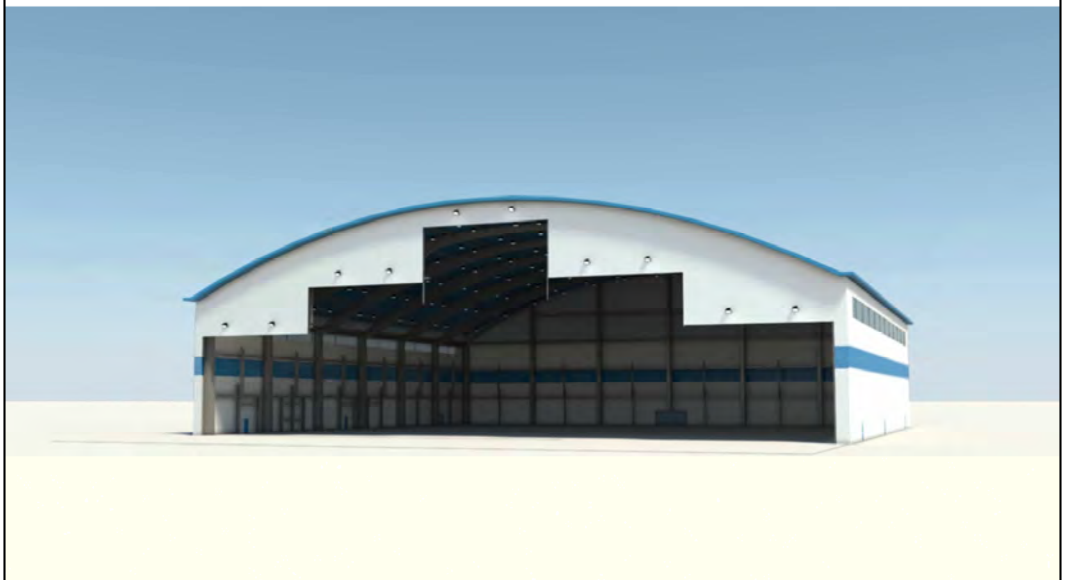
Vertical Lift Fabric Doors (VLFD)

3-10.1.1 Doors

Provide the vertical lift fabric doors, as a complete system from a single source manufacturer for the purpose of closing a hangar maintenance bay space. Design the Aircraft Maintenance Bay superstructure to support the doors vertically and laterally. Design for the different load combinations imposed by open and closed door panels resulting in eccentric wind loads or mechanical loads from the door and mullion hoisting equipment. The mullions of the door system connect to pits at grade which serve to restrain the mullions from motion perpendicular to the face of the doors. Design the pits to resist the concentrated mullion loads and provide a means of draining water from the pits.

Design VLFD hangar doors to be individually operated with an upward acting lightweight framing system with polyvinyl fabric facing. Design doors in sections with lifting mullions between door sections. Design features include electric operation, personnel exit doors, and translucent fabric.

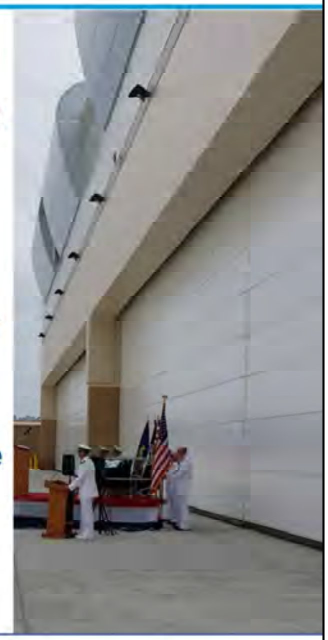
Vertical Lift Fabric Doors



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)

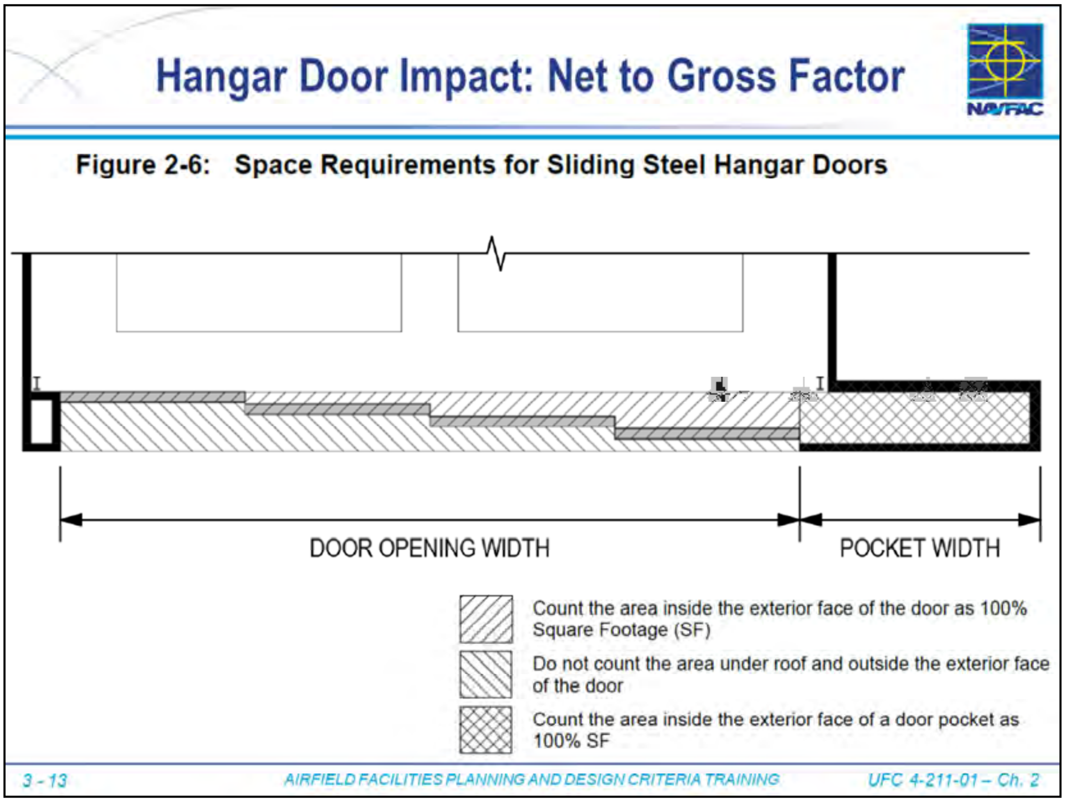


Note: per 3-10.1.3 Catwalk above these doors shall be provided.

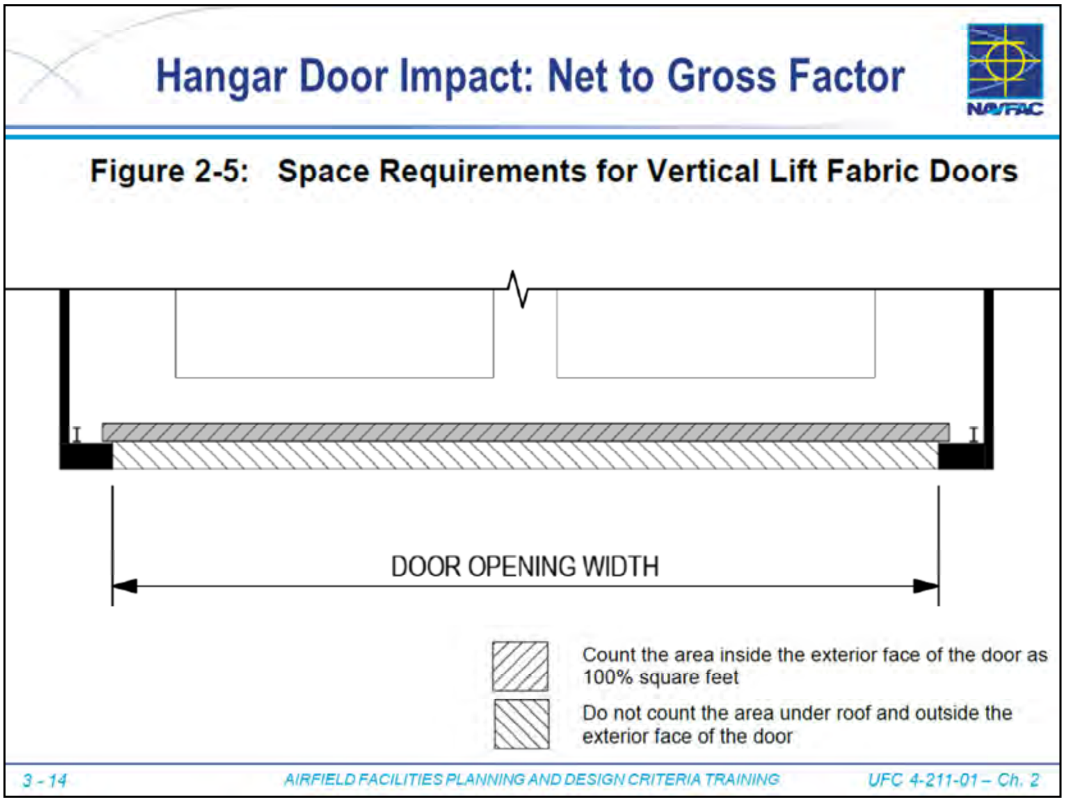
Provide a catwalk for accessing the motors and other serviceable items of the fabric door. Provide access to maintain vertical lift fabric door equipment, motors, limit switches, and other serviceable door parts. Provide access to the catwalk from inside the hangar. The catwalk must be provided for safety of critical maintenance, repairs, and manual emergency operations and must not be omitted for any reason.

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)



Refer to 2-4: Net to Gross Area in Aircraft Maintenance Hangars for requirements on calculating building gross square footage at different types of hangar doors.



Refer to 2-4: Net to Gross Area in Aircraft Maintenance Hangars for requirements on calculating building gross square footage at different types of hangar doors.

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
    - JB Pearl Harbor Hickam
    - Etc. (see wind tables)

Hangar Doors

Table 3-4: Sliding Hangar Door Pockets

<table>
<tr><th>NUMBER OF DESIGN AIRCRAFT IN HANGAR</th><th>AIR FORCE</th><th>ARMY</th><th>NAVY</th></tr>
<tr><td>1</td><td rowspan="3">POCKET REQUIRED FOR 100% OF THE DOOR PANELS TO ALLOW 100% CLEAR OPENING</td><td rowspan="2">POCKET REQUIRED FOR 100% OF THE DOOR PANELS TO ALLOW 100% CLEAR OPENING</td><td rowspan="3">POCKET REQUIRED FOR 100% OF THE DOOR PANELS TO ALLOW 100% CLEAR OPENING</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td><td>NO POCKET REQUIRED - STACK DOORS ON MULTIPLE TRACKS, BLOCKING NO MORE THAN 33% OF THE DOOR OPENING</td></tr>
<tr><td>4</td><td rowspan="2">NO POCKET REQUIRED - STACK DOORS ON MULTIPLE TRACKS, BLOCKING NO MORE THAN 25% OF THE DOOR OPENING</td><td rowspan="2">NO POCKET REQUIRED - STACK DOORS ON MULTIPLE TRACKS, BLOCKING NO MORE THAN 50% OF THE DOOR OPENING</td><td rowspan="2">NO POCKET REQUIRED - STACK DOORS ON MULTIPLE TRACKS, BLOCKING NO MORE THAN 25% OF THE DOOR OPENING</td></tr>
<tr><td>> 4</td></tr>
<tr><td colspan="4">NOTE: CLEAR 100% DOOR OPENING IS PREFERRED EVEN WHEN NOT REQUIRED. COORDINATE REQUIREMENTS WITH USERS.</td></tr>
</table>

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

Section 3b – Hangar Door Specifications

Aircraft Hangars & Other Airfield Structures

9/18/2023

UFGS – Hangar Doors

- **UFGS 08 34 16.10 Steel Sliding Hangar Doors**
  - Recently Updated: 01 NOV 2021
- **UFGS 08 34 16.20 Vertical Lift Fabric Doors**
  - Recently Updated: 01 AUG 2021 (01 NOV 2021)

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

UFGS 08 34 16.10 – Steel Sliding

NAVFAC

- **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

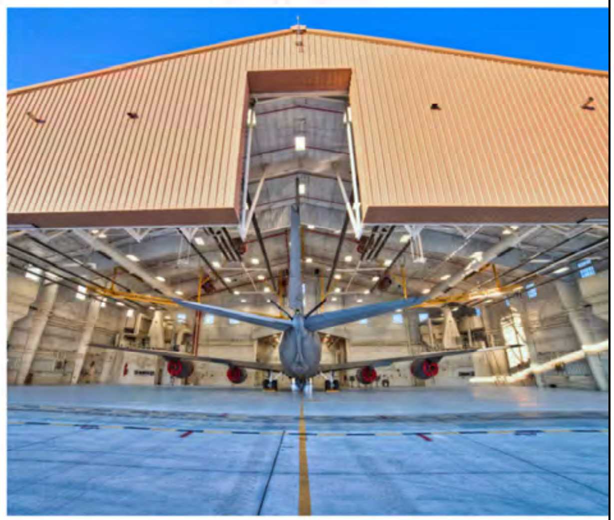
Steel Sliding – Door Configurations

- •Individually Operated Leaves
- •Anchored Group

- •One-way
- •Biparting
- •Floating

Steel Sliding – Door Configurations

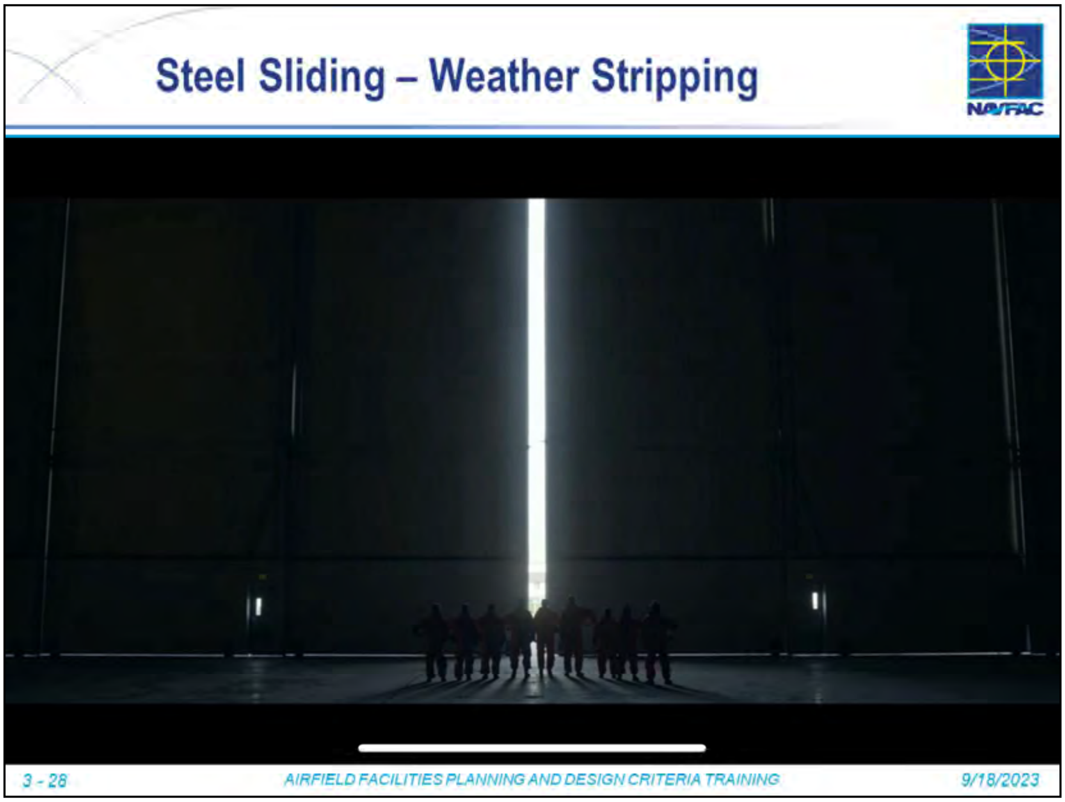
•Aperture vs. Tail Slot



Steel Sliding – Bottom Door Guide

Steel Sliding – Drive Operation


Steel Sliding – Weather Stripping
NAVFAC
3 - 27
AIRFIELD FACILITIES PLANNING AND DESIGN CRITERIA TRAINING
UFGS 08 34 16.10



Space Force Season 1 – Dramatic Scene Heading to Space ruined with poor door seals (weather stripping).

Pitch Perfect 3 – the Hangar Riff-Off Scene – again ruined with poor door seals (weather stripping).

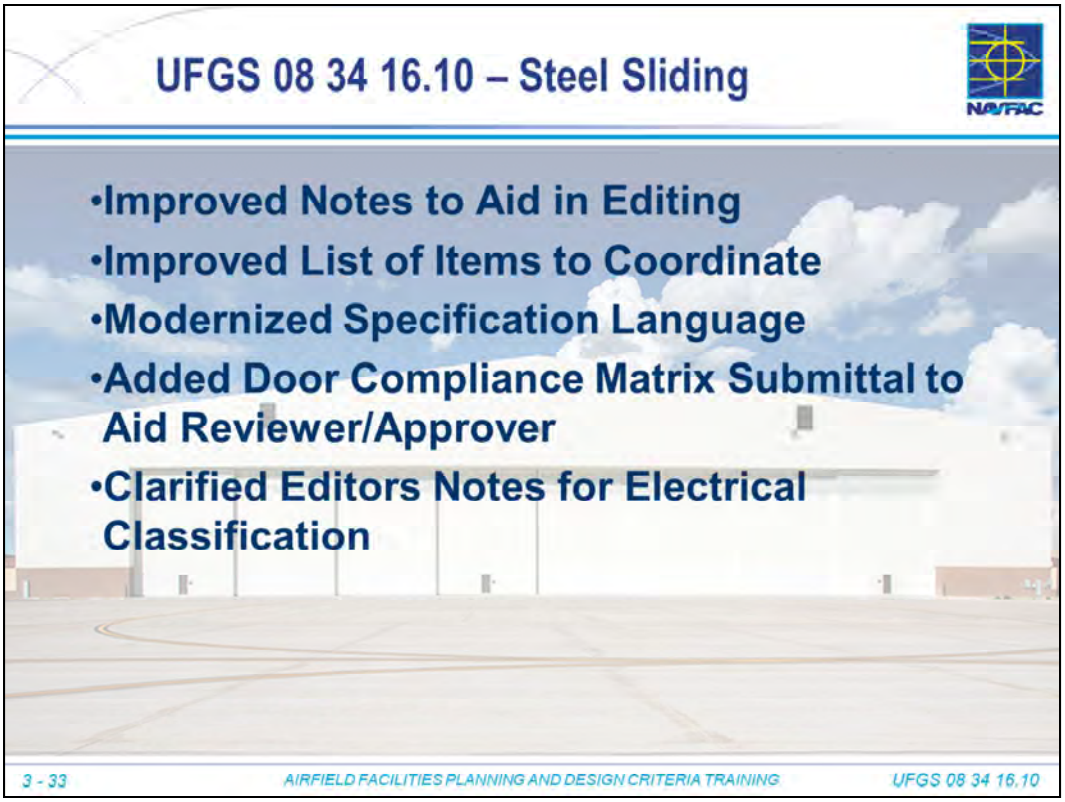
Steel Sliding – Safety Edges

Steel Sliding – Top Door Guide

Steel Sliding – Part 3 Erection Requirements

- Part 3 Execution Requirements
- Field Quality Control and Testing

- Pro Tip: Include 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)



Added Door Compliance Matrix Submittal to aid reviewer/approver in confirming all specification requirements are met

UFGS 08 34 16.10 – Steel Sliding

- Updated Wind Loads to match current UFC
- Specified Design Requirements for all Door Positions (closed and not-closed)
- Limited use of cold-formed members to wind girts with a minimum 14 GA thickness
- Added Vertical Floating Head Top Guide Roller option
- Updated Personnel Training section (with Option for Training Video)

UFGS 08 34 16.10 – Steel Sliding

NAVFAC

- **Common Failures:**
  - –Top Door Guide Wear / Binding
  - –Light Gage Steel / Frame Racking
  - –Safety Edge Failure (electric & pneumatic)
  - –Weather Stripping

- **There are a lot of advantages to Steel Sliding Doors – simplicity and dependability are at the top of this list.**

UFGS 08 34 16.20 – Vertical Lifting Fabric

- UFGS and Recent Spec Changes
- VLFD Function
- VLFD Failures
- VLFD Maintenance

UFGS 08 34 16.20 – Vertical Lifting Fabric

- **Part 1 Notes to Editor/Designer:**
  - List of information to be included in the drawings
- **Submittals Include:**
  - Professional Sealing Req'ts (delegated design)
  - Door Compliance Matrix Submittal
- **Design Requirements:**
  - Wind 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

VLFD – Part 2 Components

- **Part 2 Component Requirements:**
  - –Fabric Type and Color
  - –Operation and Safety
  - –Motors, Controls, Limit Switches and Alarms
  - –VLFD Components

Single Panel

Multiple Panels

Tail Slots of Varying Proportions

Stair Stepped

Entry on a corner of a building

Entry on two sides of an exterior corner poking into a flightline

Entry on two sides of a re-entrant corner of a flightline.

Translucent Panels let diffuse natural light in during the day and create dramatic exterior lighting at night.

Vison Panels are not glass, but allow vision through and direct natural light.

VLFD – Energy Benefits

Fantastic Energy Image:

Daylight in a northern climate with no interior lights turned on.

No air gaps between doors, structure or floor.

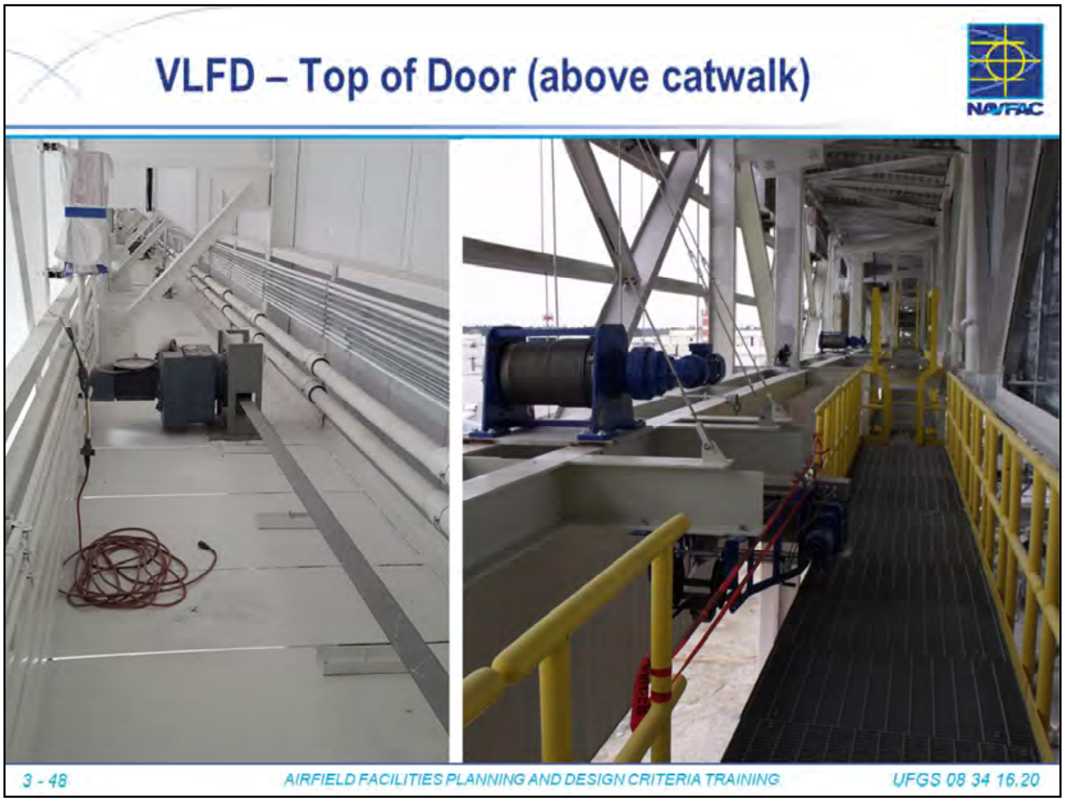
VLFD – Energy Benefits

VLFD – Operation

VLFD – Bottom of Door Mullion

VLFD – Top of Door

VLFD – Top of Door (above catwalk)



Pros and Cons of catwalk type & placement.

1. Catwalk In line with equipment vs offset catwalk (additional framing vs having to reach beyond catwalk)
2. Solid bottom and sides vs open bottom and sides (containing all tool/screw/FOD drops versus not)

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)

UFGS 08 34 16.20 – Vertical Lifting Fabric

- Improved Notes to Aid in Editing
- Improved List of Items to Coordinate
- Modernized Specification Language
- Added Door Compliance Matrix Submittal to Aid Reviewer/Approver
- Clarified Editors Notes for Electrical Classification
- Updated Wind Loads to match current UFC
- Specified Design Requirements for all Door Positions (closed and not-closed)

UFGS 08 34 16.20 – Vertical Lifting Fabric

- **Increased Competitiveness**
  - –Permitted Fabric to be Single-piece or Panelized
  - –Permitted more than 2 Motors and Belts/Cables
  - –Added Bottom Beam Design Requirements
  - –Clarified Controls: Enclosure, Function & Interface
  - –Inspection/Adjustment req't at 12 months
- **Additional Safety Changes**
  - –Based on recent failures of three manufacturers

VLFD – Preventative Maintenance

- Doors are not a "set it and forget it" system
- Should be treated like a Crane
  - Lifting loads overhead w/
  - Personnel and Equipment working under them
- Highly recommend Maintenance Contract
  - Perform annual inspections and maintenance

Information in this documentation is based upon the preliminary findings of an investigative team and building user account.

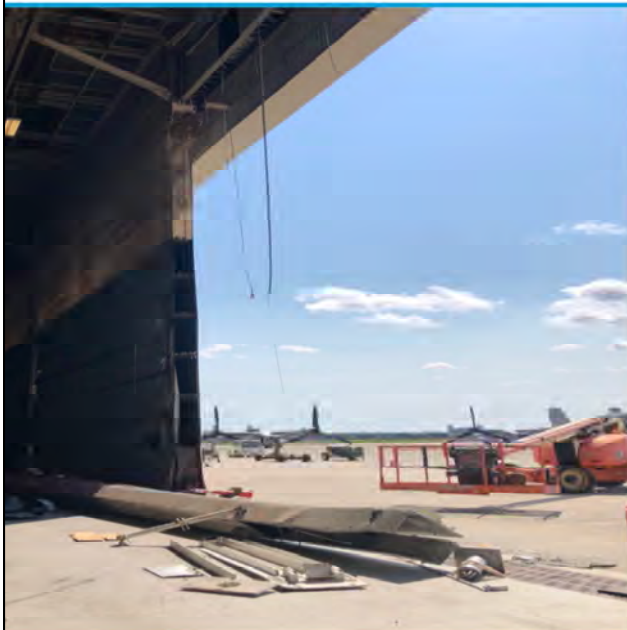
Fabric was not tight thus no tension to brace wind girts for lateral torsional buckling

Beams rotated/twisted/bent pulling/tearing them out of the tracks and tearing the fabric

Fabric then tore causing girts to drop below that point (fabric holds beams in place vertically)

Our new spec incorporates these lessons learned – but still doors need to be closed in advance of a 60 MPH wind event

VLFD – Failures



- **Failure Mechanism(s)**
- Manuf. Specific Detailing
- Outdated Constr. Methods
- Prior Versions of Specification
- Purported Lack of Maintenance

- *Information in this presentation is based upon the preliminary findings of an investigative team and User account.*

VLFD – Failures

- Left Door Closed
- Right Door Open
- **Middle Door Raised**

VLFD – Failures

- Left Door Closed
- Right Door Open
- Middle Door Open
- **Mullion Raised**

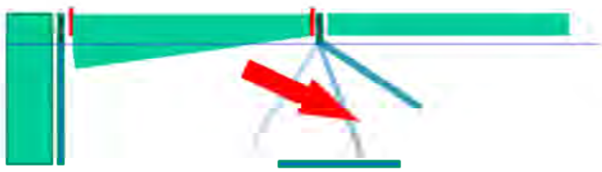
VLFD – Failures

- Left Door Closed
- Right Door Open
- Middle Door Open
- Mullion Raised
- **Middle Door's Left Cable Connection Fails**

VLFD – Failures

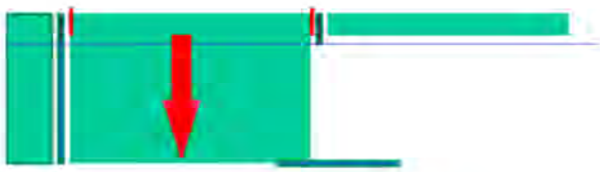
- Left Door Closed
- Right Door Open
- Middle Door Open
- Mullion Raised
- Middle Door's Left Cable Connection Fails
- **Middle Door's Fall Arrestors come off Door Guide, door weight bears on Mullion, which then gives way.**

VLFD – Failures



- Middle Door's Fall Arrestors come off Door Guide, door weight bears on Mullion, which then gives way.
  - **Mullion (with retracted pin) swings past vertical, breaks off and lands on floor**

VLFD – Failures



- Middle Door's Fall Arrestors come off Door Guide, door weight bears on Mullion, which then gives way
- Mullion (with retracted pin) swings past vertical, breaks off and lands on floor
- **Middle Door (with loss of left cable support, and with safety arrestors pulled off door guides) lowers to floor in an uncontrolled manner damaging bottom beam.**

VLFD – Failures

- Primary Cause: believed to be the U-Bolts (cable clamps) which start equally spaced, but over time slip and stack up before losing grip on cable.

- Spec revision require manuf. to properly swage cable ends

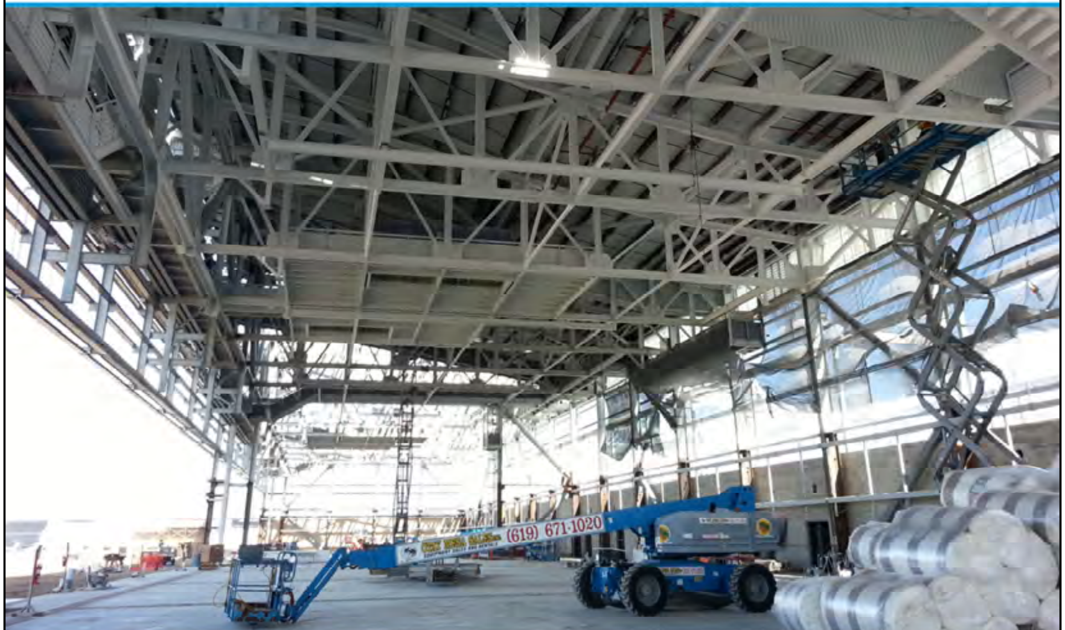
- It is believed a contributing factor in this door's failure was the ability for the guide blocks to be pulled from the door's guides.

There were other contributing factors, lessons learned and spec changes as a result. And all have been incorporated into the latest November 1, 2001 specification.

VLFD – Failures & Arrestors

Treat them like a crane in which people are walking under the lifted load – because that is what is happening on a daily basis.

Break



Section 4a – UFC 4-211-02 Aircraft Corrosion Control & Paint Facilities

Aircraft Hangars & Other Airfield Structures

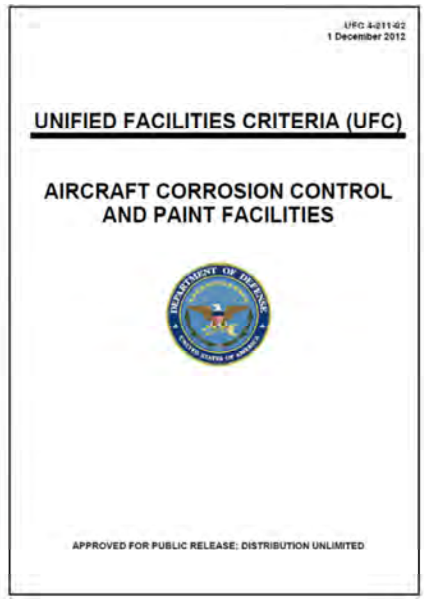
9/18/2023

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


UFC 4-211-02
1 December 2012

UNIFIED FACILITIES CRITERIA (UFC)

AIRCRAFT CORROSION CONTROL AND PAINT FACILITIES

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

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

UFC 4-211-02
1 December 2012

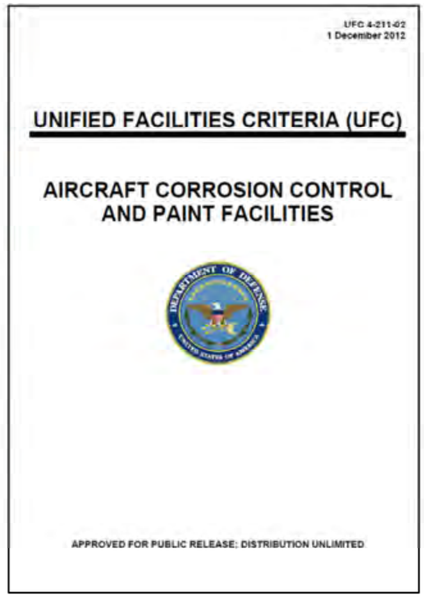
UNIFIED FACILITIES CRITERIA (UFC)

AIRCRAFT CORROSION CONTROL AND PAINT FACILITIES

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

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


UFC 4-211-02
1 December 2012

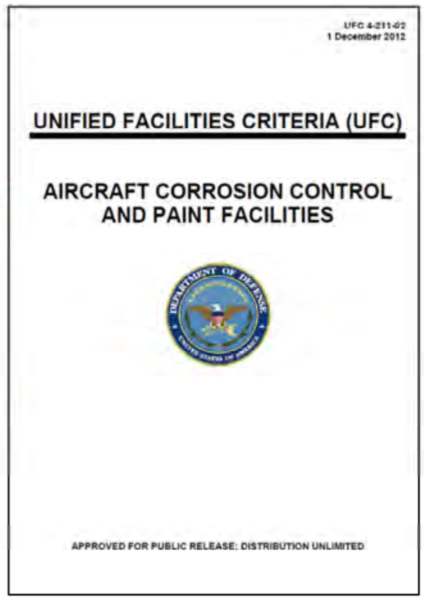
UNIFIED FACILITIES CRITERIA (UFC)

AIRCRAFT CORROSION CONTROL AND PAINT FACILITIES

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

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



UFC 4-211-02
1 December 2012

UNIFIED FACILITIES CRITERIA (UFC)

AIRCRAFT CORROSION CONTROL AND PAINT FACILITIES

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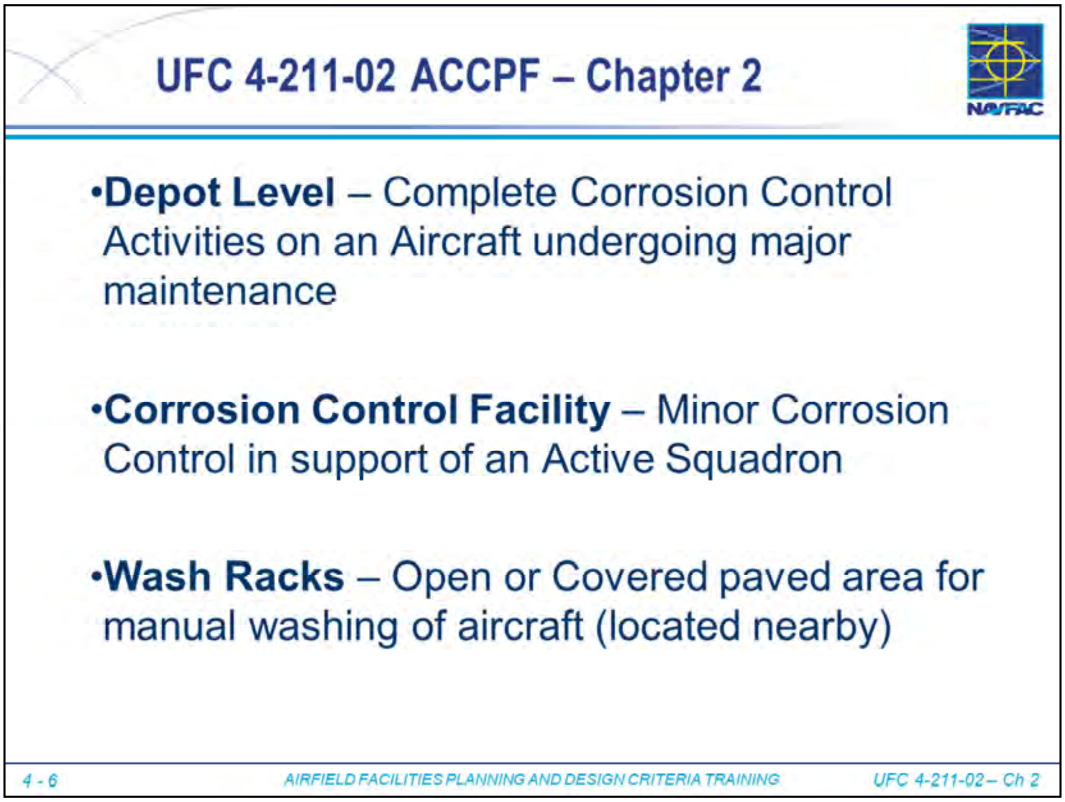


2-1.2 Depot Level Facilities.

The primary function of a Depot Level Paint or De-paint Facility is to provide the necessary space and services to perform complete corrosion control activities on aircraft undergoing scheduled major maintenance checks or a scheduled complete corrosion control repaint.

2-1.3 Corrosion Control Facilities.

The primary function of a Corrosion Control Facility is the performance of minor corrosion control activities in support of an active squadron as part of non-scheduled maintenance completed on an as needed basis.

2-1.4 Wash Racks.

a. Open (uncovered) Wash Rack

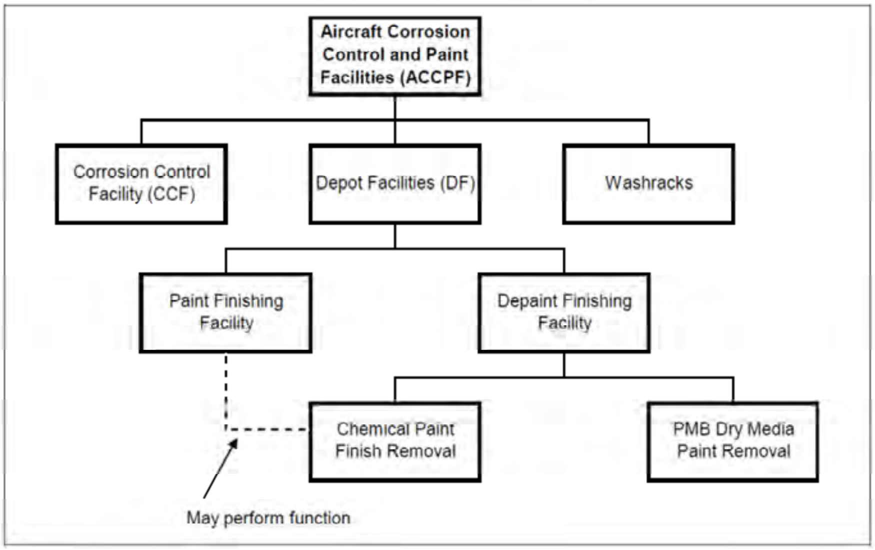
b. The Covered Wash Rack

c. Interior Wash Racks

d. Birdbaths (Aircraft Rinse Facility)

ACCPF Facilities

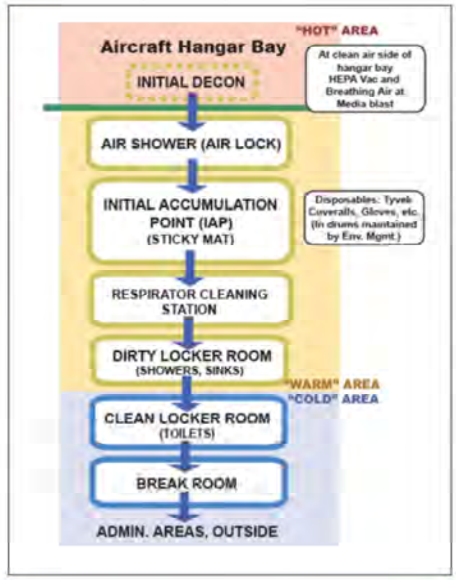
FIGURE 1-1. ACCPF FACILITIES



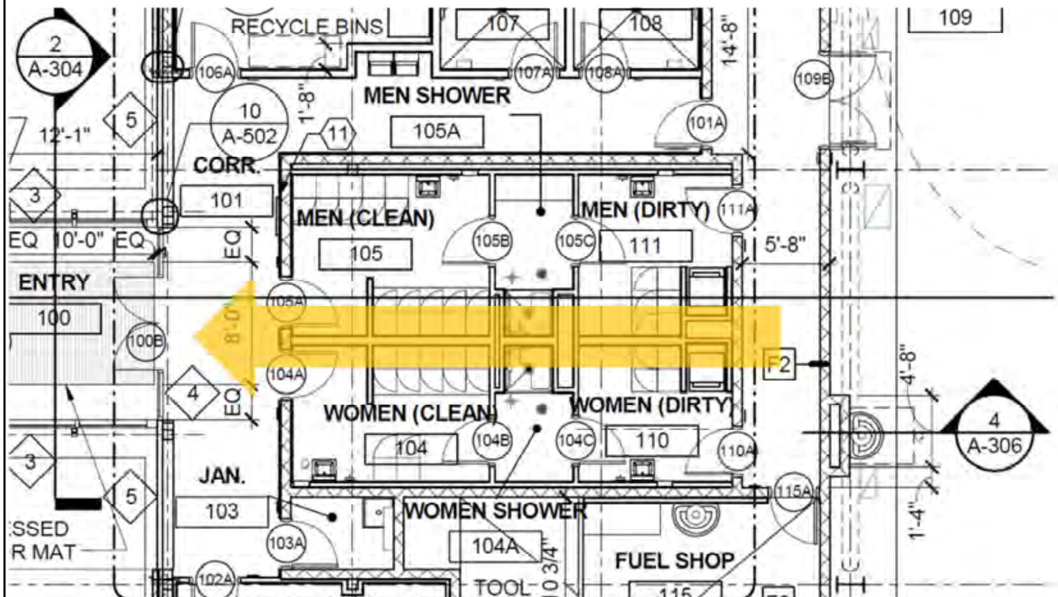
Complex and Unique Building Systems

- •Health / Environmental
- •Architectural Detailing
- •Structural Detailing
- •Mechanical HVAC Systems
- •Equipment Systems
- •Processes

FIGURE 2-5. CLEAN-DIRTY SCHEMATIC



Complex and Unique Building Systems



Bubble Diagrams

FIGURE 2-3a. DF PAINT & CHEMICAL DEPAINT BUBBLE DIAGRAM

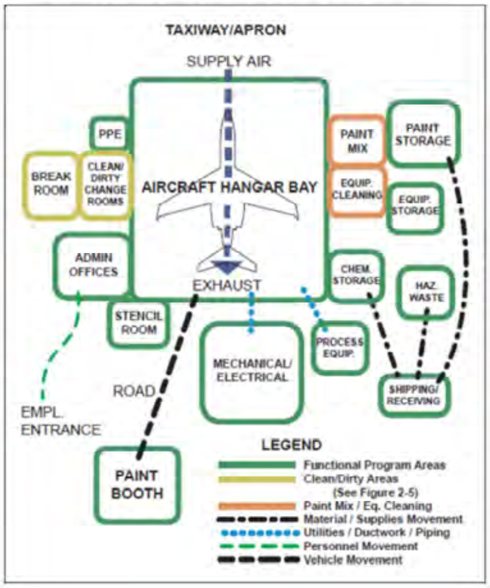
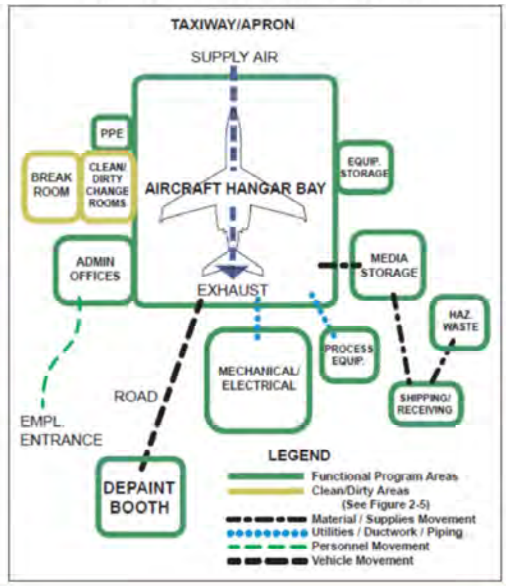
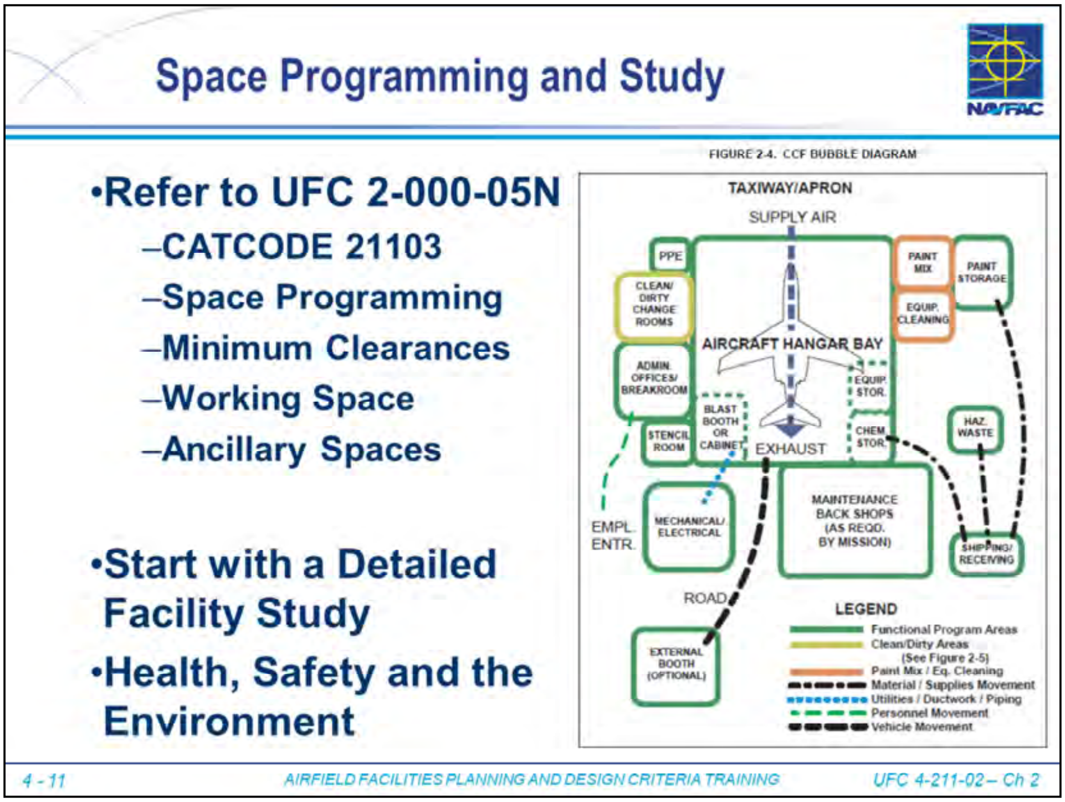


FIGURE 2-3b. DF DRY MEDIA DEPAINT BUBBLE DIAGRAM





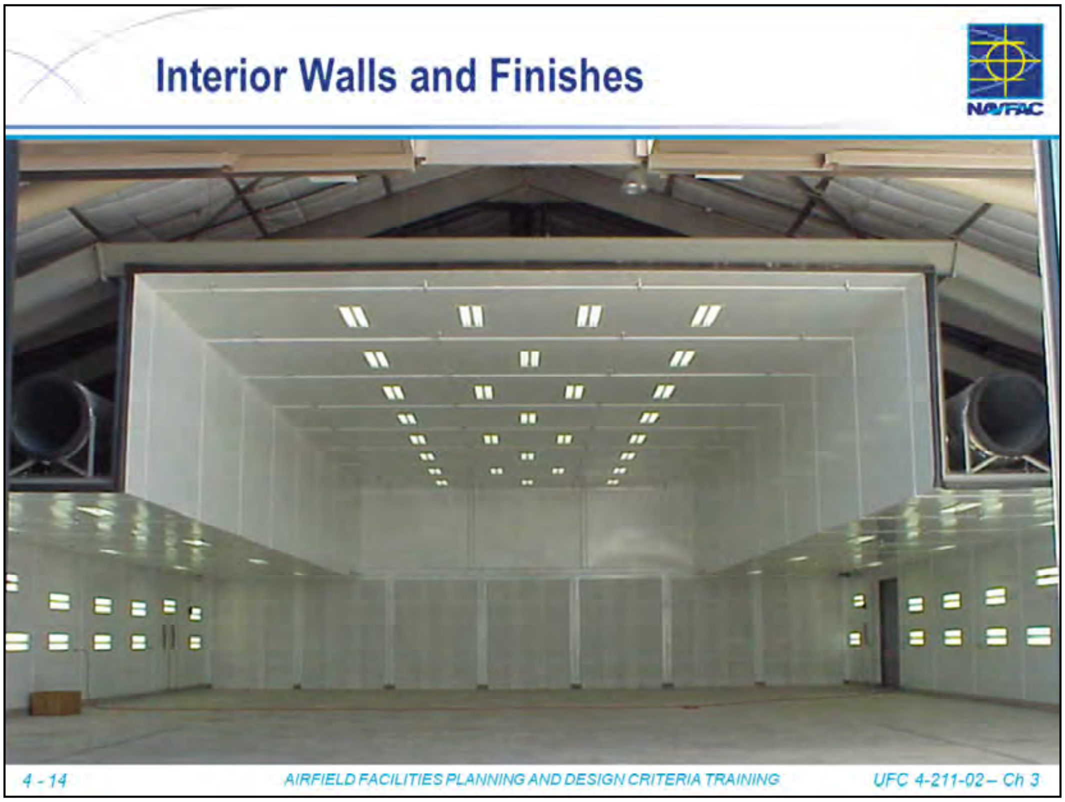
Planning activities for an ACCPF must address all requirements for worker health and safety, and environmental permitting. Compliance with all health, safety, and environmental regulations is required and is achievable without significantly disrupting the operations if adequate advanced planning and coordination is performed. These issues must be incorporated into the selection of HVAC Systems per this Chapter and Chapter 3. Appendix C provides an overview of the applicable environmental standards.

Corrosion Control Hangar CATCODE 21103

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



A fully lined and sealed space with hard, durable, light-colored, smooth surfaces/finishes.

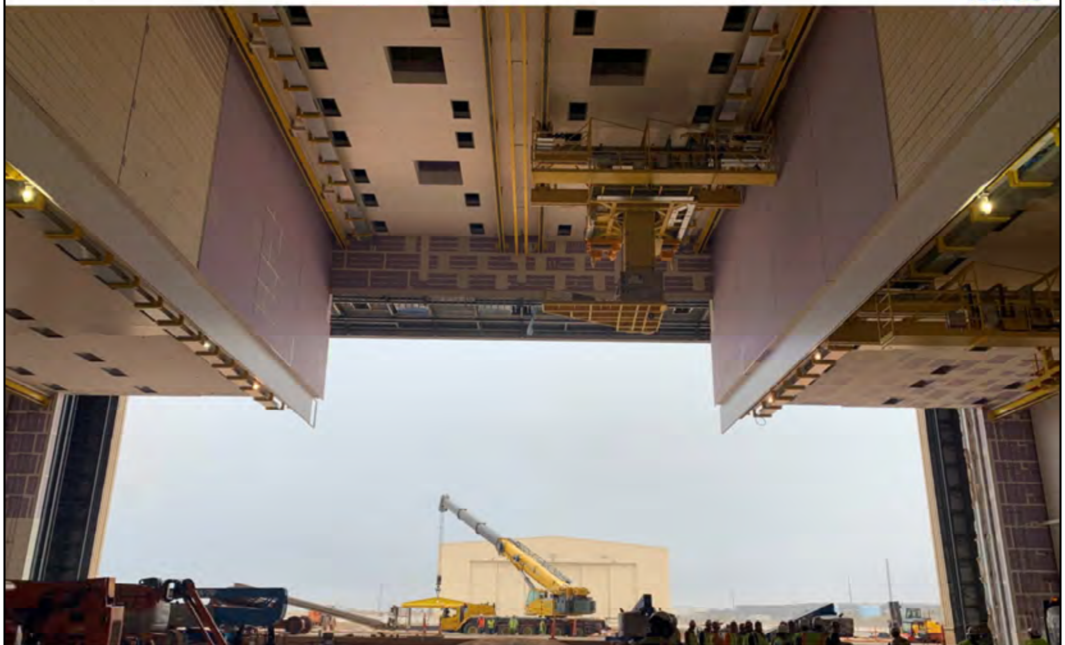
Horizontal surfaces and ledges must be covered with a sloping surface such that the accumulation of dust is mitigated

Provide wall penetrations and building joints ensure airtight performance to maintain pressure differentials and prevent contamination of the air in the hangar bay.

Provide the sidewalls, the inside of hangar doors, and the ceiling of the hangar area with a light color, smooth surface such as white enameled metal panels.

Aircraft bays and paint storage, mixing, and spray areas must have water-resistant gypsum ceilings or a metal panel ceiling system. Provide a 1-hour fire-rated ceiling in paint bays. Consideration should be given to utilization of the ceiling deck above the hangar bay as a walking surface for access to the overhead light fixtures and also mechanical and electrical distribution systems generally located in the ceiling space above the hangar bay.

Interior Walls and Finishes

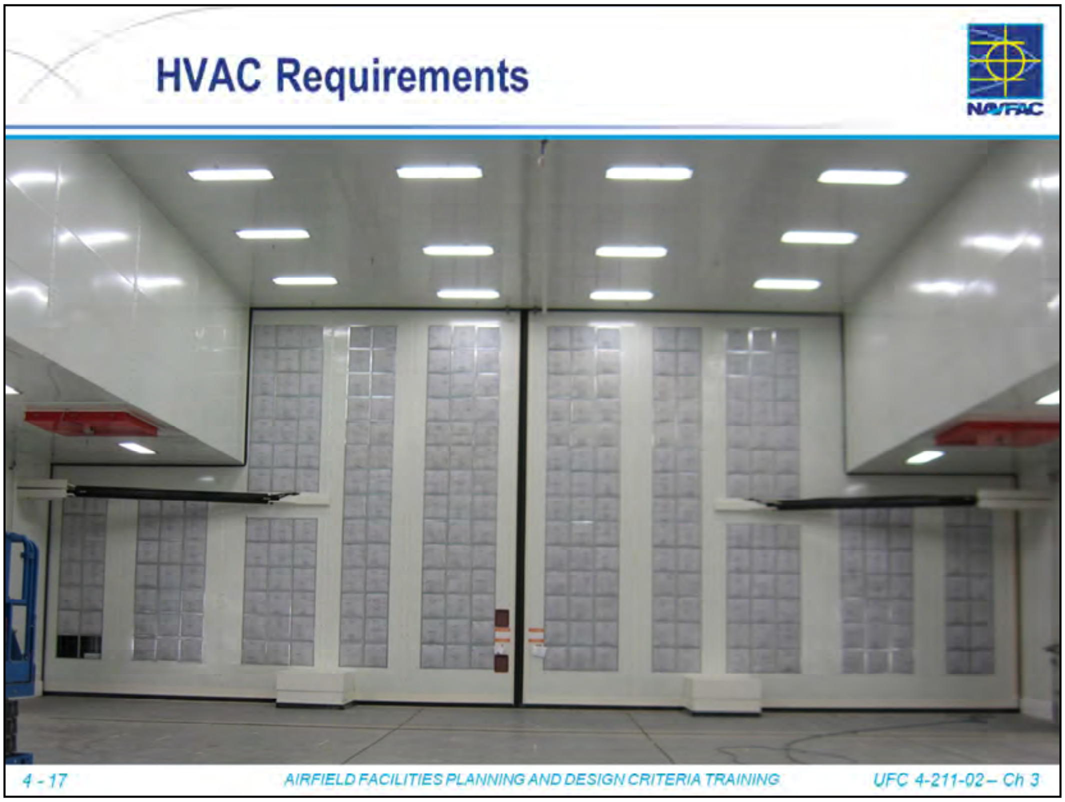


Rack utilities and other building support outside of the hangar bay to minimize the interior surfaces and maintain a clean and laminar flow through the hangar bay.

Design for Control of Hazardous Effluents is required: The corrosion control process generates large amounts of water that could potentially hold solid or liquid paint residue or other solvents and wastes. If the local wastewater treatment plant cannot accept the effluent generated from the facility, on-site treatment or containment and off-site disposal is required. Refer to UFC 4-451-10N, *Design: Hazardous Waste Storage*, and UFC 4-832-01N, *Design: Industrial and Oily Wastewater Control*.

Design for accidental spill of paint strippers and thinners, paint, cleaning solvents, pretreatment chemicals, fuel or oil. Provide above-grade containment of accidental spills with appropriate sumps for pumping and cleanup of spilled wastes. Size the containment capacity for the largest possible discharge. Provide a method to prevent the drains from clogging.

Compressed air is required in accordance with the UFC and the FRD.



Refer to UFC for Heating requirements including temperature and humidity requirements.

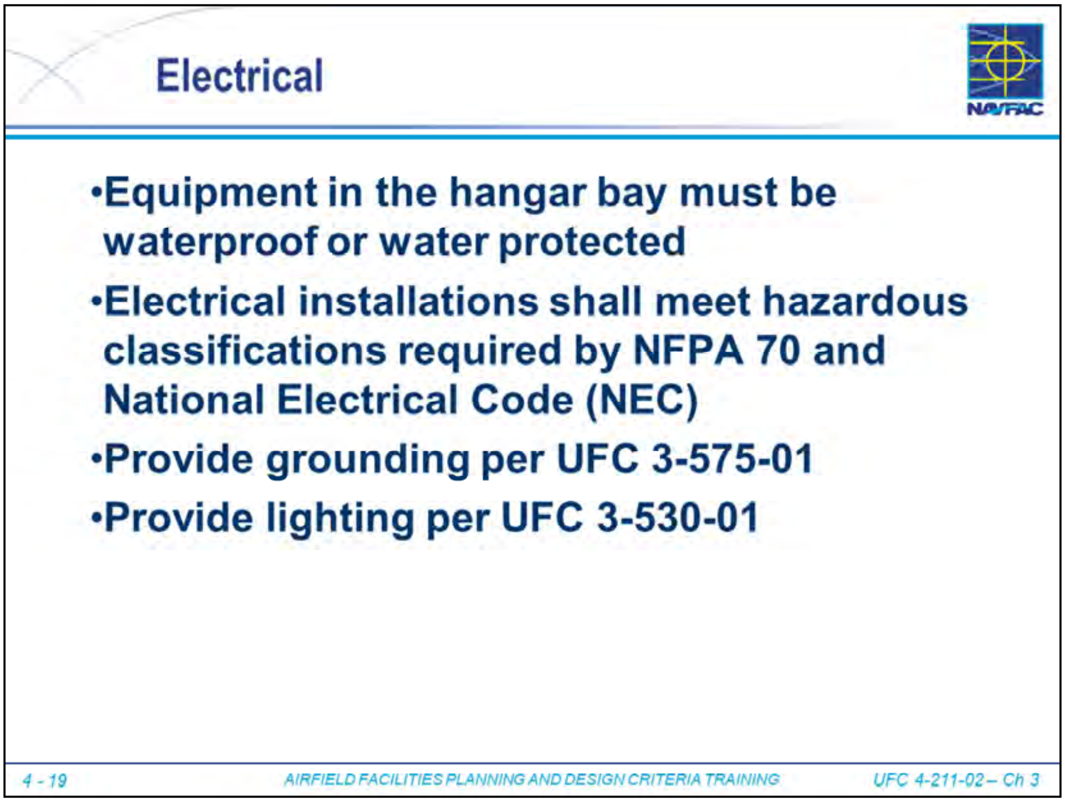
For Ventilation, the objective is to provide a system that is safe, energy efficient and cost effective (installation and maintenance) and environmentally compliant while maintaining the primary goal of ensuring operator health and safety at all times. Refer to the UFC for requirements for ventilation and control of air emissions.

Air plenums are typically incorporated into the design of the hangar doors. This design may be configured as a swing door as shown (most commonly utilized for fighter or similar sized aircraft), or a double rolling door arrangement where two sets of doors form an air plenum between the inner and outer sides. The double door configuration is generally selected for use with cargo or similar sized aircraft. The incorporation of an air plenum into a hangar door requires that the air performance characteristics of the plenum remain primary in the Plenum/Door system.

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
  - NFPA 101, Life Safety Code

    - 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.

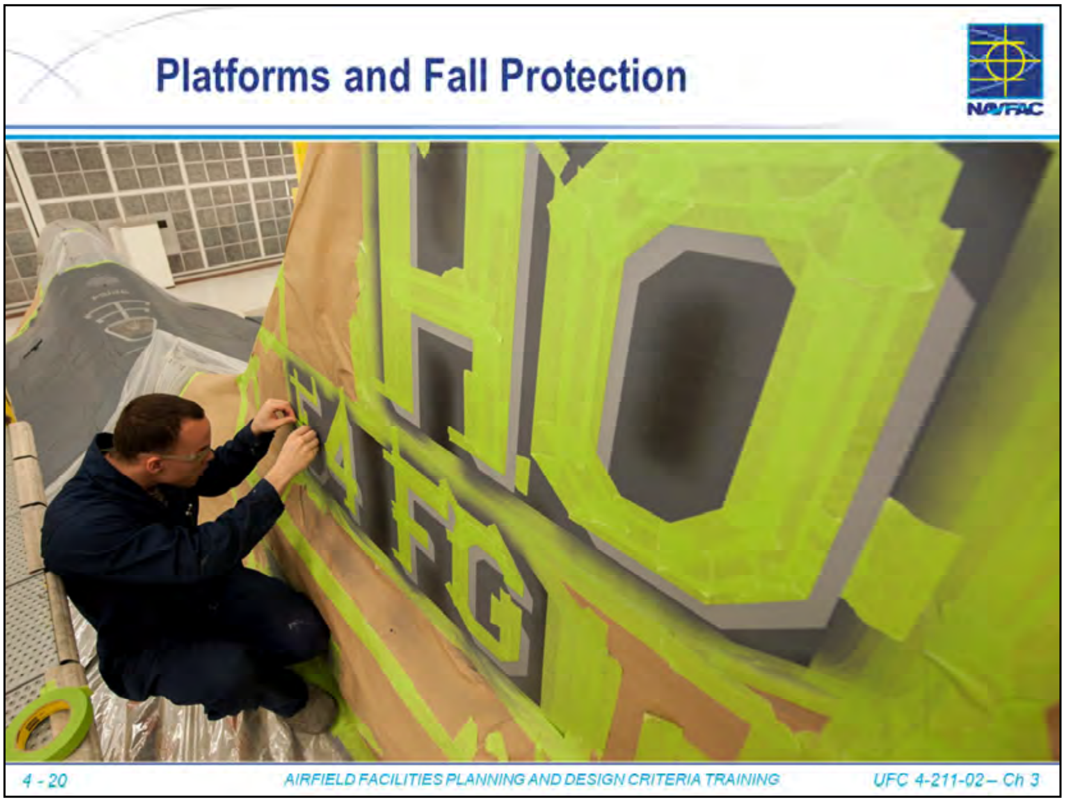


Avoid the use of explosion-proof overhead fixtures by providing sealed, ventilated space above the finished ceiling. Fixtures may then be installed above the classified space.

Hangar Lighting level – Interior lighting level of 100 FC measured 30 inches from floor must be available for Painting Operations inside the hangar bay. A lesser lighting level may be provided during non-critical operations to be determined by the Operating Group.

Controllable Hangar Bay Lighting - min. 50 FC up to 100 FC in hangar bay. Provide to the best extent possible a lighting arrangement and control which allows for staged control of fixtures which can provide 50 FC, 75 FC and 100 FC progressively to the hangar floor.

Vertical aircraft surfaces must be considered and incorporated into the hangar interior lighting design. This lighting may be permanently installed in the side walls, on man lift platforms (if provided), or as portable units. A minimum of 70 FC must be used as the design lighting level for vertical surfaces. Note: Hazard classification must be maintained in all cases.



Options Include:

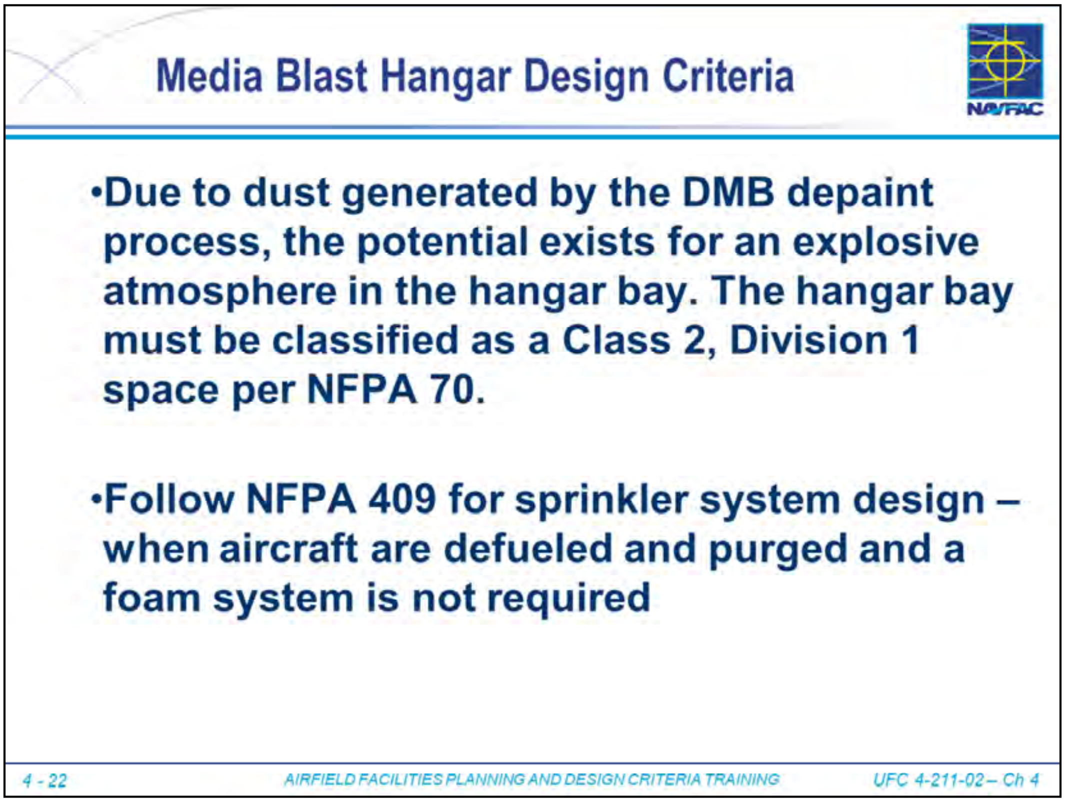
1. Floor Supported Platforms: most economical, generally purchased separately from the facility construction budget and not included as part of real property. Consideration of this equipment during the planning phase, however, is essential to ensure sufficient clearance around the aircraft when the lifts are in place, and housing the lifts when not in use.

2. Telescoping Platform Systems: most expensive, few manufacturers, significant flexibility and efficiency of operation for an ACCPF, especially if for large aircraft depot maintenance. TPS impart significant load on the structure of the facility and ultimately to the foundations. Therefore, inclusion or exclusion of TMPS must be established early in the planning phase.

3. Fall Protection / Fall Arrest: Personnel fall protection or fall arrest is required when work platforms are not adequate or practical to reach the upper surfaces of the aircraft or when personnel must walk on aircraft wings or other surfaces during corrosion operations.

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)



Review Comment: For the ACCPA (paint booth) follow NFPA 33 and if performing blasting (paint stripping), follow NFPA 652 and possibly FM Data sheets 7-73 & 7-76.

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

Description/ Usage	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
Ceiling Ht.	Based on largest part anticipated, with sufficient clearances for movement of personnel and equipment
Windows/Doors	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;
Interior Construction/ Built-in Equipment	
Finishes	**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
Plumbing	Drains, if installed must be routed to IW systems for proper treatment. Emergency Shower & Eyewash, floor drains to IW system
Industrial Ventilation	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)

Section 4b – UFGS 08 34 16 Corrosion Control Hangar Doors

Aircraft Hangars & Other Airfield Structures

9/18/2023

Corrosion Control (Filter) Doors

NAVFAC

- 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

The hangar door acts as a plenum.

Galvanized steel perforated plates are used with a means to balance air distribution to achieve evenly distributed laminar flow in the hangar bay.

Specialized, insulated, swinging or sliding

Designed to serve as insulated supply air plenums when closed

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)


(619) 671-1020

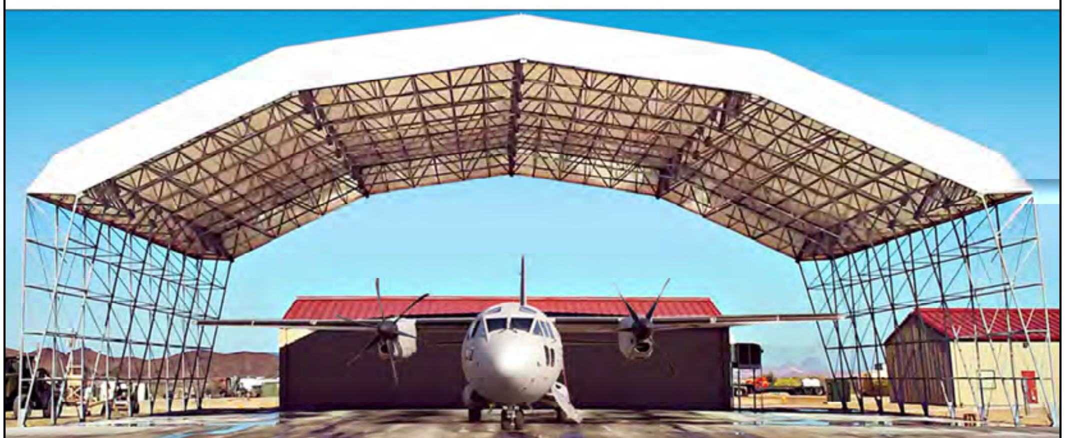
Section 5 – Frame Supported Membrane Structures for the Protection of Aircraft

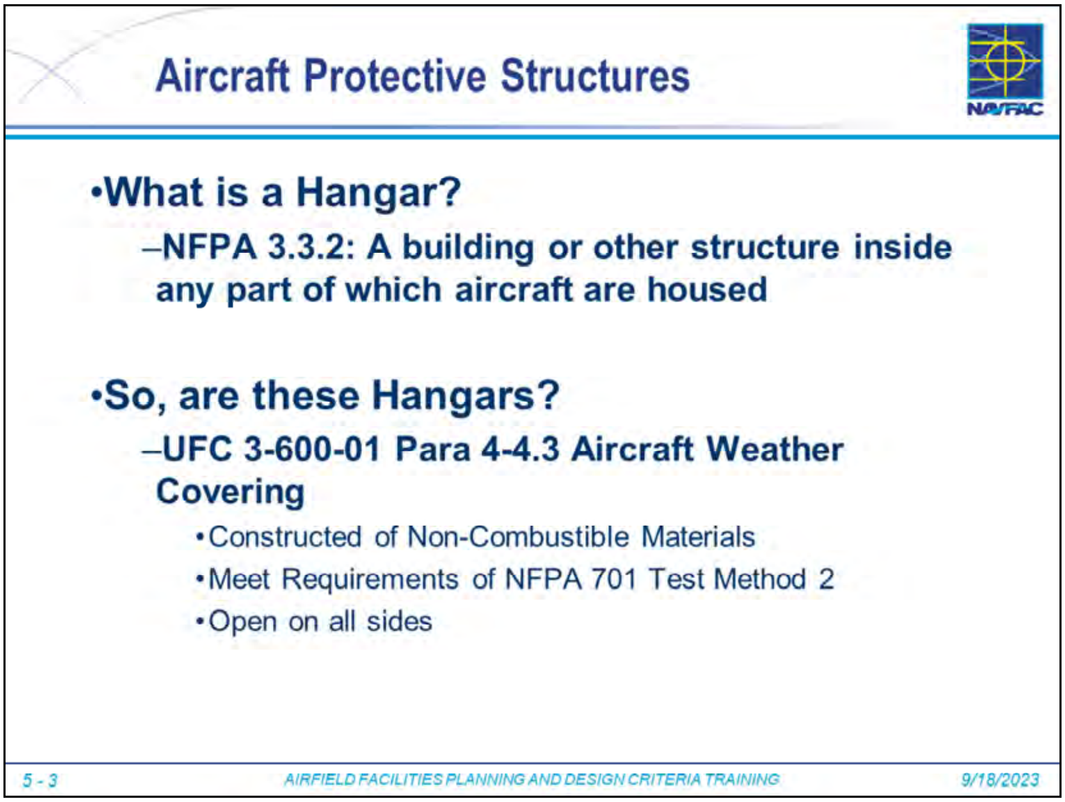
Aircraft Hangars & Other Airfield Structures

9/18/2023

Aircraft Protective Structures

- Also Known As:
  - Aircraft Sunshades, Sun Shelters, Canopies, Weather Covering, etc.





The weather covering being open on all sides allows for the dissipation of heat, dispersion of vapors from flammable or combustible liquids, and will not restrict firefighting operations from any side of the structure. The open sides maintain the current conditions on the flight line.

Any permanent electrical devices or equipment (receptacles, lighting, or other similar devices) installed on the aircraft weather covering (sunshade) must comply with the requirements of NFPA 70, Article entitled “Aircraft Hangars”…

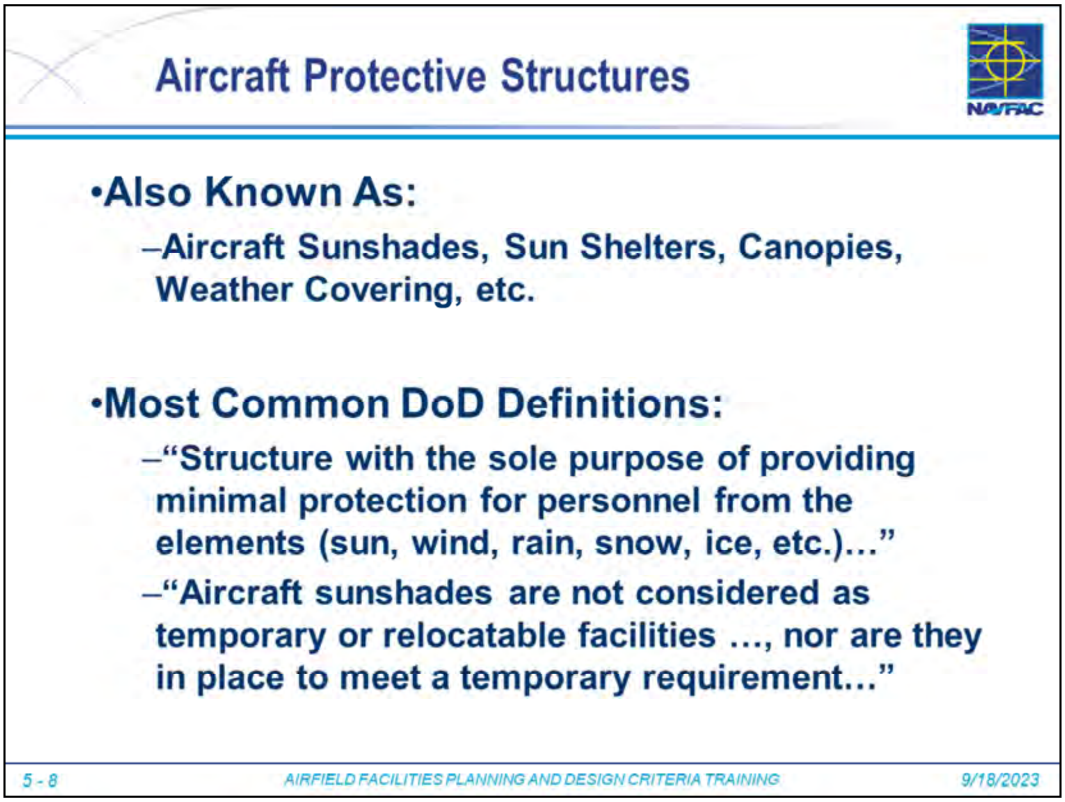
A fire detection or suppression system is not required.

Aircraft Protective Structures

Aircraft Protective Structures

Aircraft Protective Structures

Aircraft Protective Structures



Some definitions conflict with the latest UFC 3-600-01 Fire Protection, by allowing up to two side walls – and some definitions exclude lightning protection.

Aircraft Protective Structures

- No Clear Standard or Consensus Specification

- Designed with Fatal Flaws (often include):
  - Code Violations
  - Designed for Temporary, but Used Permanently
  - Superstructure Flaws
  - Foundation/Attachment Flaws

- Not Maintained and/or are Altered During Use:
  - Modifications
  - Corrosion, UV Breakdown, Extreme Weather

Aircraft Protective Structures

Aircraft Protective Structures

Aircraft Protective Structures

Use this Specification and Enforce this Specification – and the following historical issues should all be addressed properly!

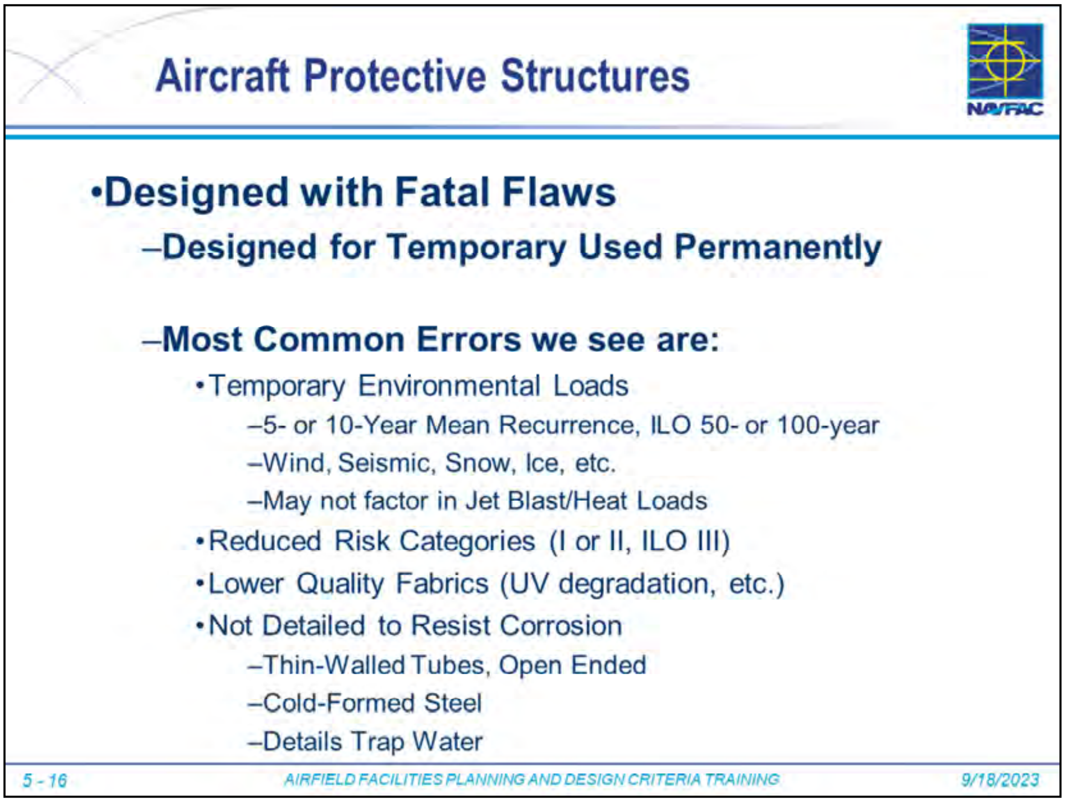
Aircraft Protective Structures

- Designed with Fatal Flaws
  - Code Violations
  - Designed for Temporary, but Used Permanently
  - Superstructure Flaws
  - Foundation/Attachment Flaws

Aircraft Protective Structures

- Designed with Fatal Flaws
  - Code Violations

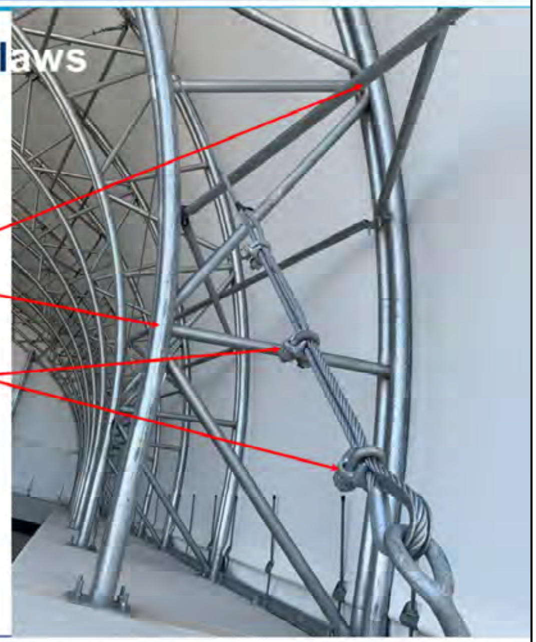
Not open on all sides – so it must comply with UFC 4-211-01 as a Hangar (fire protection, emergency egress, etc., …)



There are multiple studies and evaluations summarizing the specific design issues in existing structures.

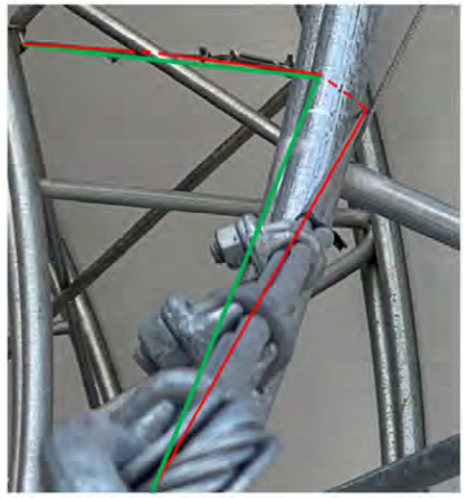
Aircraft Protective Structures

- **Designed with Fatal Flaws**
  - **Superstructure Flaws**
  - **Non-Concentric Panel Points**
  - **Temporary Swaging**
  - **Misaligned Bracing**
  - **Structural Details Deteriorate Fabric**



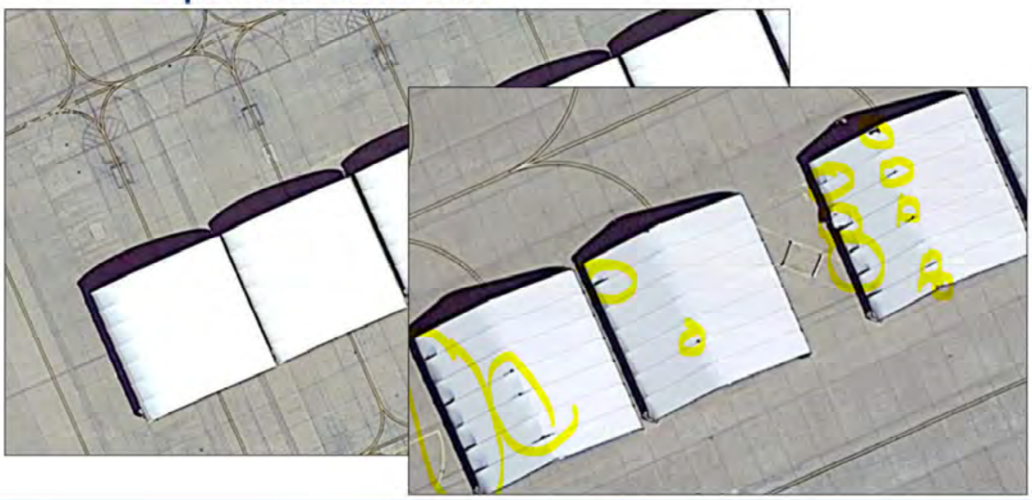
Aircraft Protective Structures

- **Designed with Fatal Flaws**
  - **Superstructure Flaws**



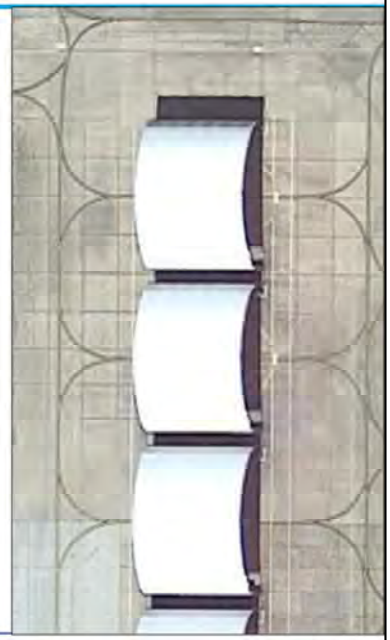
Aircraft Protective Structures

- Designed with Fatal Flaws
  - Superstructure Flaws

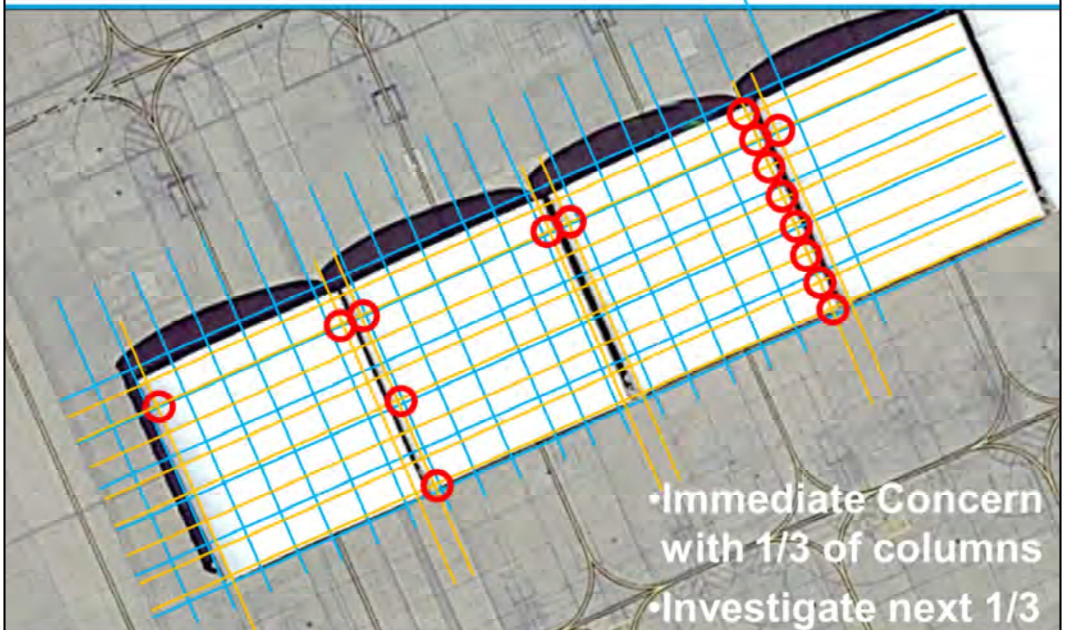


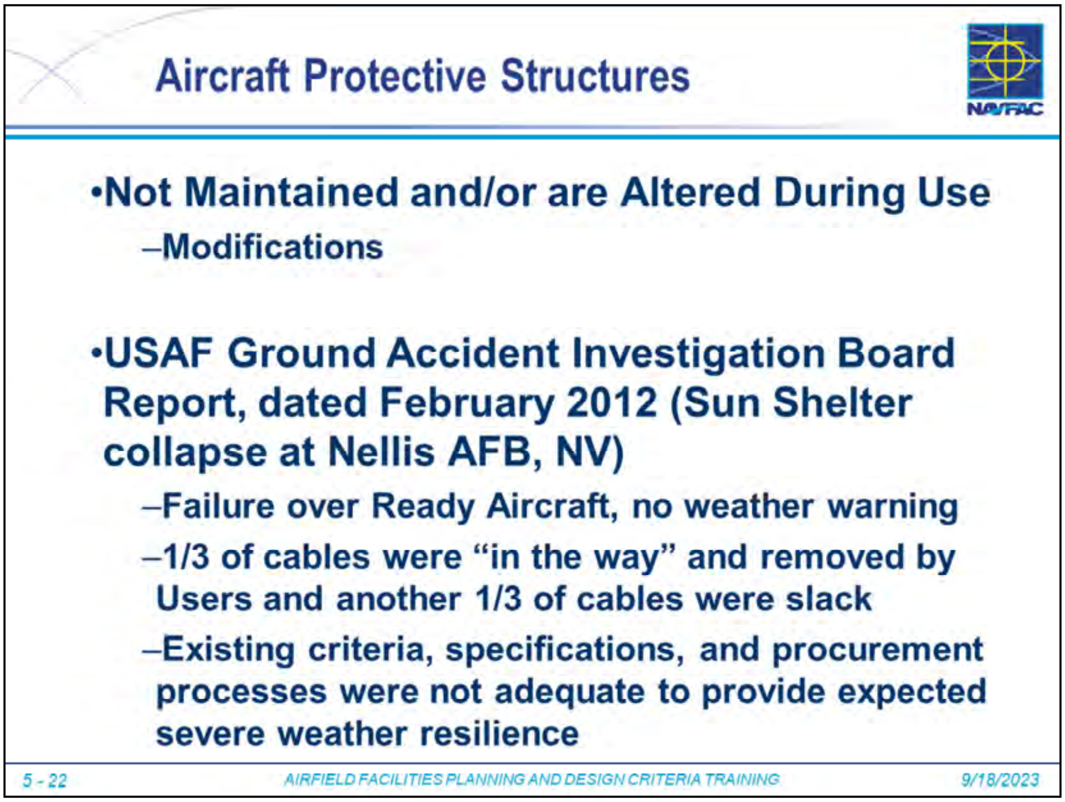
Aircraft Protective Structures

- **Designed with Fatal Flaws**
  - **Foundation/Attachment Flaws**
  - **Most Common Errors are in Attaching to Existing Airfield Pavement**
    - Reduced Anchor Capacity if too close to Pavement Joints
    - Reduced Uplift Resistance in Unreinforced Concrete



Aircraft Protective Structures





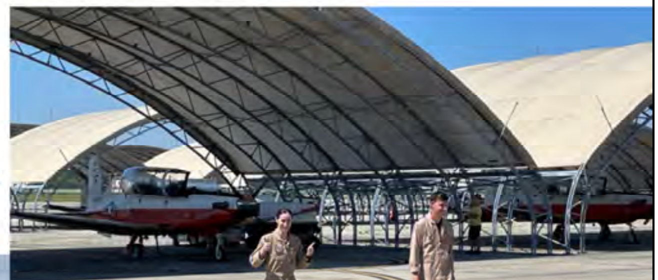
- Acquisition Policies/Design Processes: Acquisition of the sunshade as equipment did not require a technical design review, technical oversight of installation, or require operation and maintenance documentation. Further, no overall Air Force guidance was established at the time of acquisition of the sunshade or of the collapse of the sunshade.
- Perceptions of Equipment: Personnel did not consider the possibility that the sunshade could collapse. As a result, in inspection or maintenance procedures were developed.
- Procedural Guidance/Publications: No inspection procedures or checklists were developed for the sunshade when installed.

Aircraft Protective Structures

- Not Maintained and/or Altered During Use
  - Corrosion, UV Breakdown, Extreme Weather
- Severe Weather Readiness Assessment (SWRA), dated December 2018, authored by an Assessment Team for HQ Air Combat Command (multiple hurricane failures)
  - Do not classify as equipment, develop UFGS
  - Add to UFC; require hangar structural standards
  - Require design & construction review of PE
  - Inspections every 5 years

Aircraft Protective Structures

- UFGS 13 31 33 FRAME SUPPORTED MEMBRANE STRUCTURES FOR PROTECTION OF AIRCRAFT
  - Loads
  - Materials
  - Quality
  - Critical Details
  - Lots of Notes



Aircraft Protective Structures

- UFGS 13 31 33 FRAME SUPPORTED MEMBRANE STRUCTURES FOR PROTECTION OF AIRCRAFT
  - In addition to Manufacturer's Professional Engineer the following may also be required:
    - Foundation and Column Anchorage Design
    - Airfield Pavement Design
    - Lighting, Power, Grounding, Lightning Protection Design
    - Any other necessary Utilities
  - Lists of all design information which must accompany the UFGS to provide a complete design

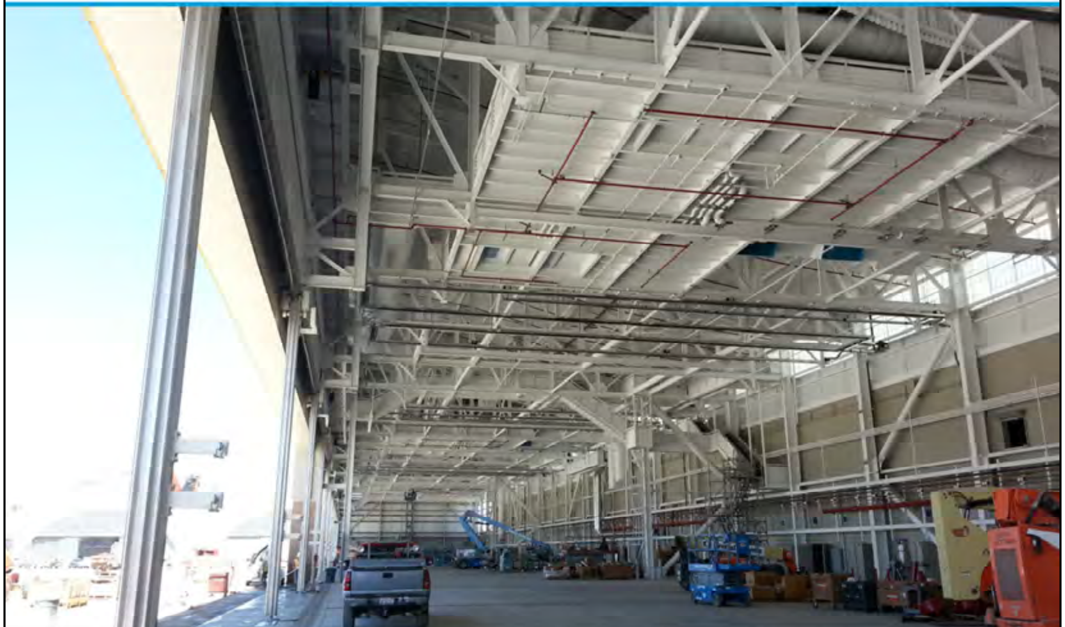
Aircraft Protective Structures

- UFGS 13 31 33 FRAME SUPPORTED MEMBRANE STRUCTURES FOR PROTECTION OF AIRCRAFT
  - Lists of Reference Publications and Standards
  - Lists of all Design and Construction Submittals for Government Approval
  - Design Loads and Structural Standards for compatibility with adjacent hangar designs
  - Required Warranties

Aircraft Protective Structures

- UFGS 13 31 33 FRAME SUPPORTED MEMBRANE STRUCTURES FOR PROTECTION OF AIRCRAFT
  - Minimum Materials and Quality
    - Steel only structures of a minimum uncoated thickness
      - Specific Detailing Requirements
      - Prohibition on Cable Bracing; Preference to not use Tension Only
    - PVC coated polyester fabric membrane characteristics
      - Minimum fabric weight and fabric construction type
      - UV Stabilized and waterproof
      - Flame Retardant and self extinguishing
      - Temperature and Strength Requirements
      - Recommendations for use in harsh environments
  - Construction Requirements

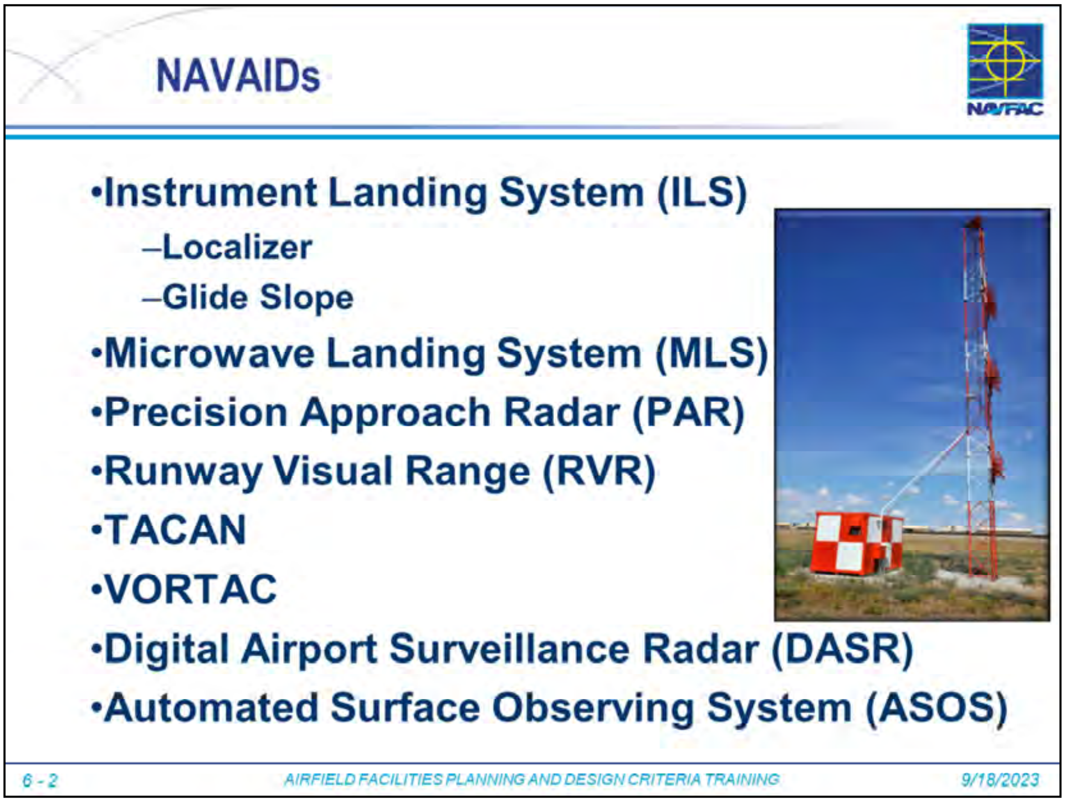
Break



Section 6 – UFC 4-133-01
Air Traffic Control Facilities

Aircraft Hangars & Other Airfield Structures

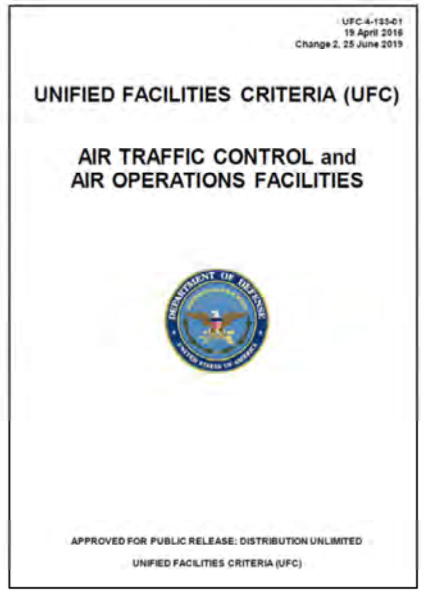
9/18/2023



- Rich just finished introducing folks to NAVAIDS, reviewing:
  - Several different system components
  - Permitted within the Primary Surface because "fixed by function"
  - Frangible where appropriate
  - Shelters/Backup Generators outside primary surface if feasible

UFC 4-133-01 Air Traffic Control

- Chapters:
  1. Introduction
  2. Planning and Layout
  3. General Requirements
  4. Special Design Requirements
  5. Functional Data Sheets
- Appendices



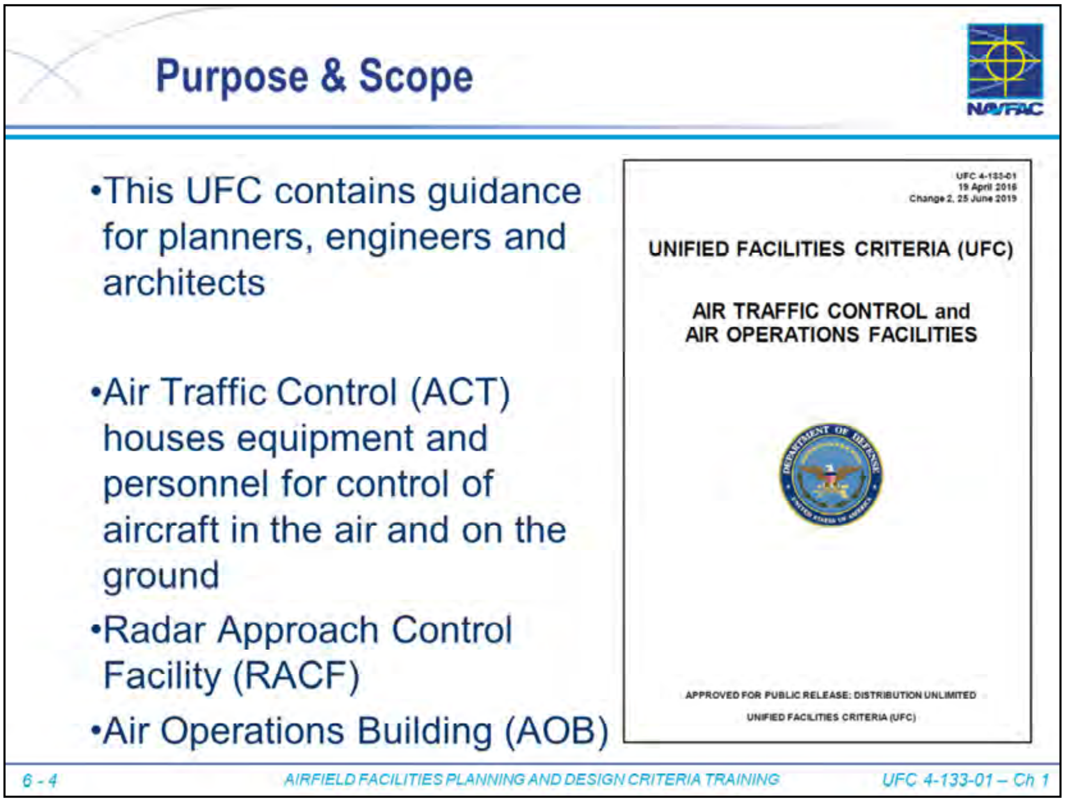
UFC 4-133-01
19 April 2016
Change 2, 25 June 2019

UNIFIED FACILITIES CRITERIA (UFC)

AIR TRAFFIC CONTROL and
AIR OPERATIONS FACILITIES

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

UNIFIED FACILITIES CRITERIA (UFC)



These three facilities may be separate structures or combined into a single structure.

Air Traffic Control Tower CATCODE 14170

Radar Air Traffic Control Facility (Radar Approach Control Facility) CATCODE 13371

Air Operations Building CATCODE 14140

IFR Room in the RATCF (Radar Air Traffic Control Facility) is connected to all airfield facilities and infrastructure.

Airport Surveillance Radar

Transmitter and Receiver Sites (talk to the aircraft)

TACAN (Tactical Air Navigation) which is the military NAVAID version of the civilian VOR (aircraft to find airfield)

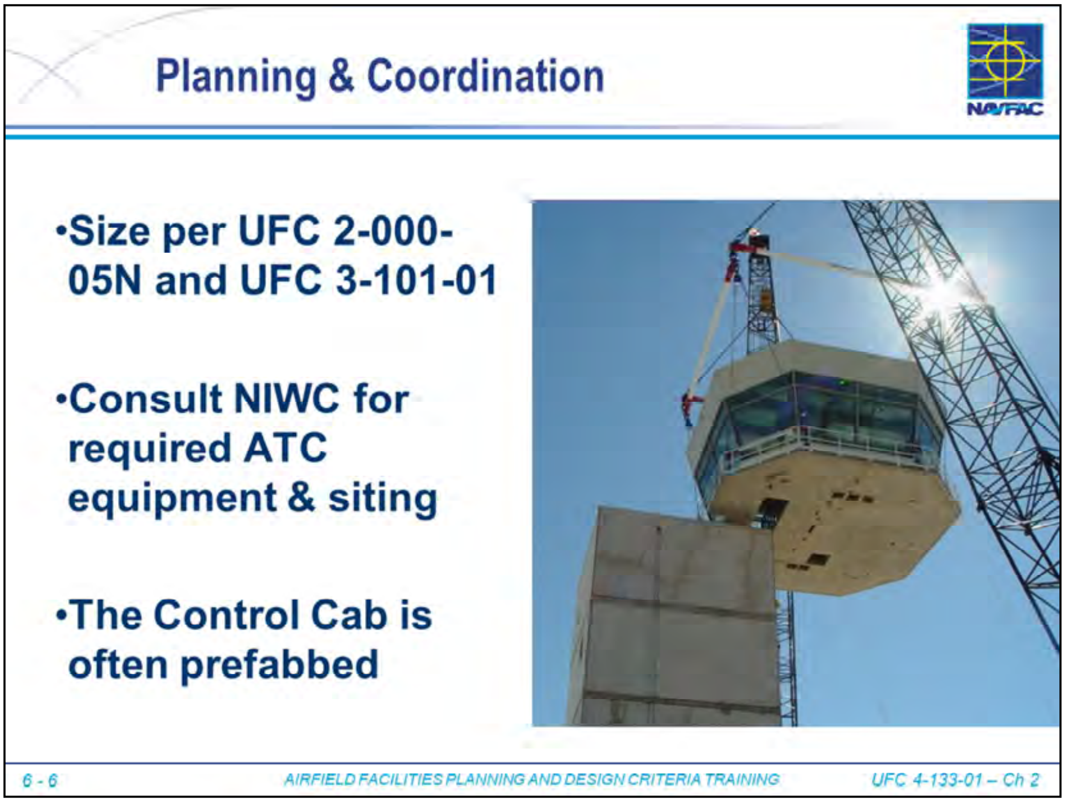
ILS (Instrument Landing System) for Instrument landing of aircraft

PAR (Precision Approach Radar)

ASOS provides weather information to pilots through the ATCT

Flight Planning / Weather Office for pilots to file flight plans and be briefed.

ATCT (Air Traffic Control Tower) may be part of the RACF or may be stand-alone. Controls airfield lights and must have visibility of all aircraft movements.



Naval Information Warfare Center (NIWC), formerly known as SPAWAR, must be contacted, consulted and involved in all steps.

Coordinate and plan for the transfer to the new ATC. Include appropriate funding.

Temporary ATC facilities (ATCT/RATCF) may be required. Airfield must remain operational during construction.

Demolition of old ATC facilities CANNOT happen until the new facility is operational.

If required, and when approved, CCTV cameras may be used to view taxiways and parking areas.

Navy has been trying to comply with the FAA requirements if the Installation has the available real estate.

Location can drive the height of the control tower, which has a large impact on the required funding.

Planning & Coordination – Table 2-1

Table 2-1 ATCT Cab Controller and Space Allowances

ATCT Service Criteria	Typical ATC Controller Positions[1]	Cab Area (SF)	
Army			
Standard Cab 3 positions and 1 supervisor	4	600 Max NSF[2]	Based on AR 420-01 and TC 3-04.81
Navy			
Standard Small Cab 2 positions and 1 supervisor	3	370 GSF[3]	Based on NAVAIR 80-T-114
Standard Medium Activity Cab 3 positions and 1 supervisor	4	500 GSF	
Standard Large Cab 4 positions and 1 supervisor	5	620 GSF	
Air Force			
Standard Cab 3 positions and 2 supervisors (including SOF – Supervisor of Flying)	5	540 NSF + 64 NSF for each additional position	Based on AFMAN 32-1084

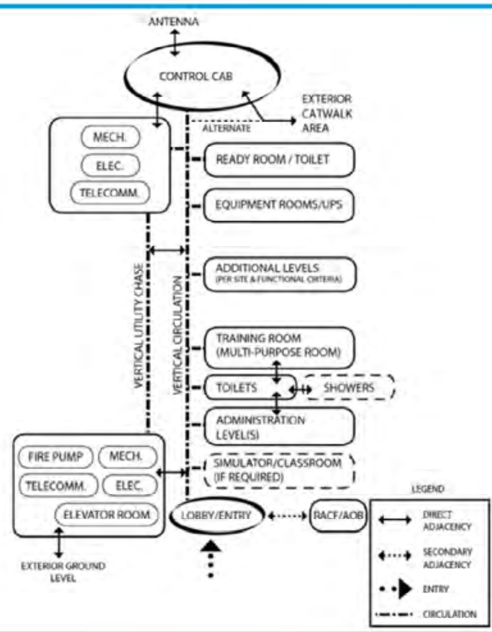
ATC electronic equipment must fit in the designated room. Too often, the space allocated in planning documents fail to account for the equipment to be installed.

Planning & Coordination – Table 2-2

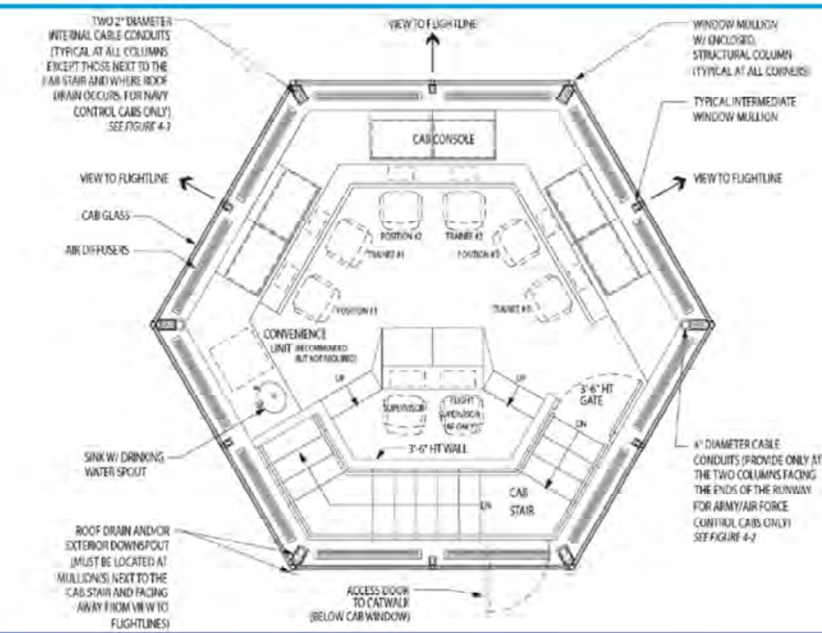
Table 2-2 ATCT Functional Program Areas

Functional Program Area	Description
Main Entrance Lobby/Vestibule (Table 5-1.1)	Main entrance to the ATCT. Include vestibule in cold weather climates.
Elevator and Elevator Lobby (Table 5-1.2)	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.
Elevator Machine Room (Table 5-1.3)	A room housing elevator machine equipment.
Tower Shaft Mechanical Room (Table 5-1.4)	A room housing mechanical equipment servicing the Tower Segment with a lockable door.

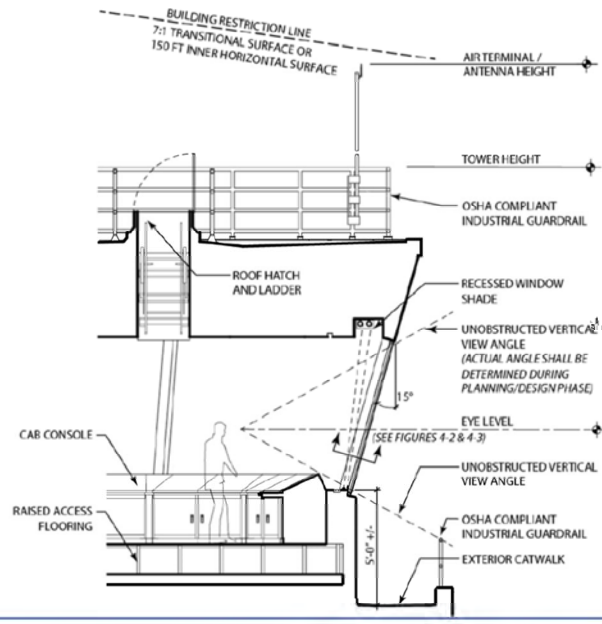
Planning & Coordination – Figure 2-1



Planning & Coordination – Figure 2-2



Planning & Coordination – Figure 2-3

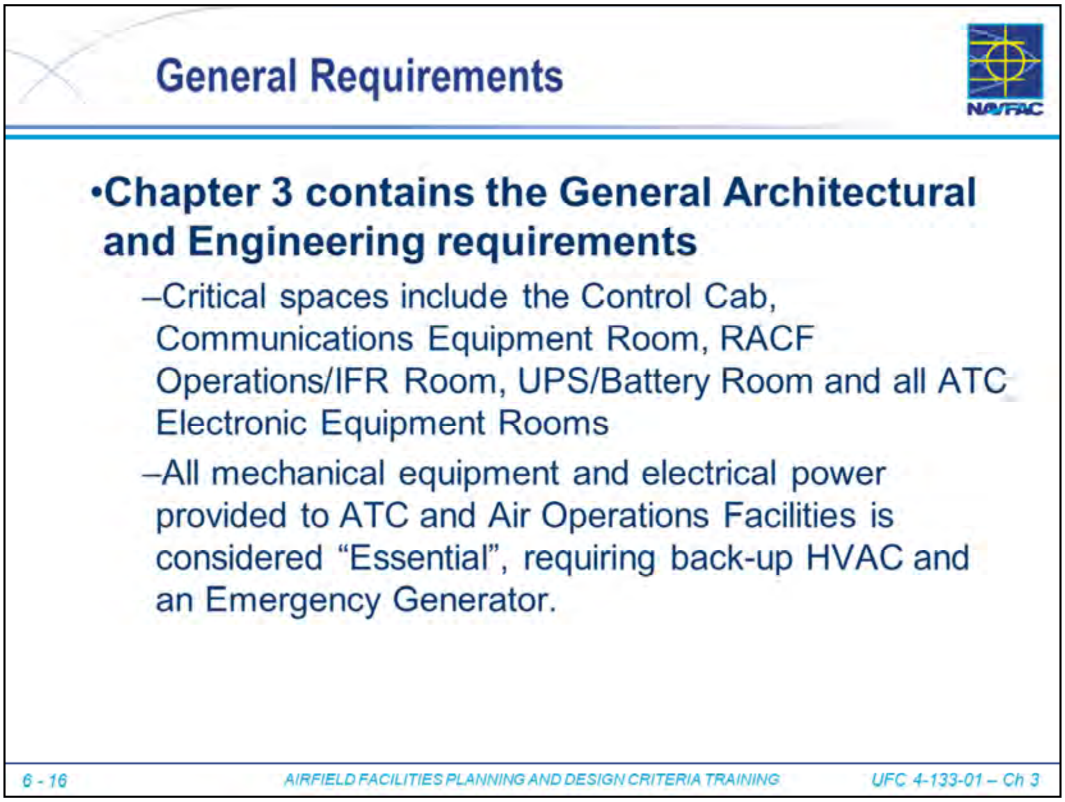


Functional Tower Shaft: Typically pertains to low and intermediate activity ATCTs where operations support functions can be located on most floors in the tower shaft. This eliminates the need for an administrative support building.

Non-functional Tower Shaft: Typically pertains to major activity ATCTs where operations support functions cannot fill up all the floors in the tower shaft. The shaft includes only unoccupied spaces (i.e. egress stair, elevator and service shafts, etc.) to reduce the floor footprint for cost efficiency. Two to three floors immediately below the cab can be used for administrative support and equipment spaces (these floors can have a wider footprint).

In either case, the preferred layout for the tower shaft is rectangular or square to maximize the efficiency of the layout of the internal spaces.

Non-functional shafts may get you out of the AT requirement for progressive collapse (fewer than 11 people).



100% redundancy is required for critical spaces, including fuel storage capacity for a minimum of 36 hours for emergency generator.

Risk Category IV results in the facility being mission essential.

If more than 11 occupants, more than one occupant per 430gsf and more than three stories then the tower must be designed for progressive collapse.

Risk Category and Progressive Collapse both have a large funding impact, must be decided during planning (DD1391 development) phase.

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

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

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"

Use Basic Design Requirements (ASTM E1886) if Risk Category III (see slide #16)

Use Enhanced Design Requirements (ASTM E1996) if Risk Category IV (Mission Essential) or if in a (DoD) wind borne debris region.

UFGS 08 88 58 ATC Tower Cab Glass

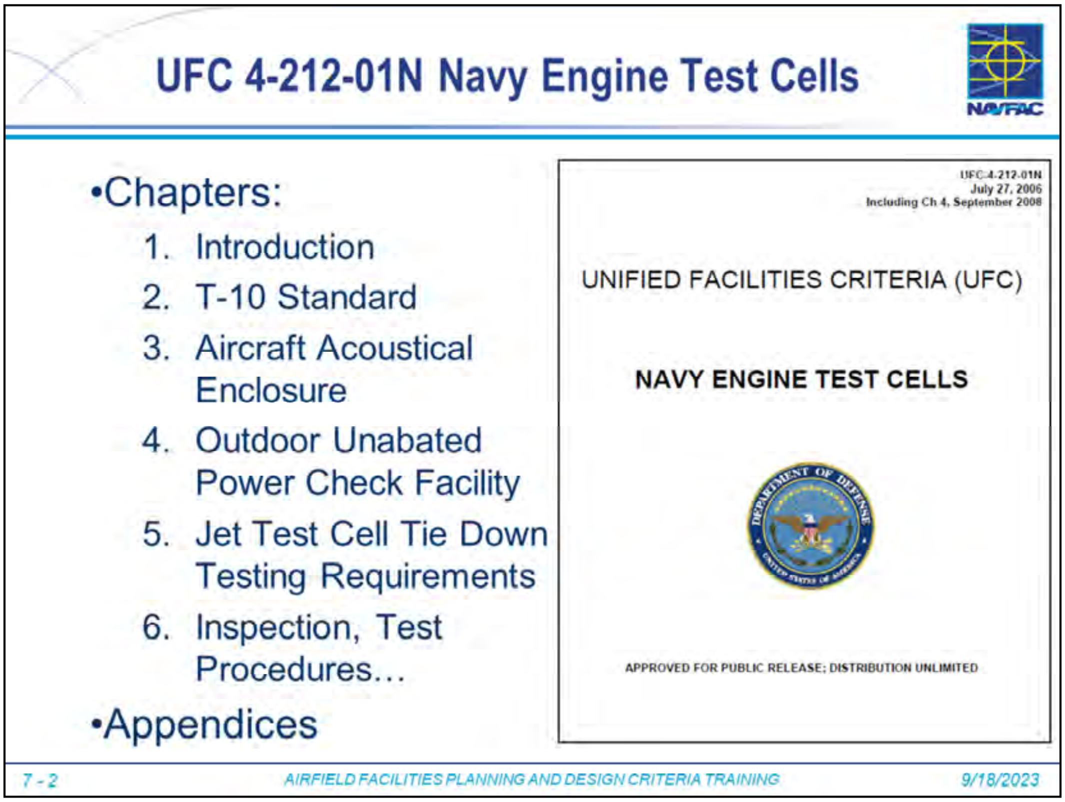
- **Part 2 Notes to Editor/Designer:**
  - **Must set requirements for Delegated Design**
  - **Component Requirements:**
    - Glass Materials
    - Tower Cab Glass Assemblies
    - Setting and Sealing Materials
    - Fabrication
- **Part 3 Execution Requirements**
  - **Preparation, Glass Setting, Cleaning, Protection**
  - **Maintenance Manuals**

Break

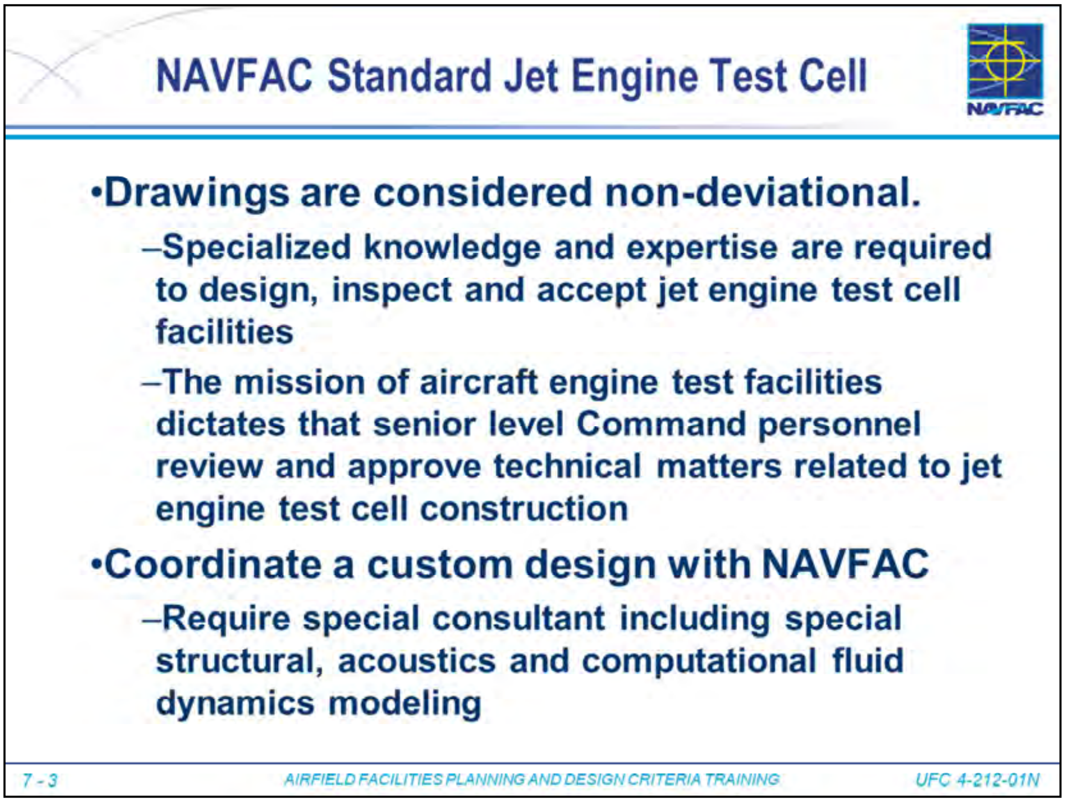
Section 7 – UFC 4-212-01N Navy Engine Test Cells

Aircraft Hangars & Other Airfield Structures

9/18/2023



Aircraft Engine Test Cell Building (Non-NAVAIR DEPOT) CATCODE 21101



NFESC, NAVAIR, and NAVFAC facility engineering commands must jointly provide technical support for the ROICC offices administering aircraft engine test facility contracts. To avoid conflicts, rework, and unauthorized standard design deviations, NFESC, and NAVAIR are designated as the Navy's expert for airflow configuration management and safety. The designer of record and the technical expertise resident within each FEC or EFD supports all routine facility design technical issues. Deviations made in the field can lead to construction of facilities that will not be accepted and approved for testing of jet engines by NAVAIR. Deviations to facility designs affecting airflow or safety are not encouraged.

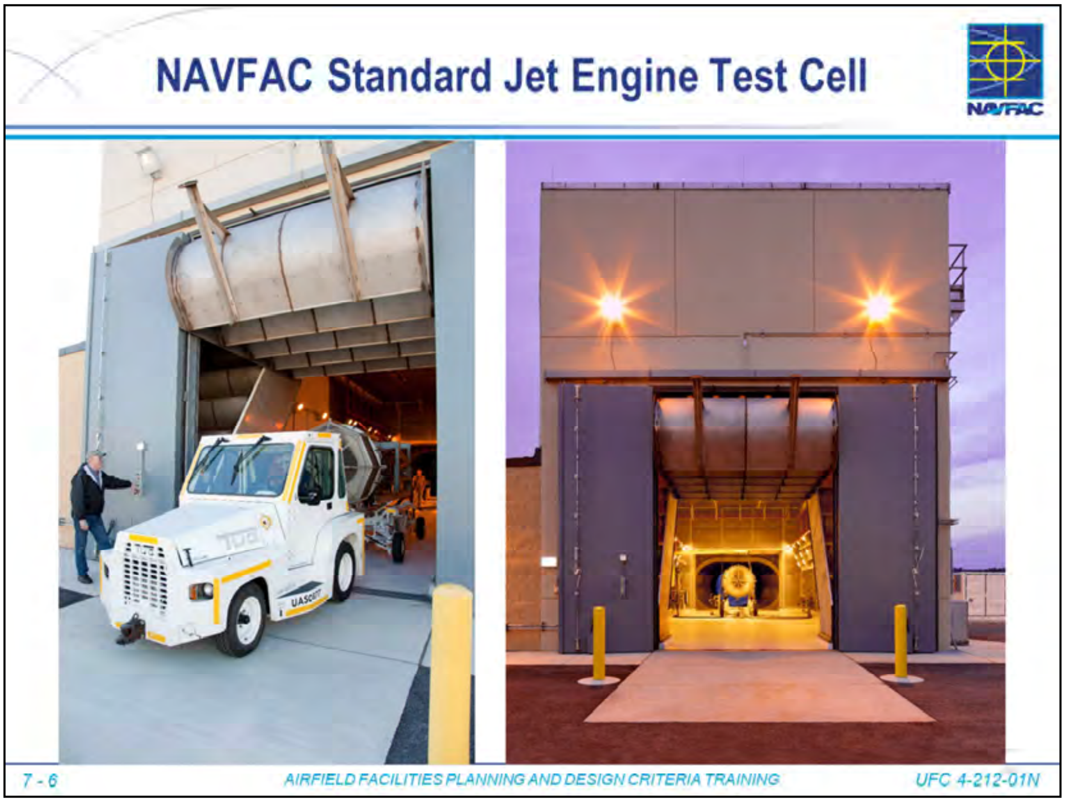
NAVFAC Standard Jet Engine Test Cell

- Test Cell Enclosure (Run Room & Air Intake)
- Exhaust Stack
- Control Room
- Fuel Source
- Air Start
- Augmentor

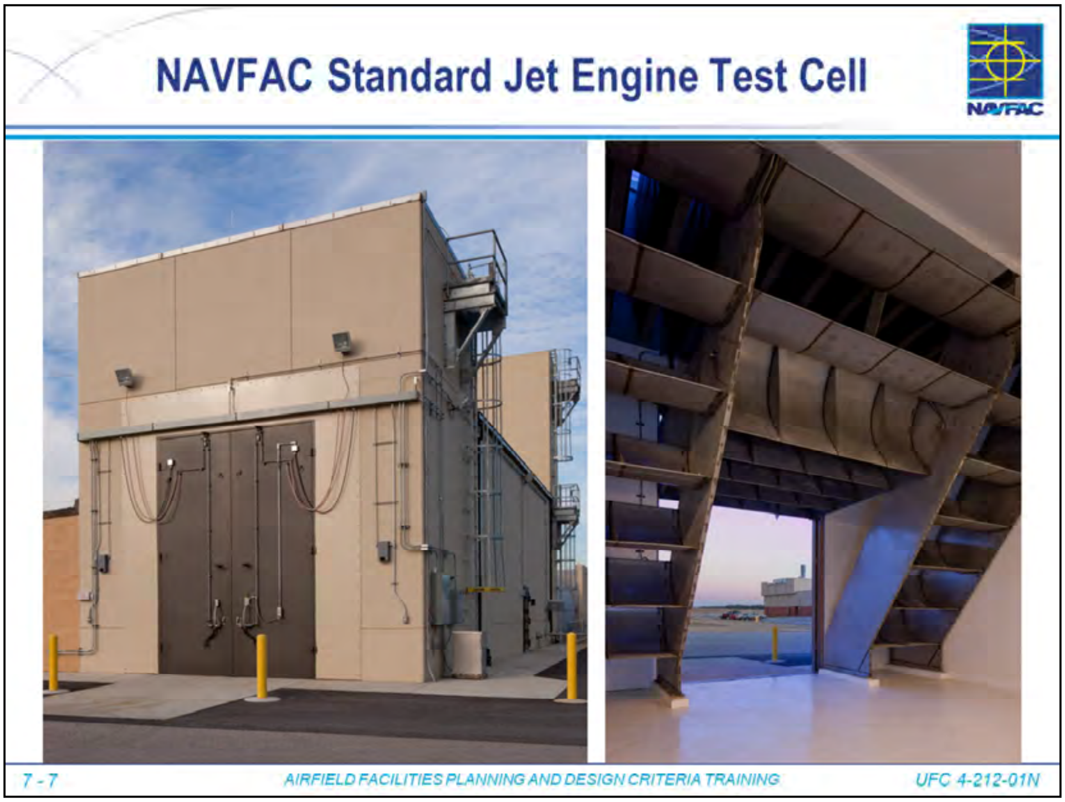
Test Cell Enclosure (Run Room & Air Intake)

Augmentor

Exhaust Stack



Test Cell Enclosure (Run Room & Air Intake)

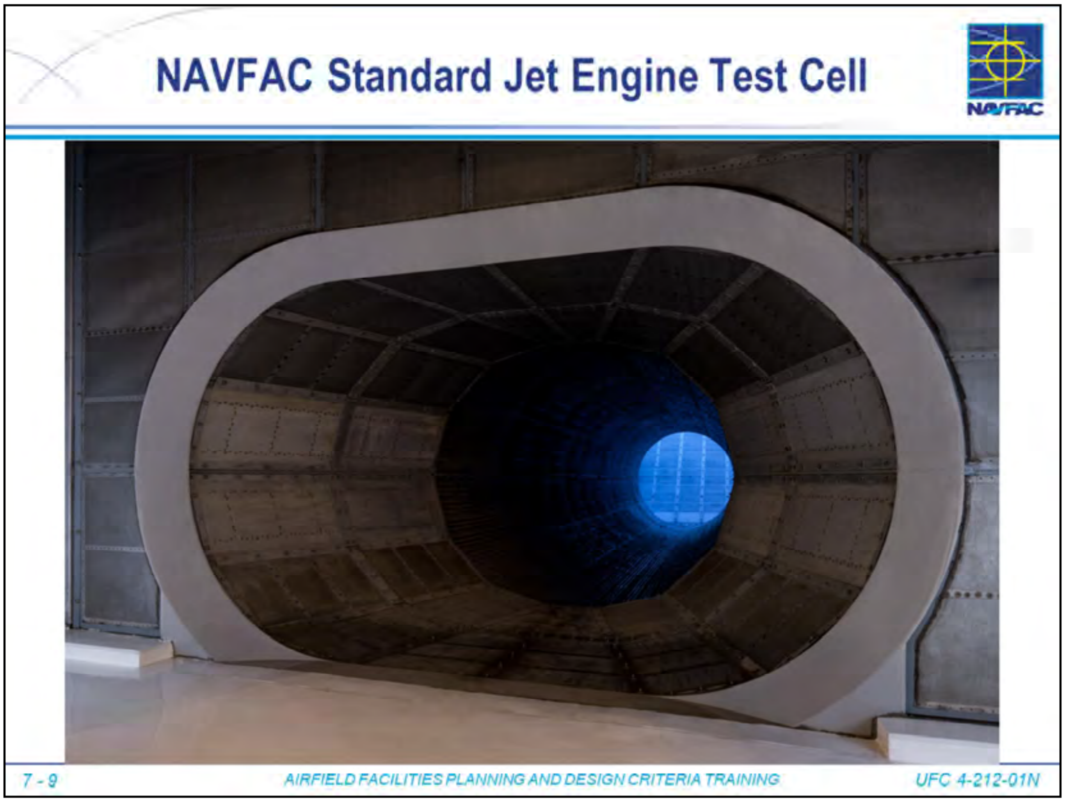


Test Cell Enclosure (Run Room & Air Intake)

Test Cell Enclosure (Run Room & Air Intake)

Control Room

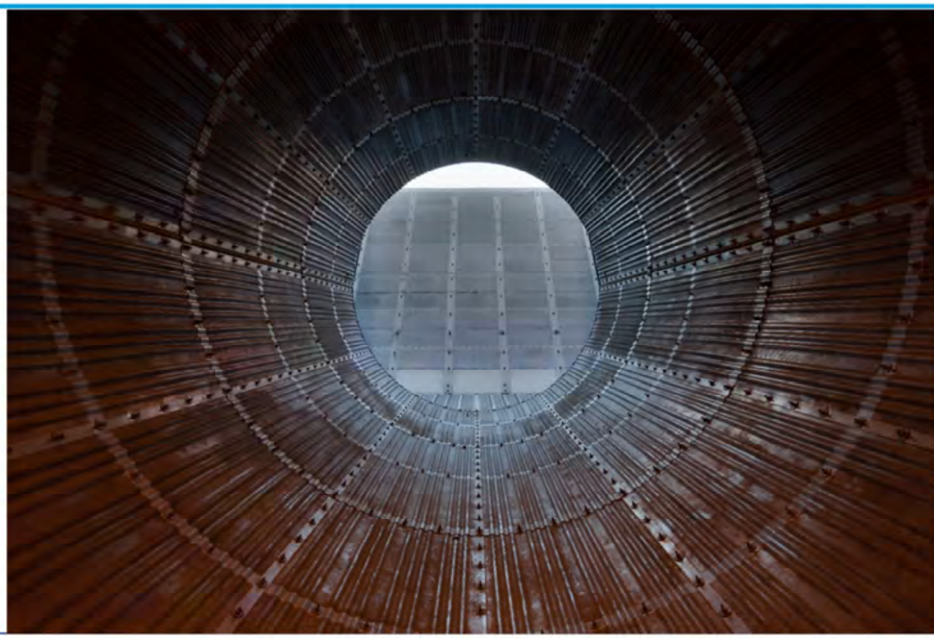
Augmentor



Augmentor

Exhaust Stack

NAVFAC Standard Jet Engine Test Cell



7 - 10 AIRFIELD FACILITIES PLANNING AND DESIGN CRITERIA TRAINING UFC 4-212-01N

Augmentor

Exhaust Stack

NAVFAC Standard Jet Engine Test Cell

7 - 11 AIRFIELD FACILITIES PLANNING AND DESIGN CRITERIA TRAINING UFC 4-212-01N

Test Cell Enclosure (Run Room & Air Intake)

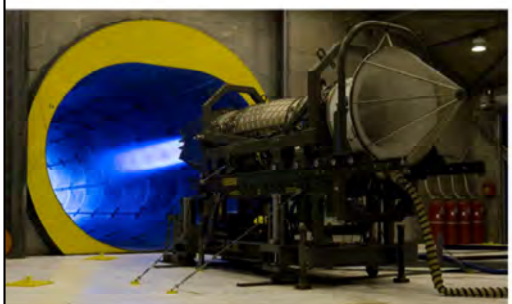
Augmentor

Control Room

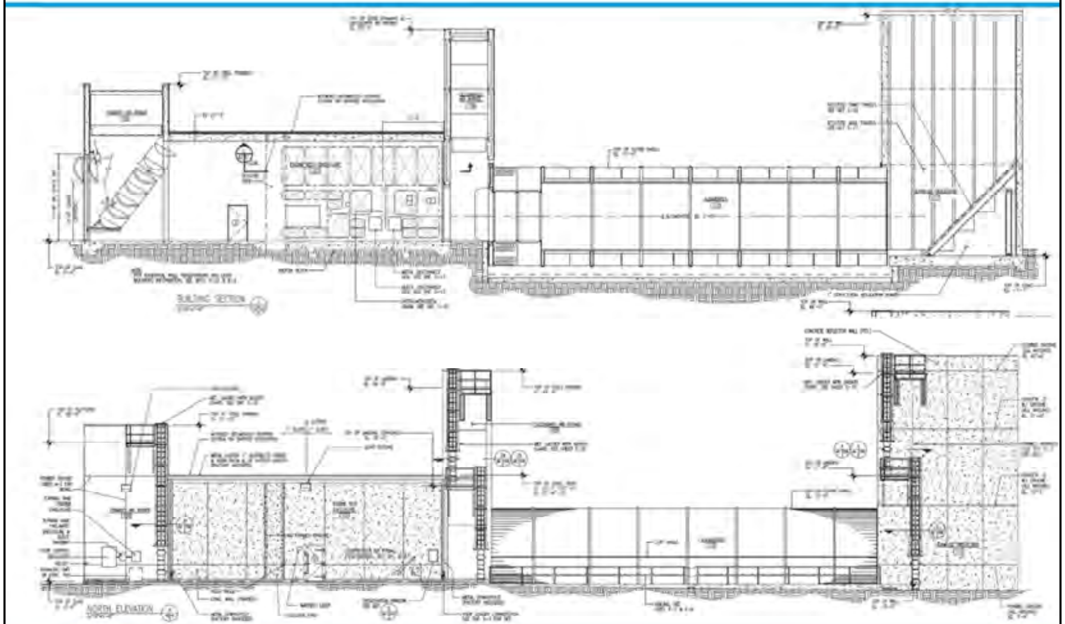
Test Cell Enclosure Run Room

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



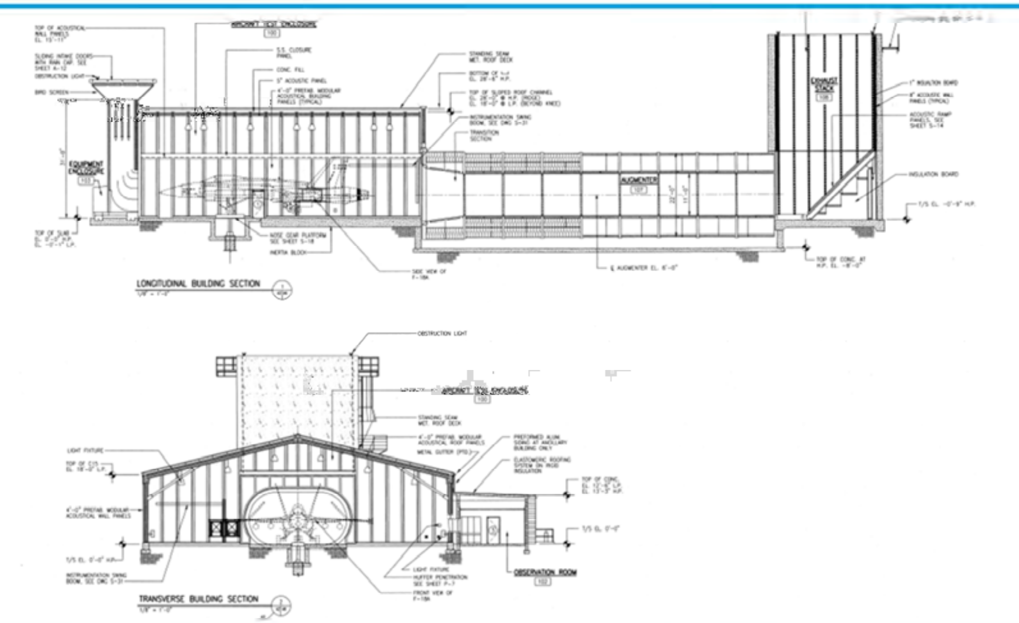
T-10 Standard Jet Engine Test Cell



Aircraft Acoustical Enclosure

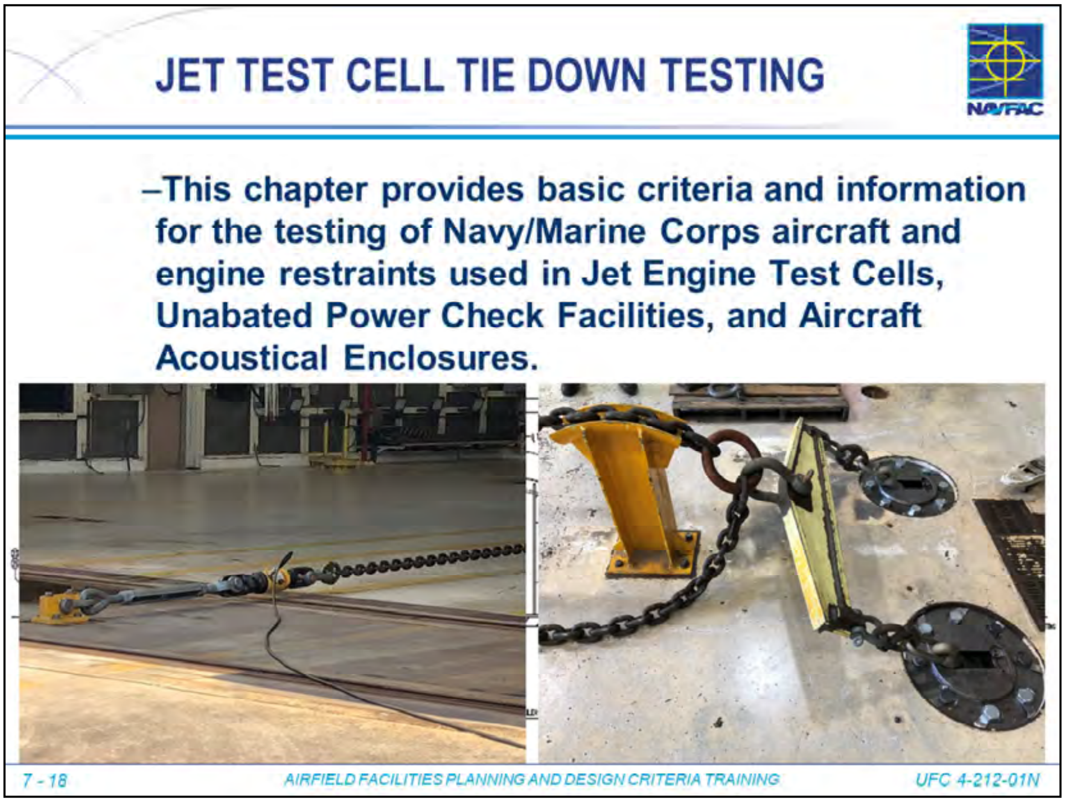
- List of NAVFAC Standard Drawings are included in Paragraph 3-4
- List of NAVFAC Standard Specs are included in Paragraph 3-5

Aircraft Acoustical Enclosure



Outdoor Unabated Power Check Facility

–List of NAVFAC Standard Drawings are included in Paragraph 4-4



Use the following guidance for inspection and testing to determine that all component parts of a land-based aircraft and engine restraint system are in a safe and properly maintained operating condition.

Naval Air Station activities regularly engaged in aircraft engine overhaul shall inspect and proof test their aircraft engine restraints to the frequency shown in Table 5-1 and 6-1.

T-56 Turbo Prop Tie-Down Fittings

- **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

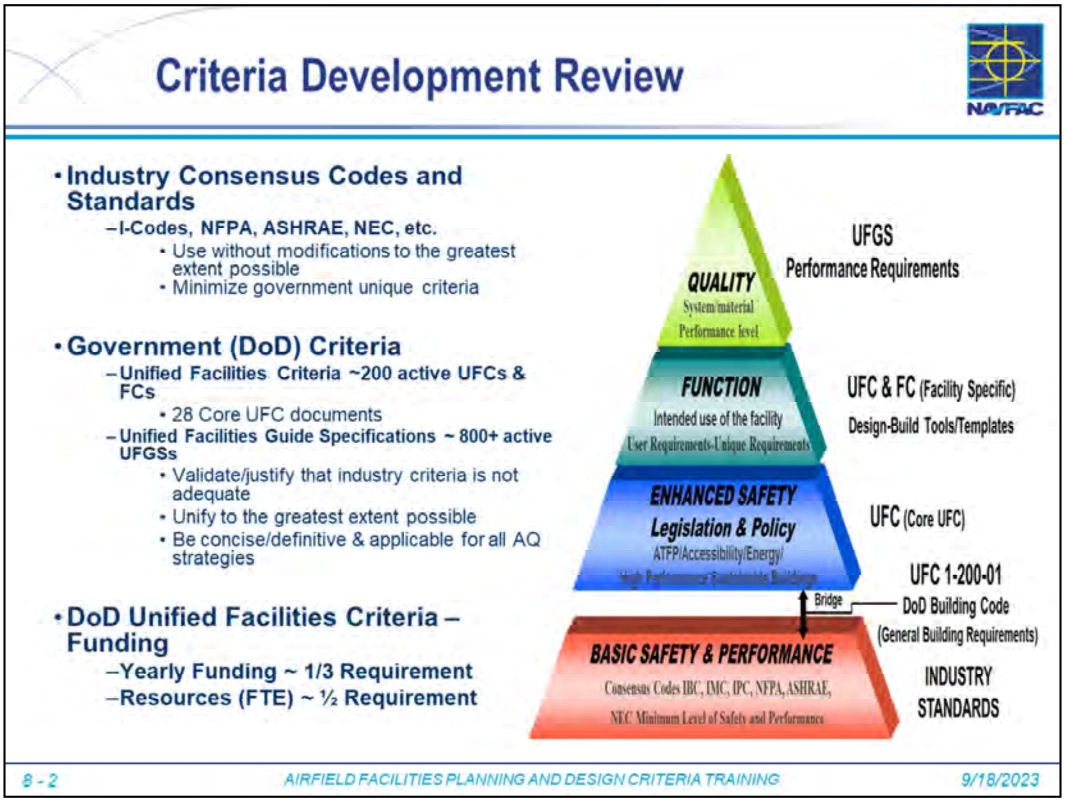
- Test Cell Enclosure is designed for 4" of water cell depression; inlet velocity should be less than 50 feet per second
- Test Cell has a standard airflow configuration enabling the engine to be tested within 3% of gold plate data for standard day & temperature
- Noise Criteria: not to exceed 85 decibels at 250 feet

Naval Facilities Engineering Command

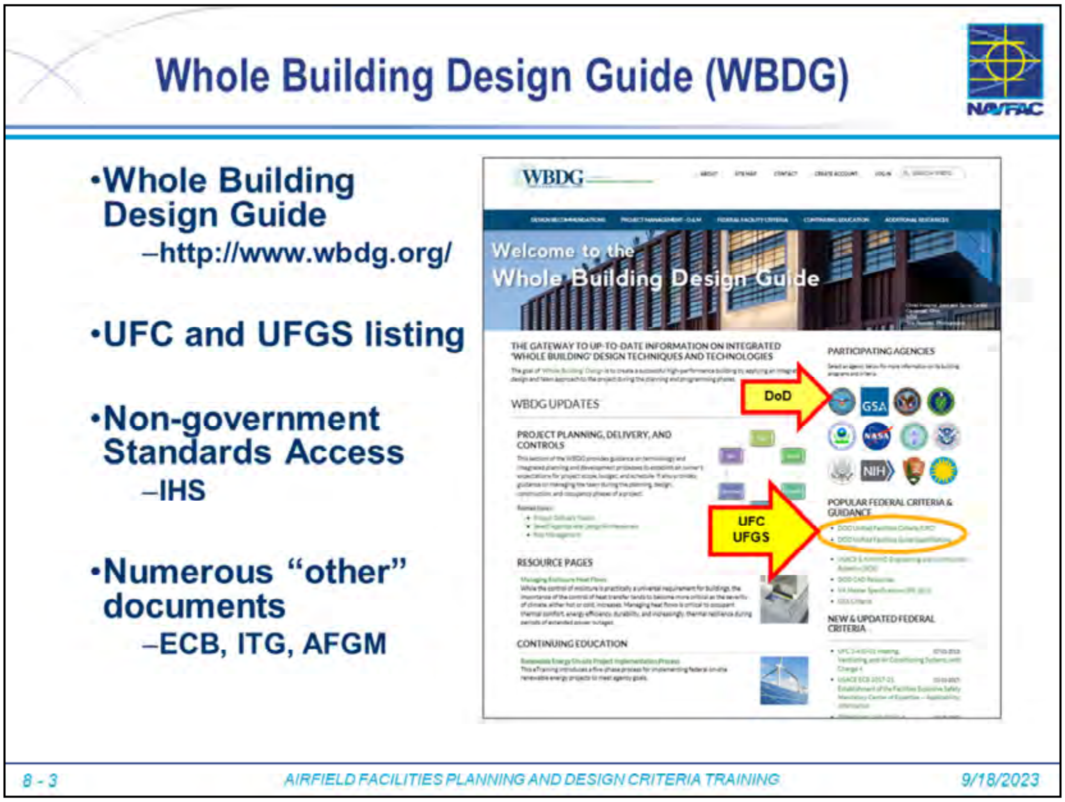
Section 8 – Closing Thoughts, Questions & Feedback

Aircraft Hangars & Other Airfield Structures

9/18/2023



1. Graphic shows how criteria is layered
2. Starts w/ Industry standards and layers government policy, then facility-type lessons learned.

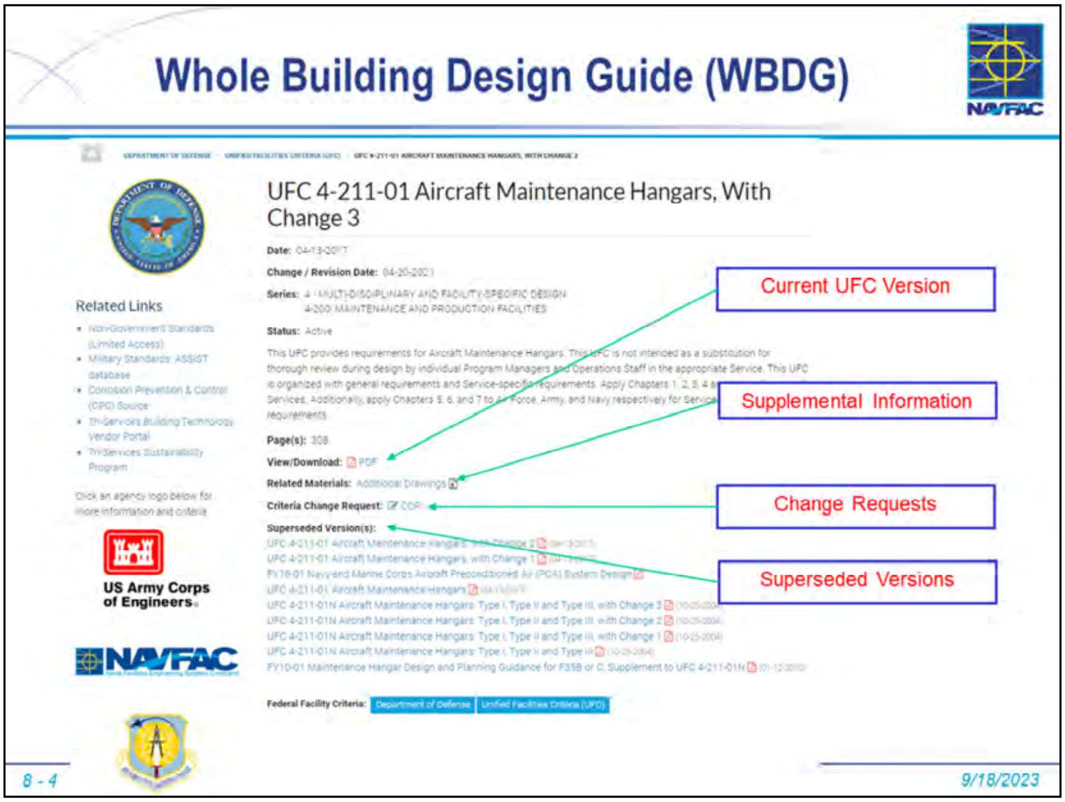


All criteria and CCRs reside on WBDG

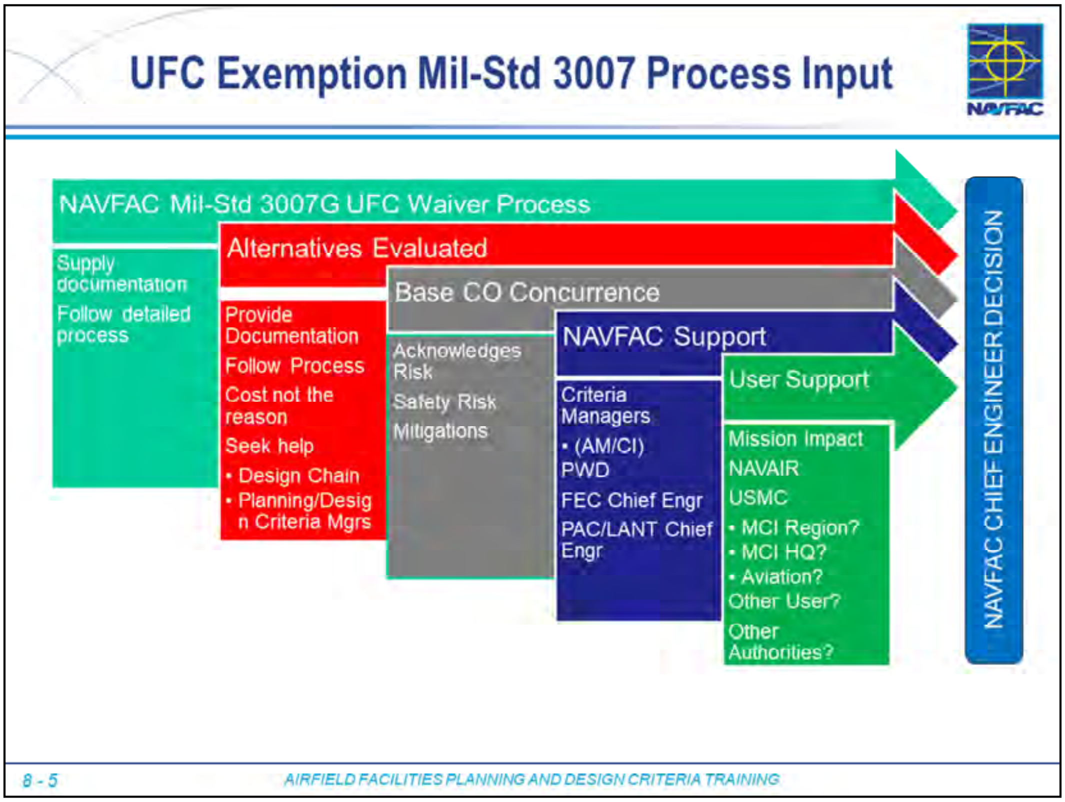
Navy issues interim technical guidance (ITG)

Army issues engineering construction bulletins (ECB)

Air Force issues guidance memorandums (AFGM)



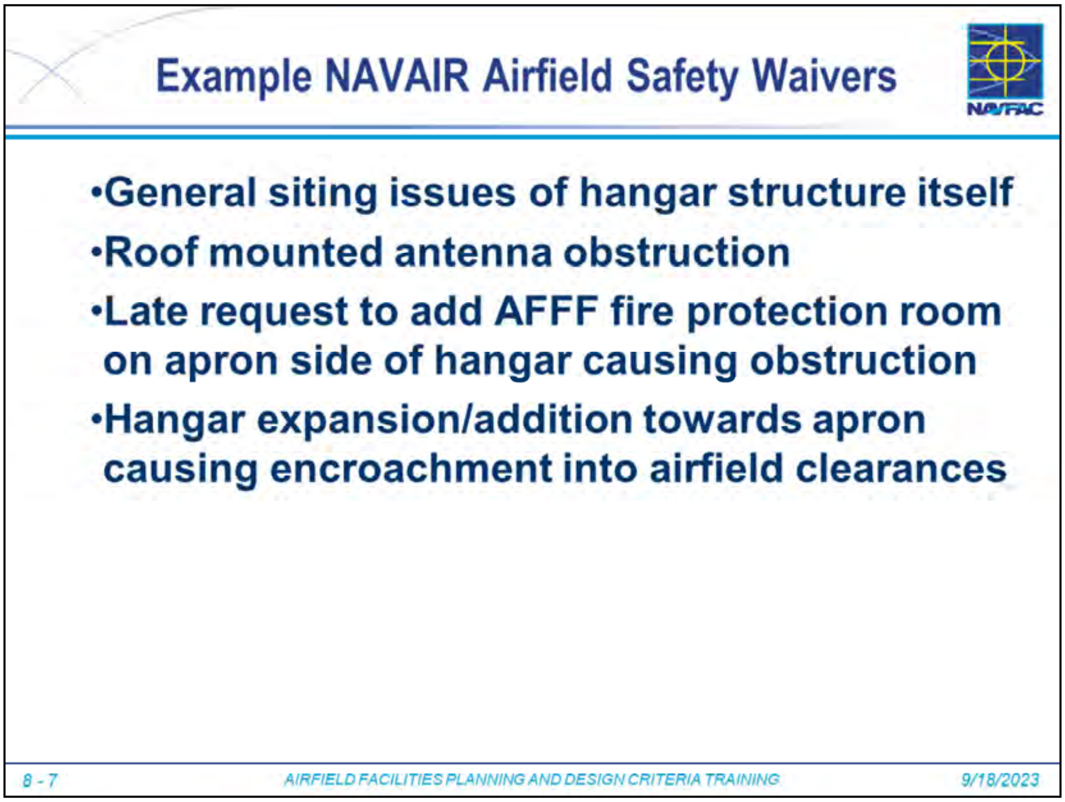
- Key information about a UFC is listed on each UFC home page
    - Current Version date and link to pdf
    - Related Materials like Interim Technical Guidance
    - Change Request Button link to CCR Form
    - Superseded Versions



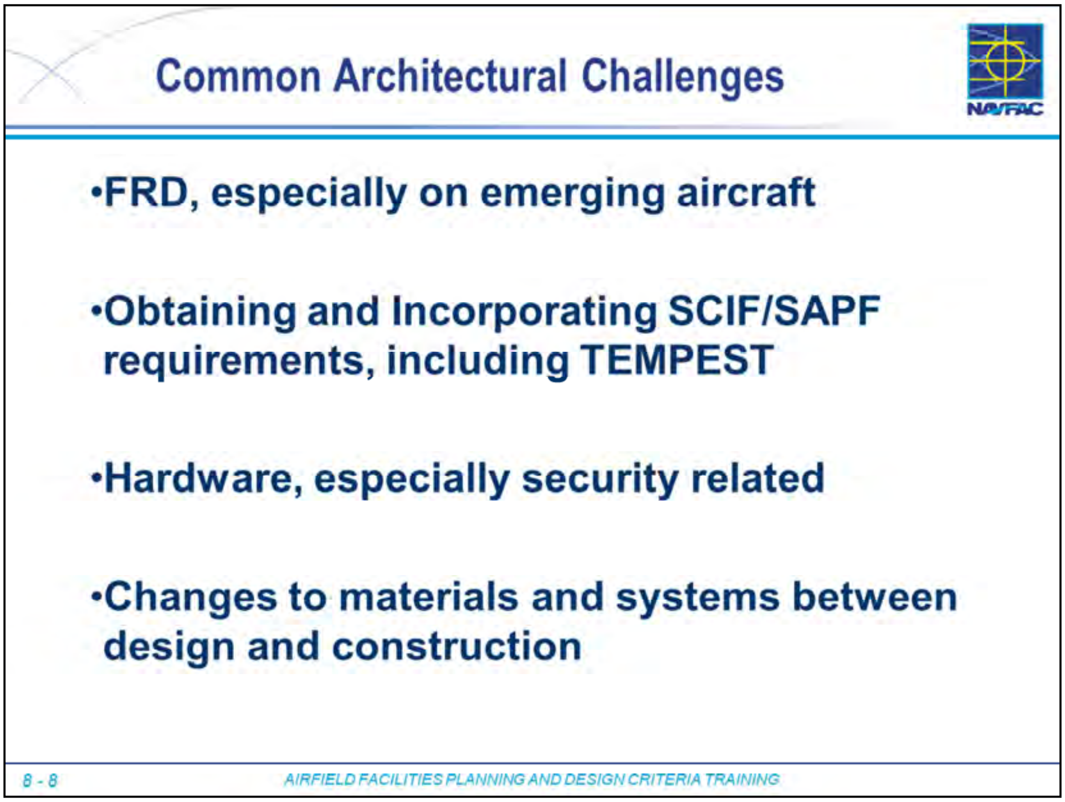
- The UFC Exemption shows parallel input required. (Does not require NAVAIR ASW unless siting is issue. See airfield class for processes.)
- Design UFC Exemption issues:
    - Not Common
    - Structural, Mechanical, Electrical, Fire protection Issues.
    - UFC Hangar Type Variation (May require Planning, Design, and Customer support)
        - Cannot provide bridge crane
        - Cannot provide fire protection (facility doesn't have fueled aircraft)
        - Issues regarding hangar door constraints (opening size)

Example Facility UFC Exemptions "Inside Hangar"

- Request to eliminate foam 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



- See airfield planning class for planning and siting approval and related NAVAIR Airfield Safety waivers.
- These approvals/waivers are different and additive to NAVFAC Design UFC Exemptions per Mil-Std 3007G.
- Note: reference the NAVAIR waiver slides/process in Day 1 (Airfield) Course for additional information.

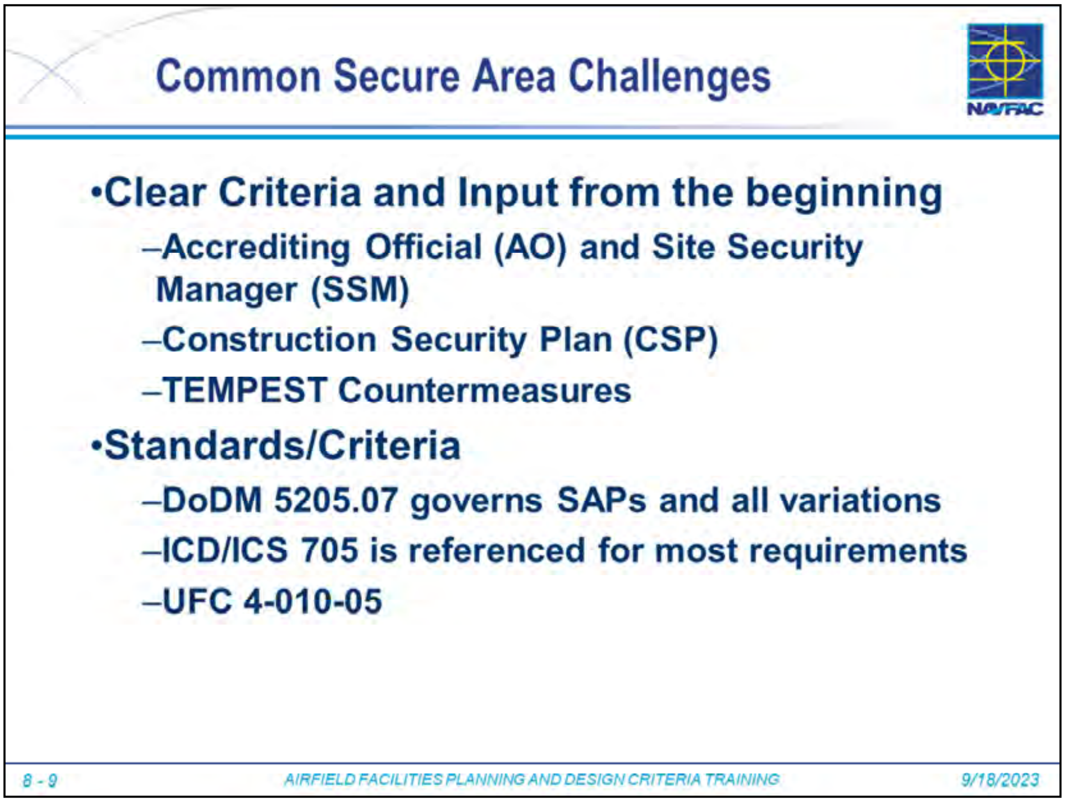


Site Security Manager (SSM) is responsible for assembling and submitting documents for Accrediting Official (AO) review and approval.

Getting the following documents early in the planning and design process

- Construction Security Plan (CSP)
  - A preliminary CSP must be developed during the planning phase to capture the scope and cost associated with security
  - CSP must be finalized and approved by the AO during design phase
- Fixed Facility Checklist (FFC)
  - Need Preliminary FFC early in the design phase.
- TEMPEST Addendum to the FFC
  - Needs to be submitted early in the design phase to incorporate TEMPEST Countermeasures

Getting AO and SSM involvement during design (and approval of CDs)



Note: there are differences in requirements and interpretations in these standards/criteria

Common Structural Challenges

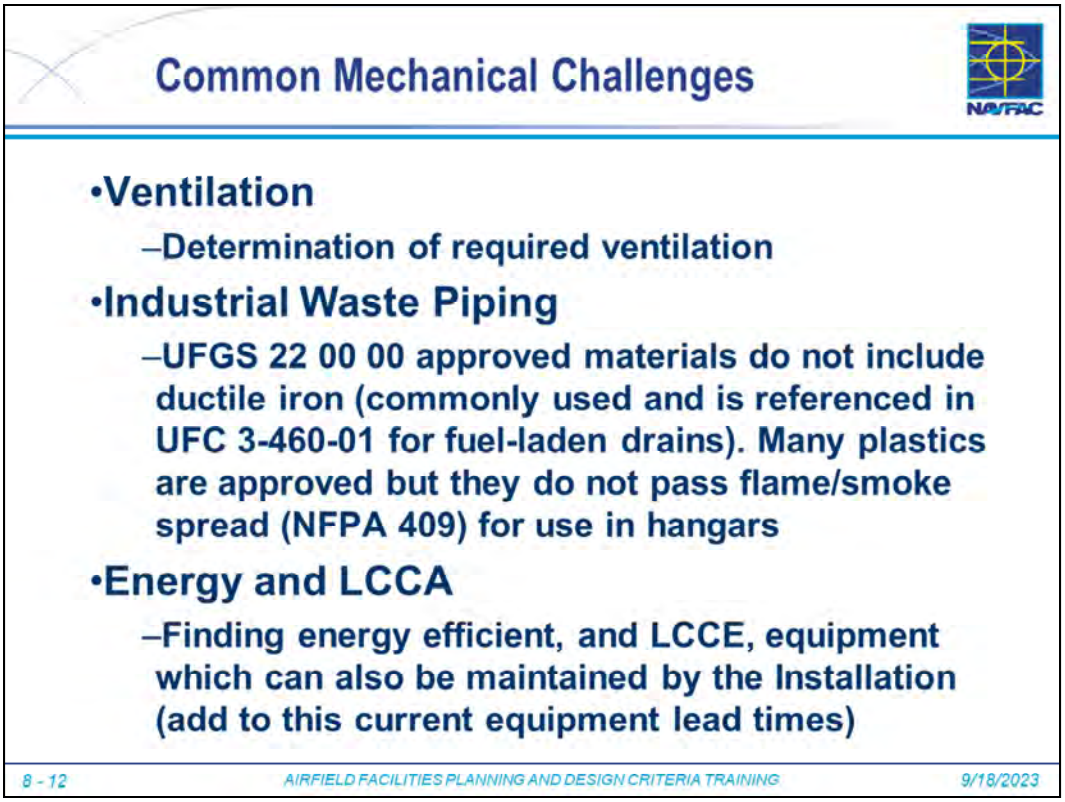
- Changes in Codes
  - 1994 Northridge Earthquake Changed Seismic
  - 2010 ASCE Changed Wind Loads
  - 2017 UFC 4-211-01 Changed to Risk Category III
  - Upgrading a hangar with 1, 2 or 3 of the above can be a very costly proposition
- Soil Conditions
- Tall, Long Span Structures, Design/Erection
- Expansion Joints
- Economy vs. Flexibility

When between changes in criteria, details are not clear. Need confirmation during design phase that assumptions regarding requirements are correct. If incorrect, need sufficient time to modify design for the correct requirements before contract documents are sealed.

Upgrades to an existing water supply within a hangar construction project are difficult to accomplish (or not allowed). However these have been worked into many projects since they are required for system functionality. This additional work is not always included in the project scope, resulting in unanticipated design and construction cost.

If a specific qualification is required by specification, do not waive it unless you want to see the same unqualified person think he can bid the next job. Begin red zone meetings 6 months before turnover on a large project. Make a schedule and keep to it. Don't let the contractor proceed into red zone without clear, detailed schedule and completion level to back it up. Contractor's fire protection engineer needs to be contracted to be fully engaged in the project, especially during red zone. Acceptance testing plan and procedures should be submitted all in advance since they typically are not sufficiently detailed, thought out or coordinated and require resulting. Test plan should be a line item on the red zone schedule.

A table of contents for fire protection test reports in the specs would assist the contractor in preparing the report, without requiring resubmittal. Include flushing plan, apparatus, measured flushing flow rate per outlet with report. Include test data such as intelligibility and audibility test data.



Determination of required ventilation, particularly when considering heating: UFC 4-211-01 3-5.2 and 3-5.3 would benefit from a significant rewrite with a focus on simplicity. One place specifies 0.5 CFM/SF, another switches to units of air changes per hour but only when using a specific type of heater, etc. There are also other documents with conflicting requirements – sorting through all of these to determine the correct value is a challenge.

IW: UFGS 22 00 00 Table 1 includes one Service F which is broadly labeled as “corrosive service” which is often applied to hangar trench IW, but the approved piping materials listed do not include ductile iron which is commonly used in similar applications and referenced in UFC 3-460-01 for fuel-laden drains. Other materials listed in Table 1 are mostly plastics which do not pass flame/smoke spread (NFPA 409) for use in hangars. This has effectively limited most projects to specifying either polypropylene or fiberglass pipe, the latter being discouraged in UFC 3-460-01 for fuel-laden influents… Also UFC 4-211-01 does not appear to discuss or prescribe piping materials. It would be helpful to see more prescriptive guidance in UFC 4-211-01 which is coordinated with both UFC 3-460-01 and UFGS 22 00 00

Common Electrical Challenges

- Collecting all required power needs for GFGI equipment and AGE
- Cybersecurity Design Input
- Power/Comm to Furniture and Equipment
  - Final Selection by Contractor
  - Model Changes between Design and Construction
- Class I Division 1 & 2 Construction

Common Acoustical Challenges

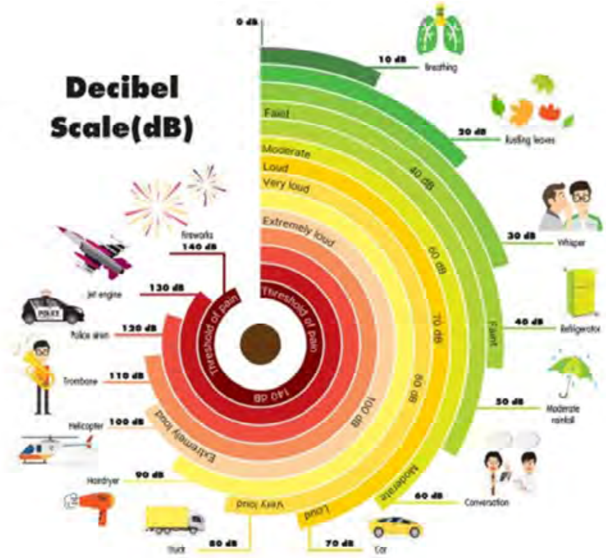
- UFC 4-211-01 Paragraph 3-3.3.3
  - Requires acoustical performance of the exterior envelope
  - References UFC 3-101-01

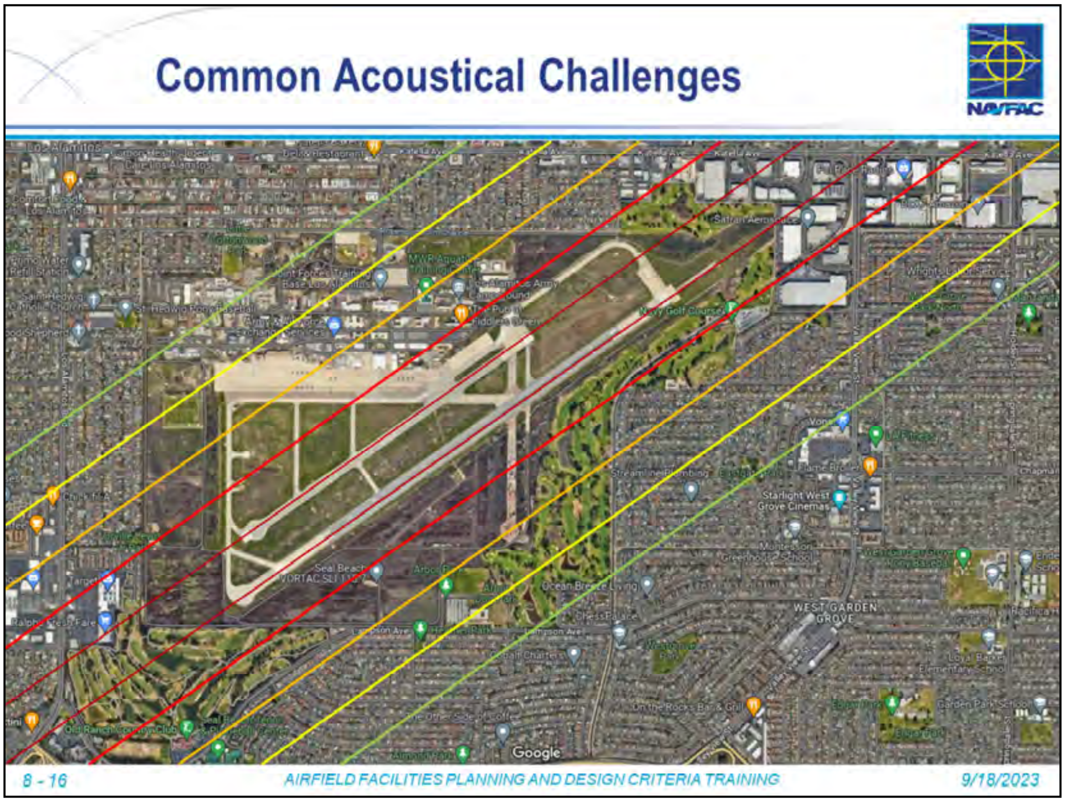
3-3.3.3 Acoustics

Provide acoustics per UFC 3-101-01 unless superseded by other criteria or the STC ratings listed in individual Functional Room Data Sheets as the basis for the sound attenuation design of the partition, door and window assemblies for the facility.

Hangar maintenance bays and maintenance shops can be high noise areas. Prevent sound from the exterior and sound from these and other noisy spaces such as corridors, toilets, elevator, machine rooms, and mechanical rooms from having negative impact on the adjacent spaces.

Common Acoustical Challenges





Aerial Image of NAS Los Alamitos from Google.com

Note: These maps are often FOUO – This acoustical map is made up and for illustrative purposes only – Do not use for actual design.

Common Acoustical Challenges

- **UFC 3-101-01 contains acoustic design requirements (OITC ratings)**
- **Where buildings are in the >75 DBA you need OITC value of 50 per Table 3-1**

Table 3-1 Building Façade Sound Isolation

Required Composite[1] Isolation of Building Façade and Roof Construction Based on Interior Background Noise Levels				
Interior Background Noise Level [2]	Exterior Sound Level at the Site (DNL or CNEL)			
	< 65 dBA	65 dBA - 70 dBA	70 dBA - 75 dBA	> 75 dBA
NC-25 or Lower	OITC 35	OITC 40	OITC 45	OITC 50
NC-30	OITC 30	OITC 35	OITC 40	OITC 45
NC-35	OITC 28	OITC 30	OITC 35	OITC 40

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Note: STC is measured between 125 – 4,000 Hz while OITC (introduced in 1990) is measured between 80 – 4,000 Hz to capture lower frequencies like street noise and air traffic.

Common Acoustical Challenges

Nominal unit thickness, in. (mm)	Density, pcf (kg/m^3)	OITC[A]			
		Hollow unit	Grout-filled unit	Sand-filled unit	Solid unit
4 (102)	85 (1,362)	34	40[B]	38	38
	95 (1,522)	35	40[B]	39	39
	105 (1,682)	36	41[B]	40	40
	115 (1,842)	37	42[B]	40	41
	125 (2,002)	38	43[B]	41	42
	135 (2,162)	39	43[B]	42	43
8 (203)	85 (1,362)	39	51	47	47
	95 (1,522)	40	51	48	48
	105 (1,682)	41	52	49	49
	115 (1,842)	42	53	49	51
	125 (2,002)	43	53	50	52
	135 (2,162)	44	54	51	53
12 (305)	85 (1,362)	43	58	53	52
	95 (1,522)	44	58	54	54
	105 (1,682)	45	59	55	55
	115 (1,842)	46	60	56	57
	125 (2,002)	48	60	56	58
	135 (2,162)	49	61	57	60

Test Specimen	24 Gauge Standing Seam Roof	8" Purlins @ 60" o.c.	Thermal Spacer Blocks	Fiberglass Insulation	2x2 Acoustical Ceiling Tile	Layers of 5/8" Gypsum Board Type X	STC	OITC
R-1	X	X	R-2.5	R-19+R-11	-	0	37	26
R-2	X	X	R-2.5	R-19+R-11	X	0	45	30
R-3	X	X	R-2.5	R-19+R-11	-	1	56	43
R-4	X	X	R-2.5	R-19+R-11	-	2	58	46

- Fully Grouted 8" CMU or Concrete Walls are Common
- Compliance with Metal Panels?
- What are folks doing for Roofs?

Common Acoustical Challenges

- Standard Doors would not comply, but exterior sound rated doors could comply
- Standard Exterior Glazing (thermally broken window) would achieve about 35, but sound rated windows could comply
- OITC design is not common, but is a current design requirement

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.

Future Hangar Related Criteria Projects

- Update UFC 2-000-05N
- Update UFC 4-211-01
  - Update, Improve upon, and Clarify all Topics
  - Fire Protection
  - Tension Fabric Structures
  - Corrosion, Painting
- Update UFC 4-211-02
  - Consolidate and Coordinate with UFC 4-211-01
  - Update, Improve upon, and Clarify all Topics

Questions & Feedback Forms

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