NAVFAC
Naval Facilities Engineering Command

AIRFIELD PLANNING AND DESIGN

Airfield Facilities Planning and Design Criteria Training

FEBRUARY 2024

NAVFAC

AIRFIELD FACILITIES PLANNING AND DESIGN CRITERIA TRAINING

COURSE SCHEDULE

DAY 1 (5 Feb 2024)			
AIRFIELD PLANNING AND DESIGN			
Section	**Time**	**Title**	**Content**
	0830-0845	Doors Open	• Sign-in
1	0845-0900	Welcome, Schedule Review, Course Logistics	• Introductions – instructors and students • Facilities (Exits, Bathrooms, Wi-Fi, etc.) • Syllabus • Breaks/Snacks/Coffee, etc.
2	0900-1000	Course Purpose – NAVFAC Perspective	• Course Development & Goals • Criteria Program Overview • UFC Criteria Exemption Processing • Airfield Safety Waiver Processing • Exemption/Waiver Examples Discussion
	1000-1015	BREAK	

3	1015-1115	Airfield Planning	• UFC 2-000-05N
			• UFC 3-260-01 – Chapters 1 and 2
			  ○ Existing vs New Facilities
			  ○ CONUS vs OCONUS Criteria
			  ○ Planning Considerations
			  ○ Siting Approval Process
			  ○ Air Traffic Control Tower Siting

4	1115-1200	Fixed-Wing Runways	• UFC 3-260-01 – Chapter 3 • Classification
	1200-1300	**LUNCH**	

4	1300-1330	Fixed-Wing Runways	• Geometry and Design Considerations
			  ○ Orientation
			  ○ Dimensions
			• Imaginary Surfaces, APZs and Clear Zones

5	1330-1415	Rotary Wing Helipads and other Facilities	• UFC 3-260-01 – Chapter 4 • Types of Rotary Wing Facilities • Geometry and Design Considerations • Imaginary Surfaces, APZs and Clear Zones
6	1415-1430	Taxiways, Aprons and Other Facilities	• UFC 3-260-01 – Chapters 5 and 6 • Taxiway Types and Geometry
	1430-1445	BREAK	

6	1445-1545	Taxiways, Aprons and Other Facilities (cont'd)	• Apron Types and Nomenclature Special Apron Facilities
			  ○ Power Check Pad
			  ○ Arm/De-arm Pad
			  ○ Compass Calibration Pad
			  ○ Wash Racks

	1545	**End of Day 1**	• **Speakers to be available for questions**

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AIRFIELD FACILITIES PLANNING AND DESIGN CRITERIA TRAINING

COURSE SCHEDULE

DAY 2 (6 FEB 2024)			
AIRFIELD PLANNING AND DESIGN			
Section	**Time**	**Title**	**Content**
7	0845-0930	LZs, STOVL, and UAS Facilities	• UFC 3-260-01 – Chapters 7, 8 and 9 • LZs for C-130 and C-17 o Dimensions, Marking, Lighting • Fixed-wing STOVL Facilities o LHD, Vertical Landing Pads, FOB, OLF • UAS Facilities
8	0930-1015	Airfield Pavements Design and Evaluation	• Pavement Design Procedures o Required Design Inputs o Field Investigations
	1015-1030	**BREAK**	
8	1030-1100	Airfield Pavements Design and Evaluation (cont'd)	• Paving Materials • Pavement Evaluation
9	1100-1200	Airfield Surface and Subsurface Drainage	• Stormwater Drainage Design Requirements • Stormwater Design Considerations near Airfields • Subsurface Drainage systems
	LUNCH (1200-1300)		
10	1300-1400	Airfield Markings	• UFC 3-260-04 • NAVAIR 51-50AAA-2 • Joint Use Facilities and FAA Markings • Runways, Taxiways, Aprons, Special Facilities
11	1400-1430	Airfield Lighting & NAVAIDs	• NAVAIR 51-50AAA-2 • UFC 3-535-02 • Runways, Taxiways, Special Facilities
	1430-1445	**BREAK**	
11	1445-1515	Airfield Lighting & NAVAIDs (cont'd)	• NAVAIR 51-50AAA-2 • UFC 3-535-02 • Runways, Taxiways, Special Facilities
12	1515-1545	Questions and Examples	• Airfield Design Best Practices
	1545	**End of Day 2**	**• Speakers to be available for questions**

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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) o Applicability o Planning and Layout
	1045-1100	BREAK	
2	1100-1200 (1:00)	Aircraft Maintenance Hangars (Design)	• UFC 4-211-01 o Design Requirements for Navy Hangars – with select comparisons to Air Force
	1200-1300	**LUNCH**	
2 (cont)	1330-1445 (1:15)	Aircraft Maintenance Hangars (Design)	• UFC 4-211-01 o Design Requirements for Navy Hangars – with select comparisons to Air Force
	1445-1500	BREAK	
2 (cont)	1500-1545 (0:45)	Aircraft Maintenance Hangars (Design)	• UFC 4-211-01 o Design Requirements for Navy Hangars – with select comparisons to Air Force
	1545	**End of Day 3**	

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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 o 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) o Hangar Door Selection, Requirements o UFGS 08 34 16.10 Steel Sliding Hangar Doors o 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 o Applicability o Facility Function, Layout and Adjacencies o System Function and Requirements o Best Practices o 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 o Applicability o Planning and Layout o Design Requirements o 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 o Types of Test Cells o 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

Section 1
Welcome, Schedule Review, Logistics

AIRFIELD PLANNING AND DESIGN CRITERIA TRAINING

1/16/2024

Welcome

- Introductions
- Coursebooks
- Classroom Procedures
  - Participate in Discussions
  - Ask Questions and Share Stories
  - Non-Attribution
- Schedule
- Learning Objectives

1 - 2 AIRFIELD PLANNING AND DESIGN

Review Agenda

- Introduce/recognize course sponsors
- Work in NAVFAC Headquarters in Norfolk
- George – Capital Improvements Business Line, overall manager for airfield criteria documents
- During Course Development, course content was reviewed by multiple personnel from a wide variety of Navy organizations

- Introduce self
- Ask attendees to briefly introduce themselves
    - Name
    - Location
    - Job
    - Experience with airfield design, construction, or management

Training Agenda – Monday

Section	Time	Title	Content
1	0845-0900	Welcome, Schedule Review, Course Logistics	• Introductions – instructors and students • Facilities (Exits, Bathrooms, Wi-Fi, etc.) • Syllabus • Breaks/Snacks/Coffee, etc.
2	0900-1000	Course Purpose – NAVFAC Perspective	• Course Development & Goals • Criteria Program Overview • UFC Criteria Exemption Processing • Airfield Safety Waiver Processing • Exemption/Waiver Examples Discussion
	1000-1015	BREAK	
3	1015-1115	Airfield Planning	• UFC 2-000-05N • UFC 3-260-01 – Chapters 1 and 2 o Existing vs New Facilities o CONUS vs OCONUS Criteria o Planning Considerations o Siting Approval Process o Air Traffic Control Tower Siting
4	1115-1200	Fixed-Wing Runways	• UFC 3-260-01 – Chapter 3 • Classification
	1200-1300	**LUNCH**	

- Review topics to be covered.
- Schedule will be flexible and break times may shift depending on progress moving through the material

Training Agenda – Monday Afternoon

Section	Time	Title	Content

4	1300-1330	Fixed-Wing Runways	• Geometry and Design Considerations
			  ○ Orientation
			  ○ Dimensions
			• Imaginary Surfaces, APZs and Clear Zones

5	1330-1415	Rotary Wing Helipads and other Facilities	• UFC 3-260-01 – Chapter 4 • Types of Rotary Wing Facilities • Geometry and Design Considerations • Imaginary Surfaces, APZs and Clear Zones
6	1415-1430	Taxiways, Aprons and Other Facilities	• UFC 3-260-01 – Chapters 5 and 6 • Taxiway Types and Geometry
	1430-1445	BREAK	

6	1445-1545	Taxiways, Aprons and Other Facilities (cont'd)	• Apron Types and Nomenclature Special Apron Facilities
			  ○ Power Check Pad
			  ○ Arm/De-arm Pad
			  ○ Compass Calibration Pad
			  ○ Wash Racks

	1545	End of Day 1	• Speakers to be available for questions

1 - 6 AIRFIELD PLANNING AND DESIGN

- Review topics to be covered.
- Schedule will be flexible and break times may shift depending on progress moving through the material

Training Agenda – Thursday, Afternoon

Section	Time	Title	Content

7	0845-0930	LZs, STOVL, and UAS Facilities	• UFC 3-260-01 – Chapters 7, 8 and 9
			• LZs for C-130 and C-17
			  o Dimensions, Marking, Lighting
			• Fixed-wing STOVL Facilities
			  o LHD, Vertical Landing Pads, FOB, OLF
			• UAS Facilities

8	0930-1015	Airfield Pavements Design and Evaluation	• Pavement Design Procedures
			  o Required Design Inputs
			  o Field Investigations

	1015-1030	**BREAK**	
8	1030-1100	Airfield Pavements Design and Evaluation (cont'd)	• Paving Materials • Pavement Evaluation
9	1100-1200	Airfield Surface and Subsurface Drainage	• Stormwater Drainage Design Requirements • Stormwater Design Considerations near Airfields • Subsurface Drainage systems
	LUNCH (1200-1300)		

1 - 7 AIRFIELD PLANNING AND DESIGN

- Review topics to be covered.
- Schedule will be flexible and break times may shift depending on progress moving through the material

Training Agenda – Thursday, Afternoon

Section	Time	Title	Content
10	1300-1400	Airfield Markings	• UFC 3-260-04 • NAVAIR 51-50AAA-2 • Joint Use Facilities and FAA Markings • Runways, Taxiways, Aprons, Special Facilities
11	1400-1430	Airfield Lighting & NAVAIDs	• NAVAIR 51-50AAA-2 • UFC 3-535-02 • Runways, Taxiways, Special Facilities
	1430-1445	**BREAK**	
11	1445-1515	Airfield Lighting & NAVAIDs (cont'd)	• NAVAIR 51-50AAA-2 • UFC 3-535-02 • Runways, Taxiways, Special Facilities
12	1515-1545	Questions and Examples	• Airfield Design Best Practices
	1545	**End of Day 2**	• **Speakers to be available for questions**

- Review topics to be covered.
- Schedule will be flexible and break times may shift depending on progress moving through the material

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
    - Evolving fast and proliferating
- Platform Build Out (still time to improve)
    - F-35 Program is 40%
    - P-8
    - Triton
    - MV-22/CMV-22B
    - MQ-25A
- 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.

Four key learning objectives for this class

- Navy Airfields
  - Understand the types of airfields, features of each
- Criteria
  - Know where all the airfield components are defined in different documents
- Planning and Design Process
  - Understand the planning and site approval process
  - Understand the factors that influence design and challenges encountered during design
- Best Practices
  - Share common issues that come up during planning and design and the lessons learned from past projects

- Project Success is built upon:
  - Knowledge of Airfield Planning, Design and Construction requirements of various airfield facilities
  - Sharing best practices and stories of lessons learned from past projects will help cement these concepts

- Interactive Discussion is Encouraged – we all can learn from each other’s experiences

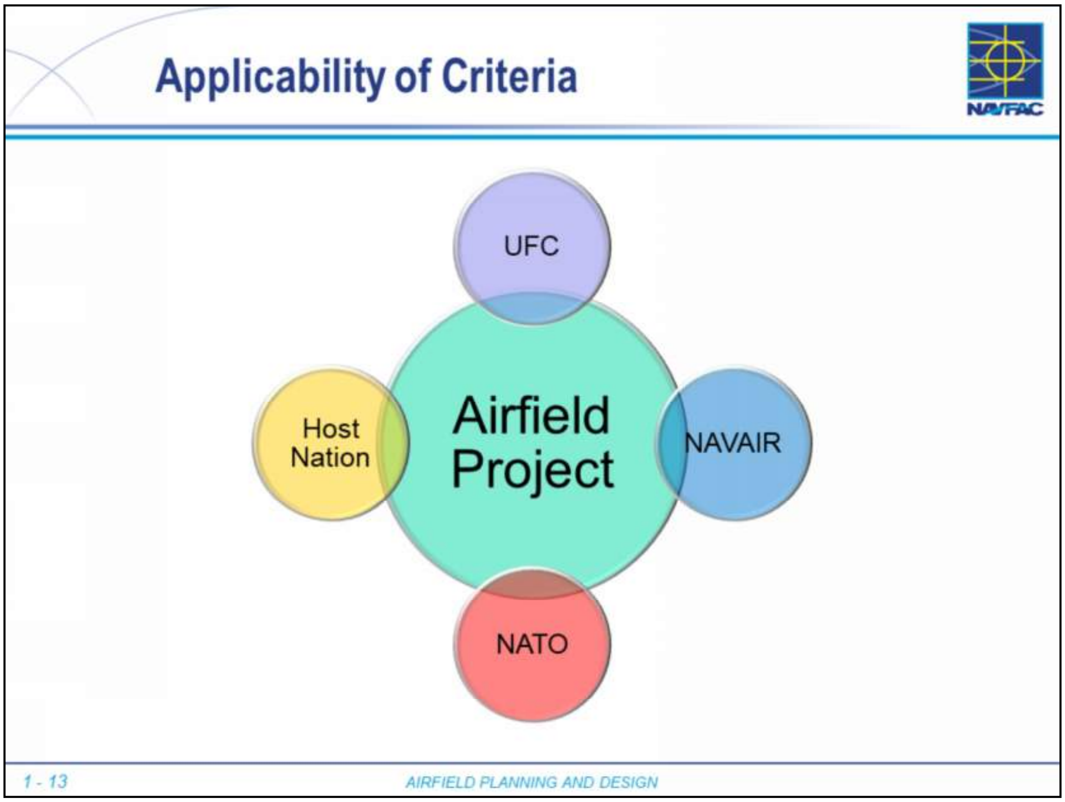
Primary Criteria Covered in this Course

Criteria Document	Title
MIL-STD 3007	Standard Practice for Unified Facilities Criteria and Unified Facilities Guide Specifications
UFC 2-000-05N	Facility Planning for Navy and Marine Corps Shore Installations
UFC 3-201-01	Civil Engineering
UFC 3-260-01	Airfield and Heliport Planning and Design
UFC 3-260-02	Pavement Design for Airfields
UFC 3-260-04*	Airfield and Heliport Marking
NAVAIR 51-50AAA-2	General Requirements for Shorebased Airfield Marking and Lighting

1 - 12 AIRFIELD PLANNING AND DESIGN

- MIL-STD 3007: Defines the how UFCs and UFGSs are organized. Defines the basics of the design criteria waiver process
- UFC 2-000-05N: Facility Planning Guide – defines types of facilities, allowed sizes, etc. Incorporates old P-80.1 Appendix C, *Runway Capacity Handbook-Fixed Wing* (1972) and P-80.3 Appendix E, *Airfield Safety Clearances* (1982)
- UFC 3-201-01: General primary criteria manual for Civil Engineering. Supplemented by other more specific UFCs
- UFC 3-260-01: Primary source for DoD Airfield and Heliport criteria
- UFC 3-260-02: Airfield Pavement Design
- UFC 3-260-04: ****Primary DoD manual for Airfield Markings; However, stipulates that Navy follows NAVAIR 51-50AAA-2 instead of 3-260-04.
- NAVAIR 51-50AAA-2: Primary <u>Navy/Marine Corps</u> guidance for markings and lighting.

- Several other criteria documents are referenced during the course, but these are the primary guidance documents.

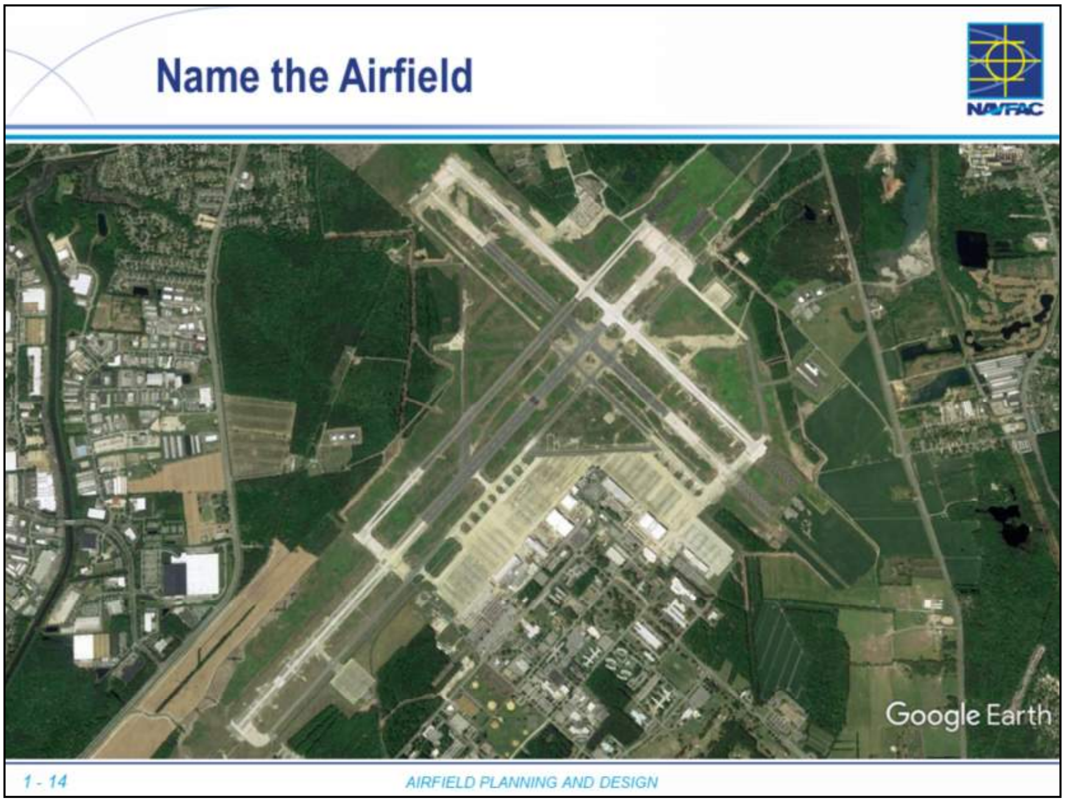


- Determining what criteria applies to a project can be difficult
- Always start with Core UFCs like 2-000-05N and 3-260-01 (UFC structure will be addressed in next section)

- NAVAIR documents will likely play a role
    - 51-50AAA-2 is a NAVAIR document, but contains engineering criteria for marking and lighting

- OCONUS
    - Host Nation agreements may stipulate some aspects of design criteria, such as ICAO
    - NATO has standards that are similar to UFCs, but not identical in all respects
    - Applicability may depend on project funding source

- FAA
    - Usually only plays a role on a joint use airfield, or if FAA is contributing funds
    - Guard and Reserve locations
    - For some items, DoD criteria references use of FAA criteria (e.g. NAVAID siting, lighting equipment specifications, marking)



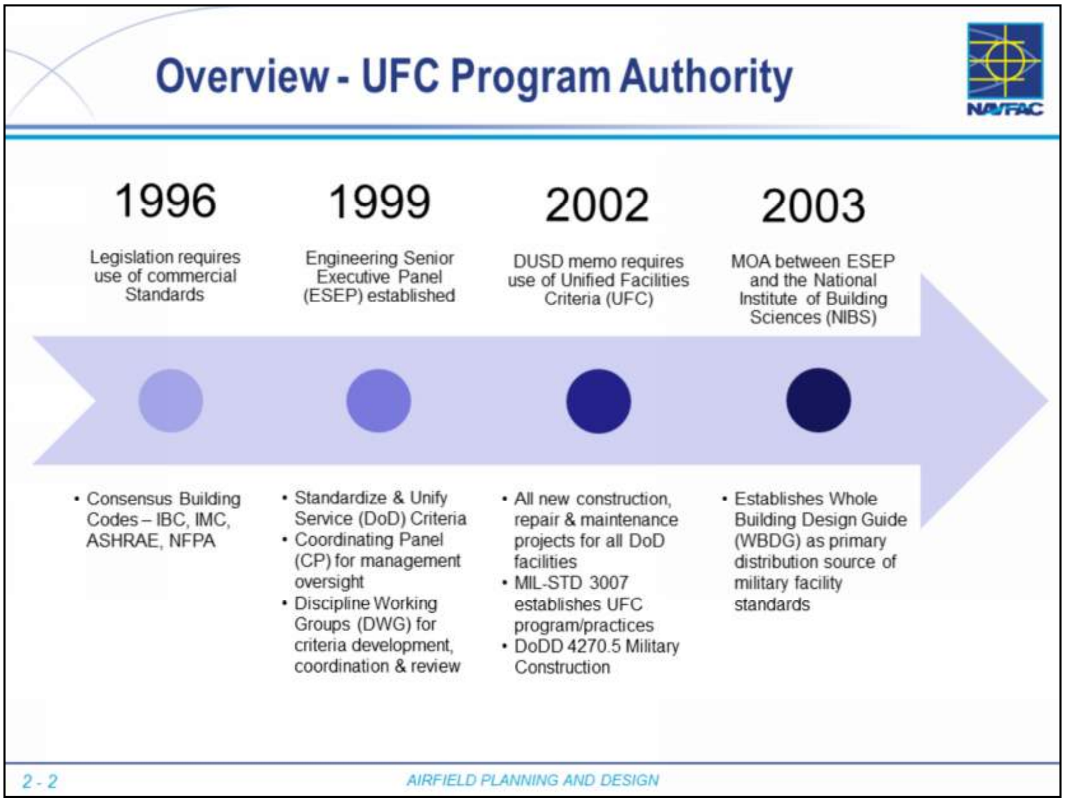
- Dual Parallel Runways – higher capacity for training operations
- Arm/De-Arm Pads at Runway Ends
- Remnant runway “ghost”

NAVFAC Naval Facilities Engineering Command

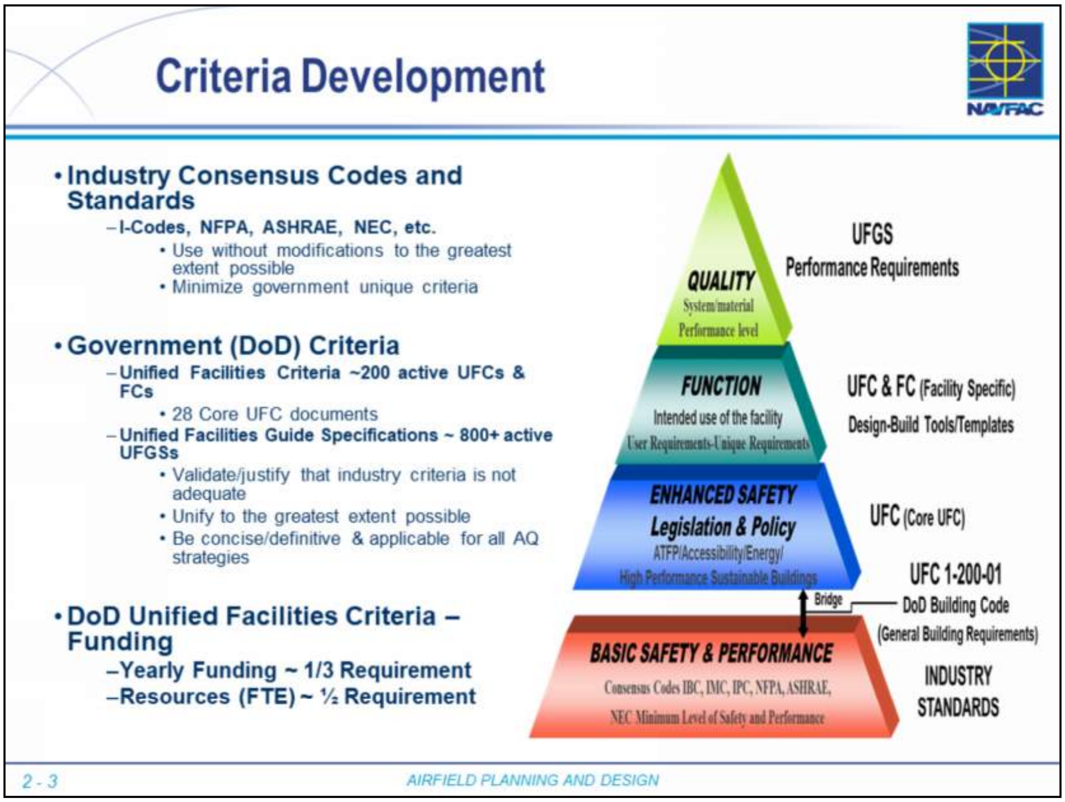
Section 2
NAVFAC Criteria Program Overview

AIRFIELD PLANNING AND DESIGN
CRITERIA TRAINING

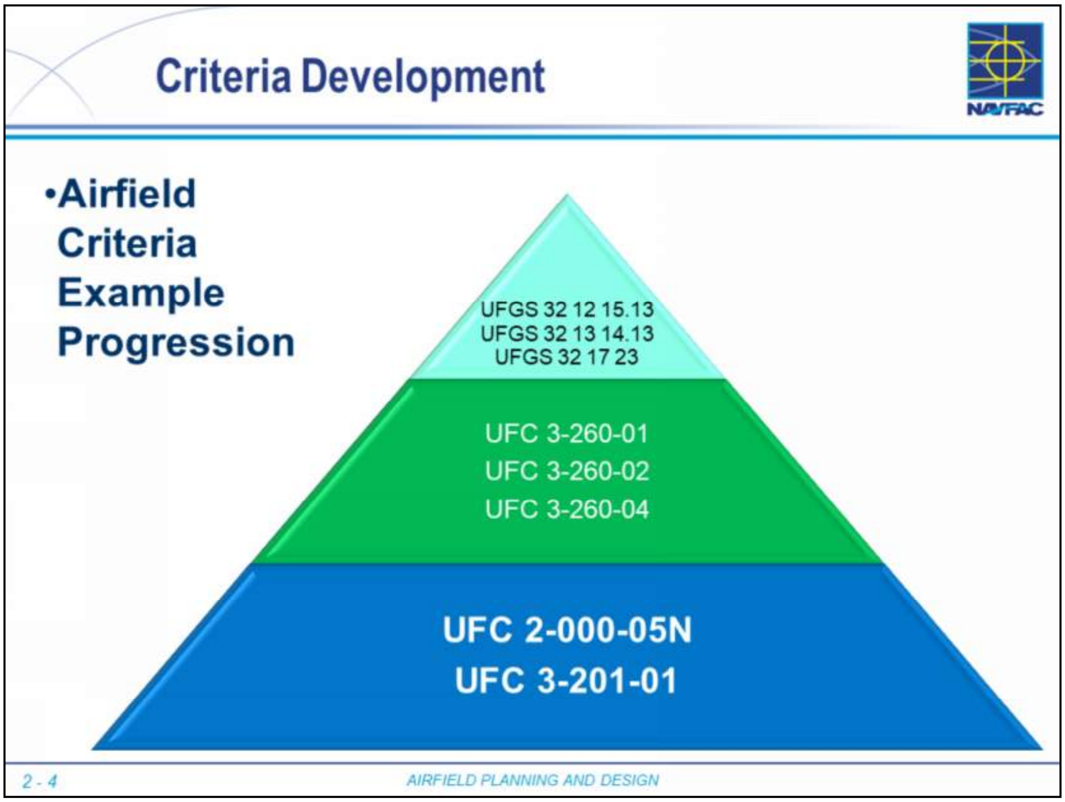
1/15/2024



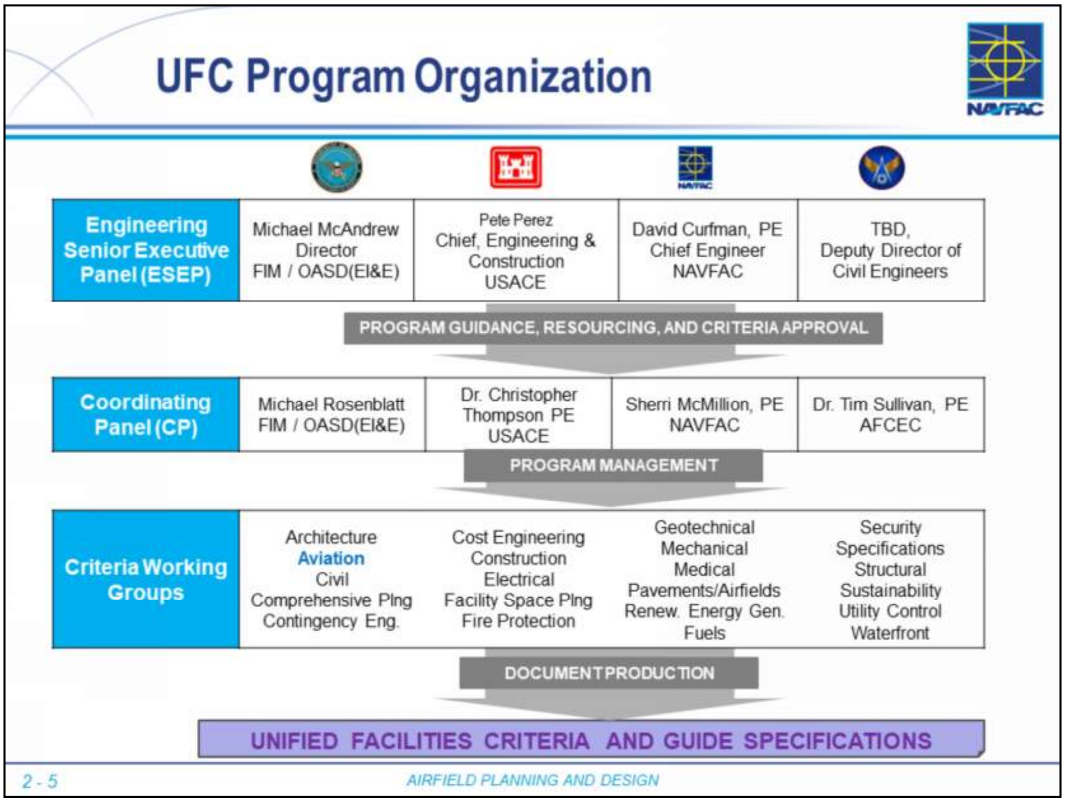
- Tri-Service Standardization Program established by law.
- MIL-STD establishes UFC Program details and management
- UFC developed over several years by consolidating content from separate services' manuals
  - Required extensive collaboration, research and (in some cases) compromise between SME's in each service
  - Process still ongoing to refine existing criteria



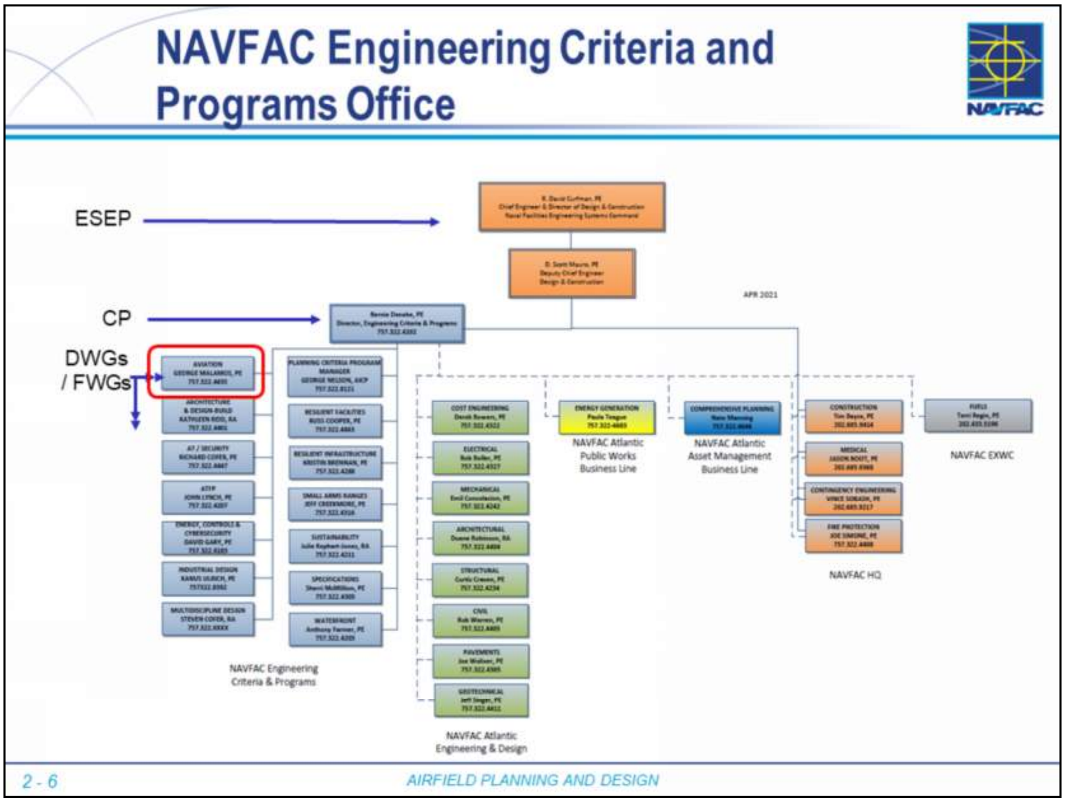
- Shows how criteria is layered
    - Explain pyramid from the bottom up
- Starts w/ Industry standards and layers government policy, then facility-type lessons learned.



- For airfields, here is an example progression:
    a. Core: UFC 2-000-05N Planning Factors for Facilities
    b. Core: UFC 3-201-01 Civil Engineering
    c. Function: UFC 3-260-01 Airfield and Heliport Planning and Design
    d. Function: UFC 3-260-02 Pavement Design for Airfields
    e. Function: UFC 3-260-04 Airfield and Heliport Marking
    f. Quality: UFGS 32 12 15.13 Asphalt Paving for Airfields
    g. Quality: UFGS 32 13 14.13 Concrete Paving for Airfields and Other Heavy-Duty Pavements
    h. Quality: UFGS 32 17 23 Pavement Markings



- Layered Tri-Service authority
- Working Groups manage respective criteria documents
- Chief Engineers are ultimate authority (comment on waiver process generally following this chain - not insignificant)
- Every UFC and UFGS has one CWG assigned to manage the document
- Aviation CWG is the sponsor for this training
    - Example Criteria documents managed by Aviation CWG
        - UFC 3-260-01
        - UFC 3-260-04
        - UFGS for Airfield Pavement Layers, Airfield Markings
    - Related Criteria documents managed by other CWG
        - UFC 3-535-01 (Electrical CWG)
        - UFGS for Airfield Lighting (Electrical CWG)

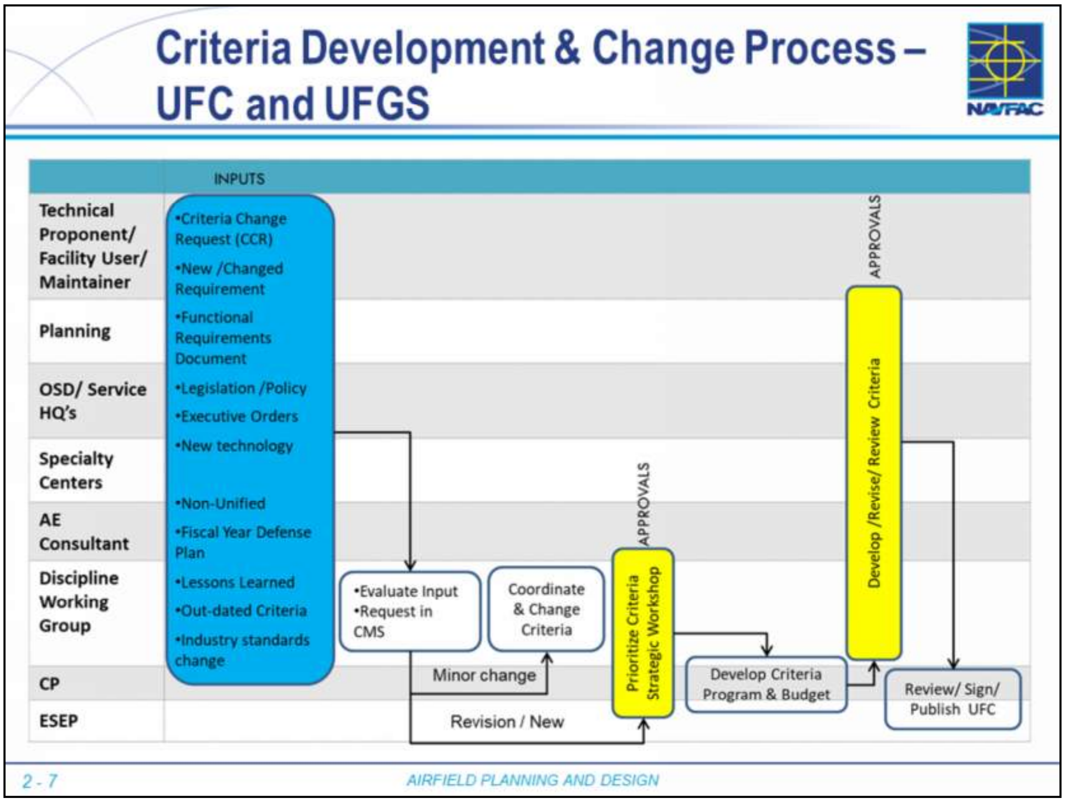


ESEP = Engineering Senior Executive Panel

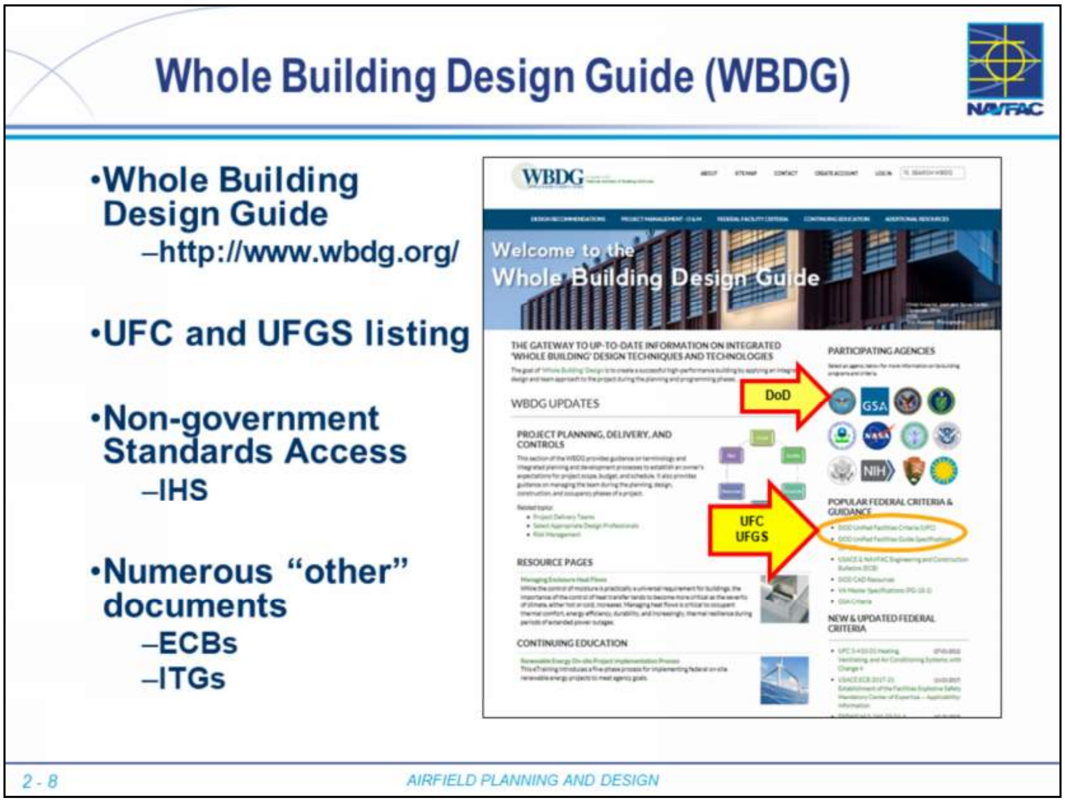
CP = Criteria and Programs

22 Criteria Focus Areas

1. Shows NAVFAC criteria office structure
2. Criteria managers exist for every UFC/UFGS

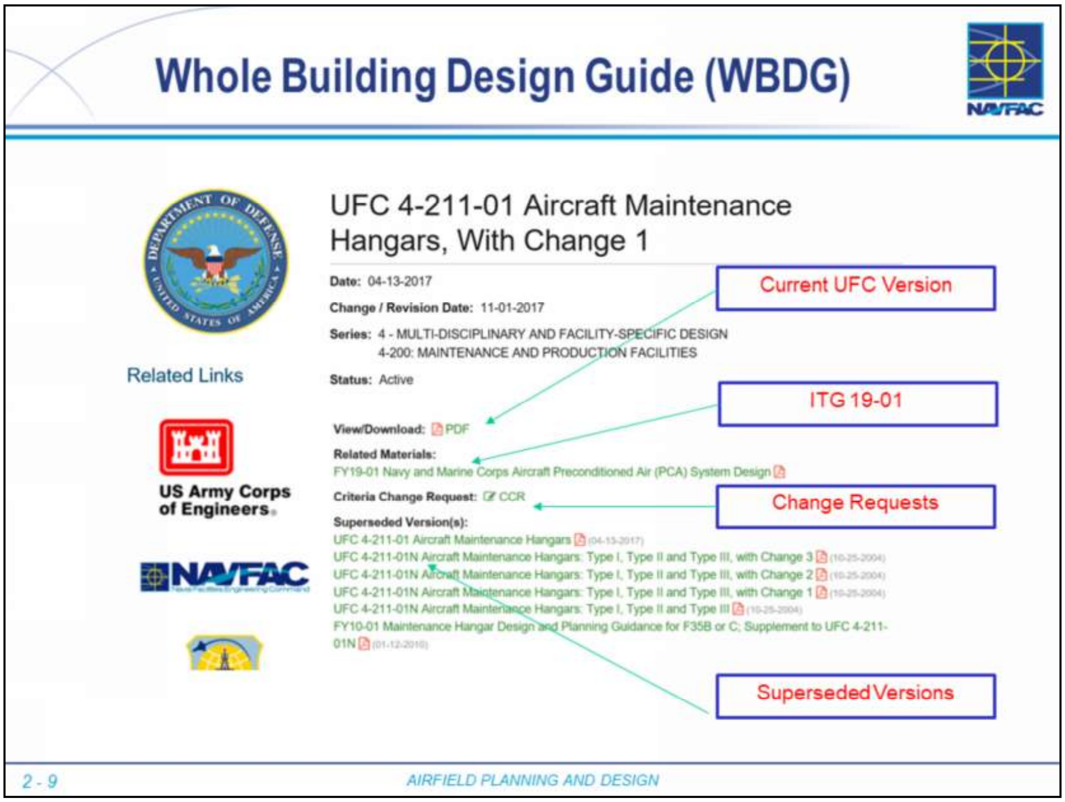


- There is a defined change process for UFCs and a mechanism for user comments
- CCR "button" on each UFC for users to input comments
    - Generates message to criteria manager for evaluation

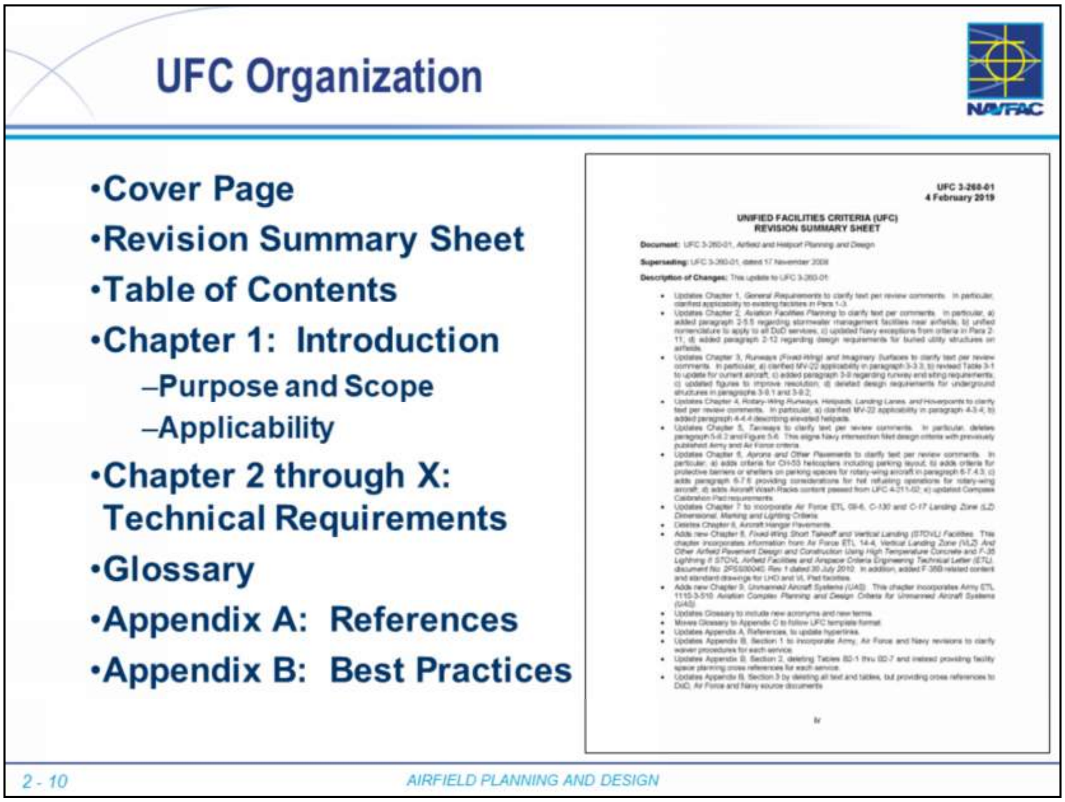


1. All criteria and CCRs reside on WBDG

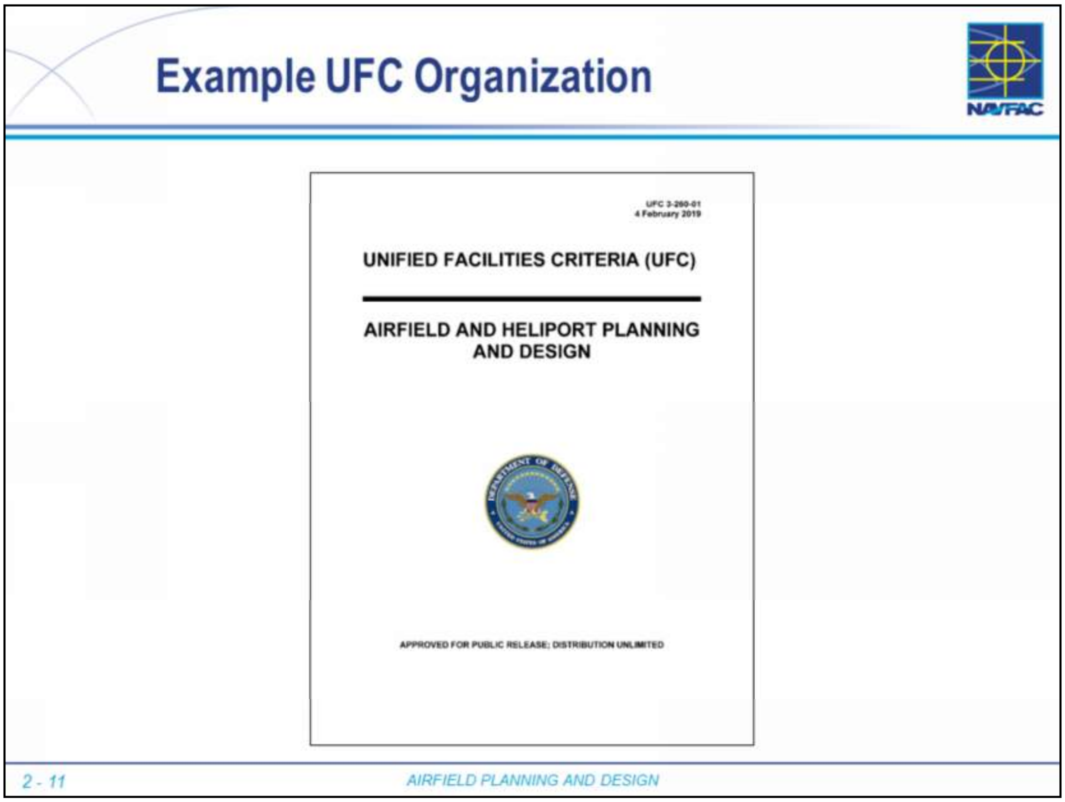
- Home
  - Federal Facility Criteria
    - Department of Defense
      - UFGS
      - UFC
        - UFC 3-260-01
          - CCR Process
      - Engineering Construction Bulletins
        - USACE
        - NAVFAC
      - DoD Supplemental Technical Criteria
        - TSEWG (Tri-Service Electrical Working Group)
        - TSPWG (Tri-Service Pavements/Airfields Working Group)



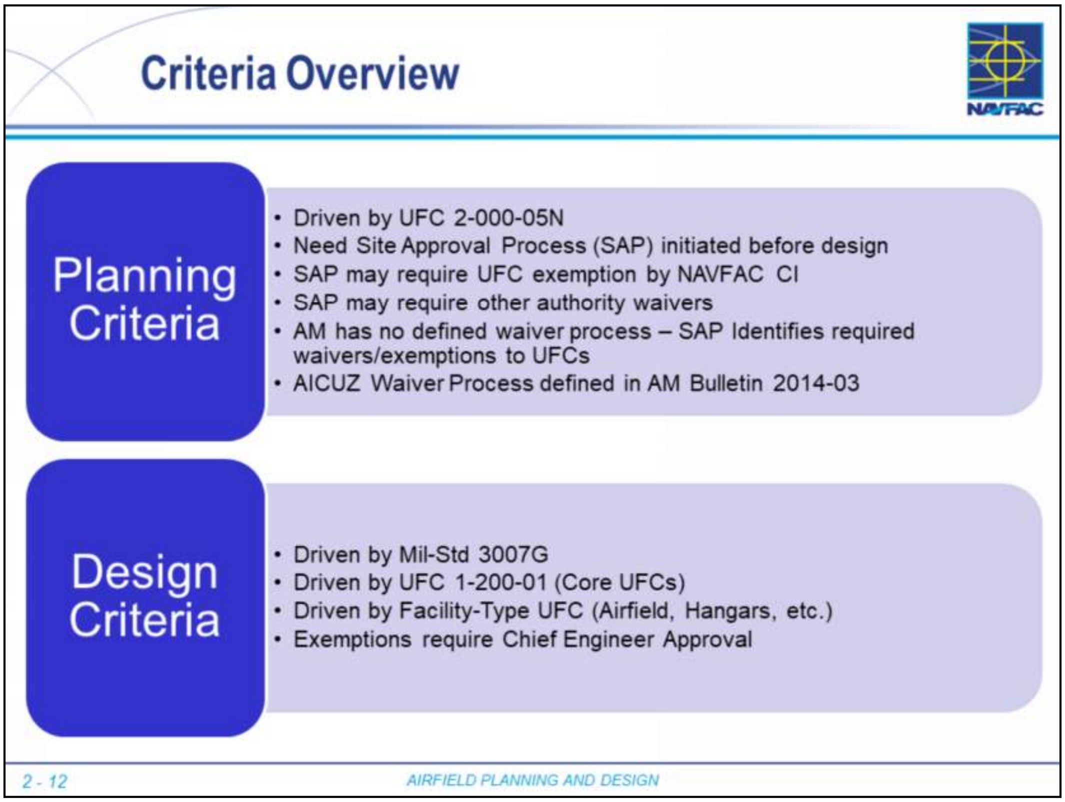
- Key information about a UFC is listed on each UFC home page
    - Current Version date and link to pdf
    - Related Materials like Interim Technical Guidance
    - Change Request Button link to CCR Form
    - Superseded Versions



- UFC's have a standard organizational structure
  - Check data
  - Check Revision Summary Sheet
  - Chapter 1 – Purpose, Scope and Applicability
    - Exceptions for Services may be listed here
  - Chapters 2 through ? – all the technical requirements
  - Glossary
  - References
  - Appendix B: Best Practices

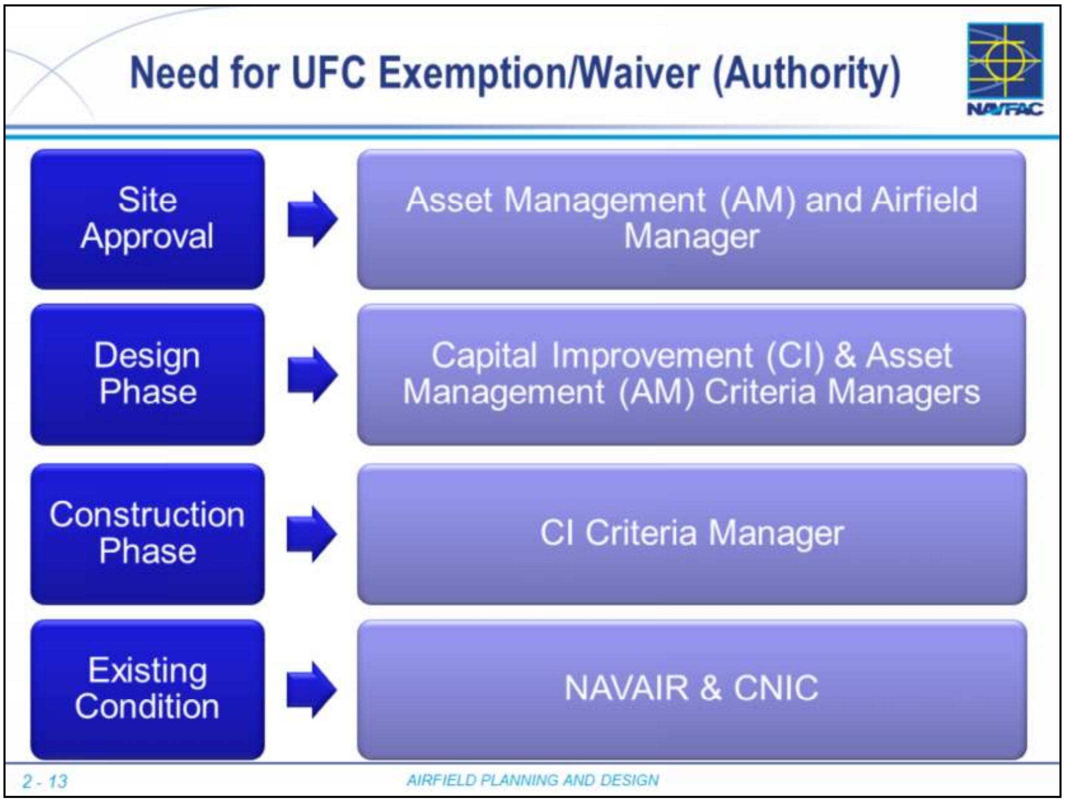


- Open pdf of UFC 3-260-01 and scroll through significant features



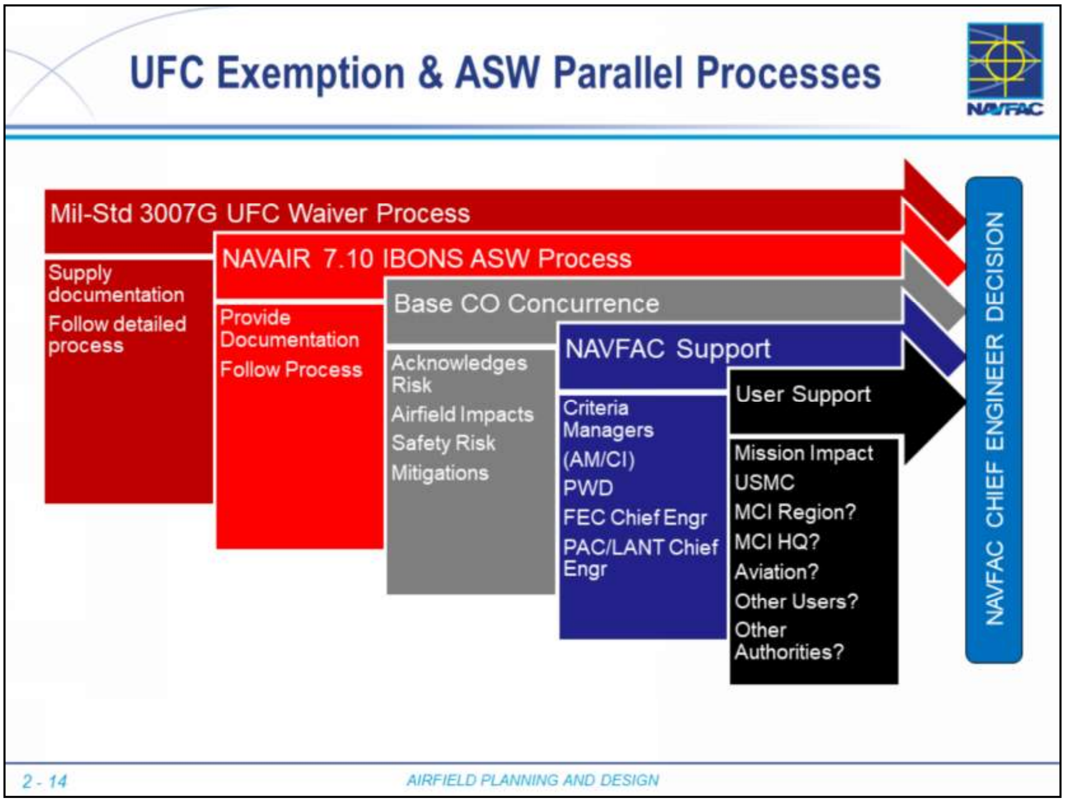
Two major types of criteria for compliance

- Planning Criteria
    - UFC 2-000-05N
    - Site Approval Process – initiated prior to design
        - Used to avoid exemptions and waivers
        - Evaluate alternatives and pursue Criteria Exemption or Airfield Safety Waiver during SAP if no other options
    - No formal Planning waiver process – planning process identifies criteria conflicts and develops mitigations
    - Formal AICUZ waiver process exists if needed as last resort – defined in AM Bulletin 2014-03
- Design
    - MIL-STD 3007G defines process
    - UFC Exemption Process
        - Require NAVFAC Chief Engineer Approval



- Stage of the Project influences who has approval

- Site Approval – want to catch issues at this phase, when there is still a chance to change course or develop mitigating strategies
    - Asset Management and/or Airfield Manager approval
- Design Phase
    - CI and AM Criteria Managers involved to evaluate for Chief Engineer and make recommendation
- Construction Phase
    - If issue identified this late, approval starts at CI. May require NAVAIR
    - UFGS Exemption approved at Field Engineering Command (FEC) level
- Existing Condition
    - NAVAIR approval of Airfield Safety Waiver (ASW)
    - Concurrence from Commander, Naval Installations Command (CNIC) or MCICOM



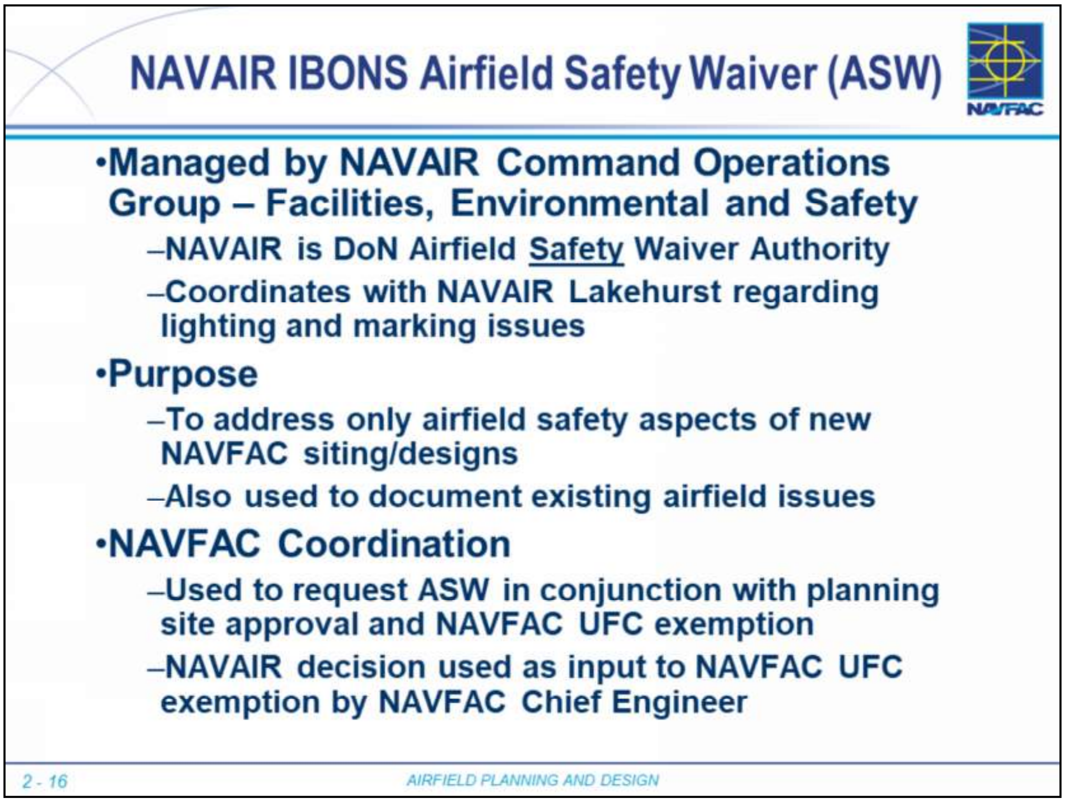
- The UFC Exemption and NAVAIR ASW Process can work in parallel.
- If UFC issue is an airfield safety issue, then ASW required in parallel because UFC Exemption will not be issued without an ASW
    - Example: reduced wingtip clearance on parking apron taxiway
- If UFC issue is not safety related, then ASW not required
    - Example: paving materials will not meet UFGS requirements
- Base CO and Staff need to be involved in developing the request
    - Base CO needs to agree to accept the risk
- NAVFAC AM and CI available to support
    - Chief Engineer ultimately approves Exemptions
- Several approvals required by multiple agencies
    - Can be worked in parallel

- MIL-STD 3007G Defines the Waiver and Exemption Process for UFC & UFGS
- Gives criteria exemption waiver authority to NAVFAC Chief Engineer
- MIL-STD 3007G 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.

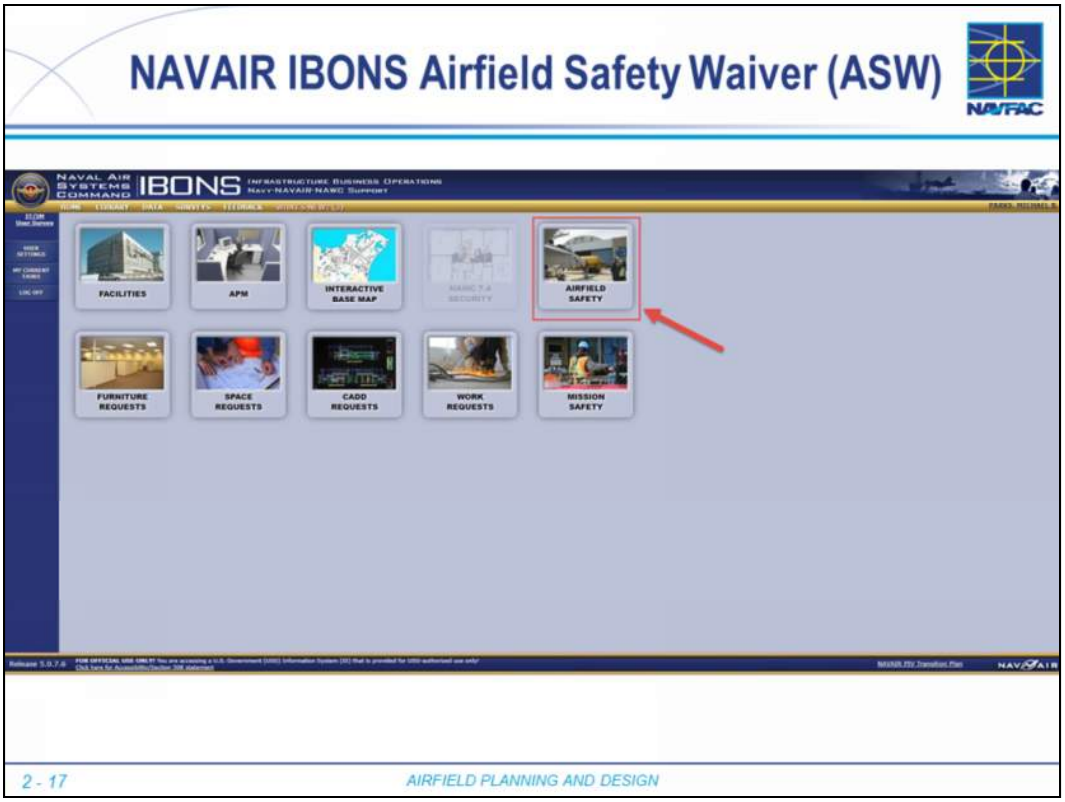
- If a waiver or exemption is unavoidable, then one package following MIL-STD 3007 and UFC process should be developed during the Site Approval Process and coordination started.

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

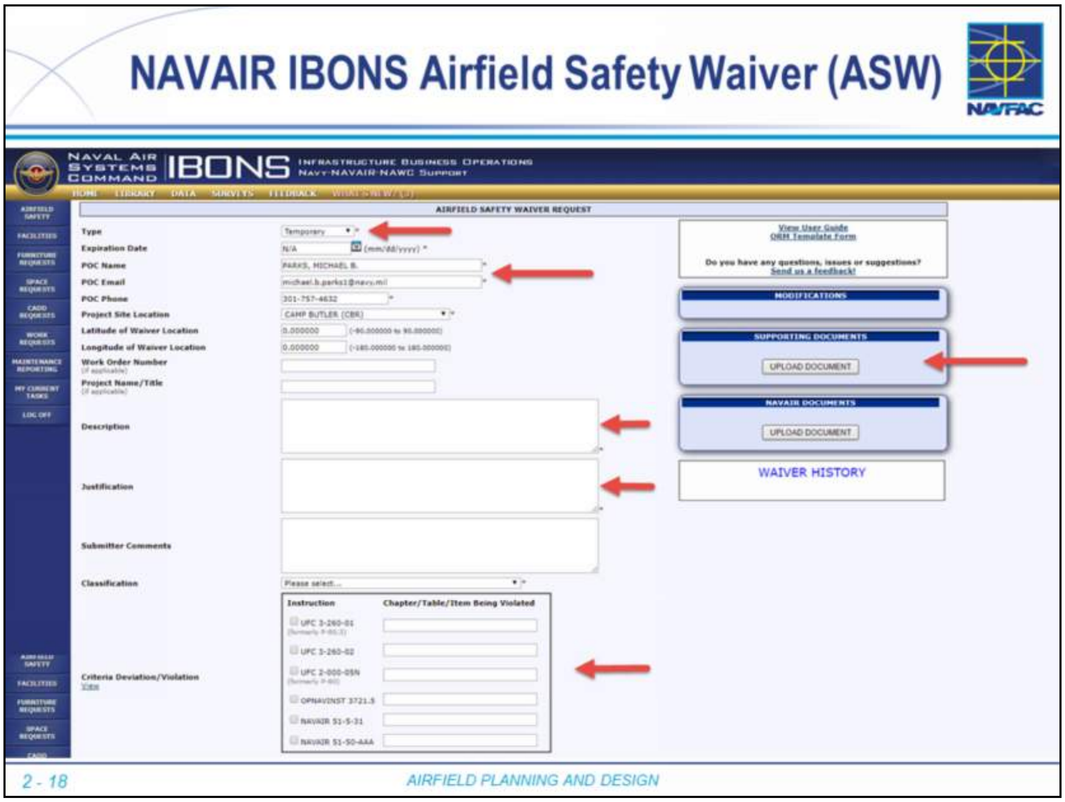


- Airfield Safety Waiver (ASW) Process Managed by NAVAIR 7.10

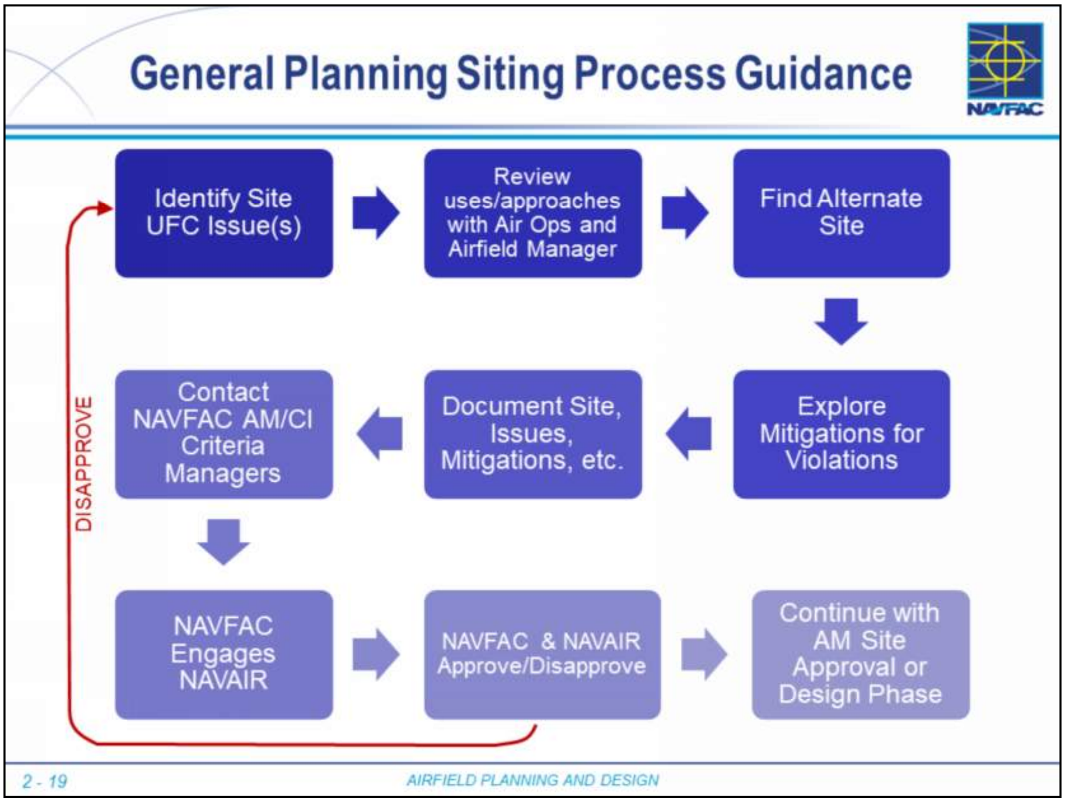
- NAVAIR issues ASW to ICO once satisfied that:
    - the risks have been mitigated to maximum extent practical
    - remaining risks are acceptable
    - <u>and</u> benefits outweigh the risks



- NAVAIR maintains an electronic airfield safety waiver (ASW) database for submission, processing, and approval.
    - Called the **I**nfrastructure **B**usiness **O**perations **N**avy **S**upport (IBONS) ASW module.
    - The IBONS web address for an account is: **https://ibons.navair.navy.mil/ibons/ibons.jsp?L=Ac145qt3**



- ASW Request Data Entry Screen Example
  - Temporary vs. Permanent
  - POC Information
  - Description: Provide a thorough description of the situation, including alternatives that have been evaluated. Attach supporting documentation.
  - Justification: Explain why the waiver can't be avoided. Cost may be a justification for temporary waivers, but should not be a primary reason for permanent waivers
  - Criteria Deviations: Identify which documents and specific paragraphs, tables, figures, etc. are violated.
    - UFC 3-260-01
    - UFC 3-260-02
    - UFC 2-000-05N
    - OPNAVINST 3721.5
    - NAVAIR 51-5-31
    - NAVAIR 51-50AAA
  - **Attach** Supporting Documents



- This illustrates the standard process for Siting Approval of facilities
    - Identify UFC Criteria conflicts early
    - Evaluate alternative sites
    - Explore mitigation options
    - Develop documentation for issue, alternatives analyzed, mitigation possibilitie
    - Consult with NAVFAC AM/CI Criteria Managers
    - If needed, NAVFAC will engage NAVAIR
    - After NAVFAC & NAVAIR Approval/Concurrence, continue with Site Approval and Design

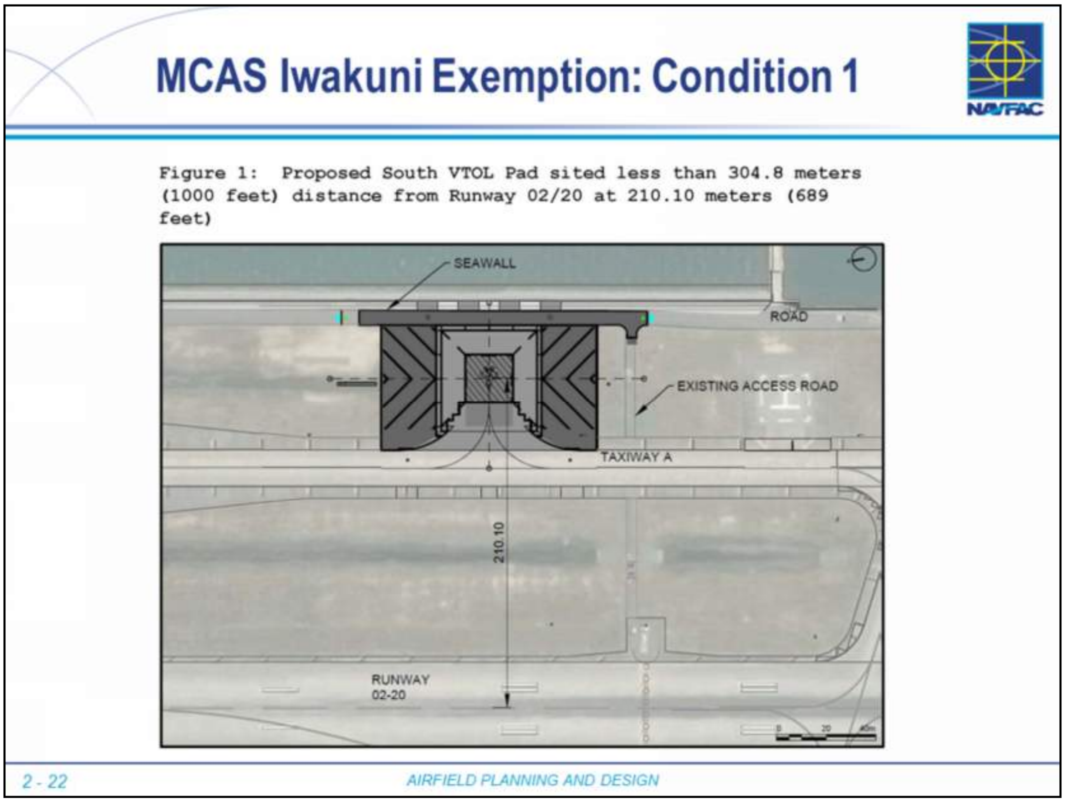
- Objective: Construct a new Vertical Landing Pad for F-35B operations on south half of airfield (left side of aerial image)

- Siting Challenges
  - Constrained site (very little available land)
  - Separation Distances from taxiways and runways
  - Vertical Sea Wall

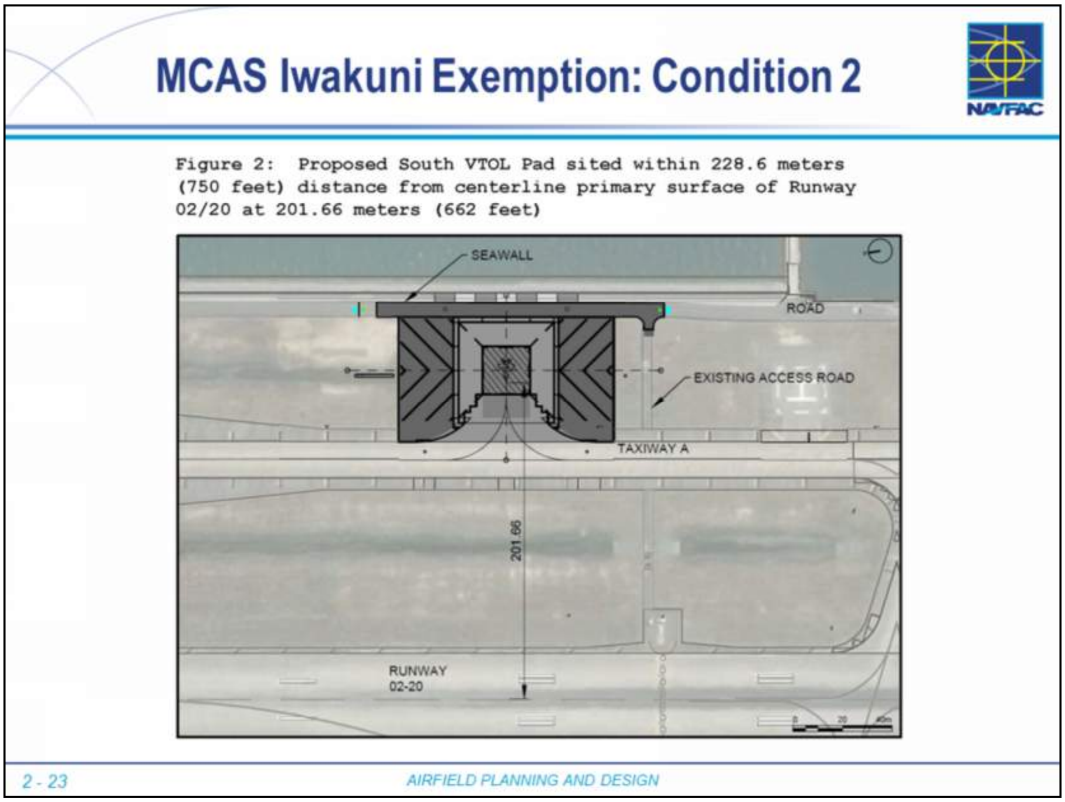
- Objective: Construct a new Vertical Landing Pad for F-35B operations on south half of airfield

- Siting Challenges
  - Constrained site (very little available land)
  - Separation Distances from taxiways and runways
  - Vertical Sea Wall

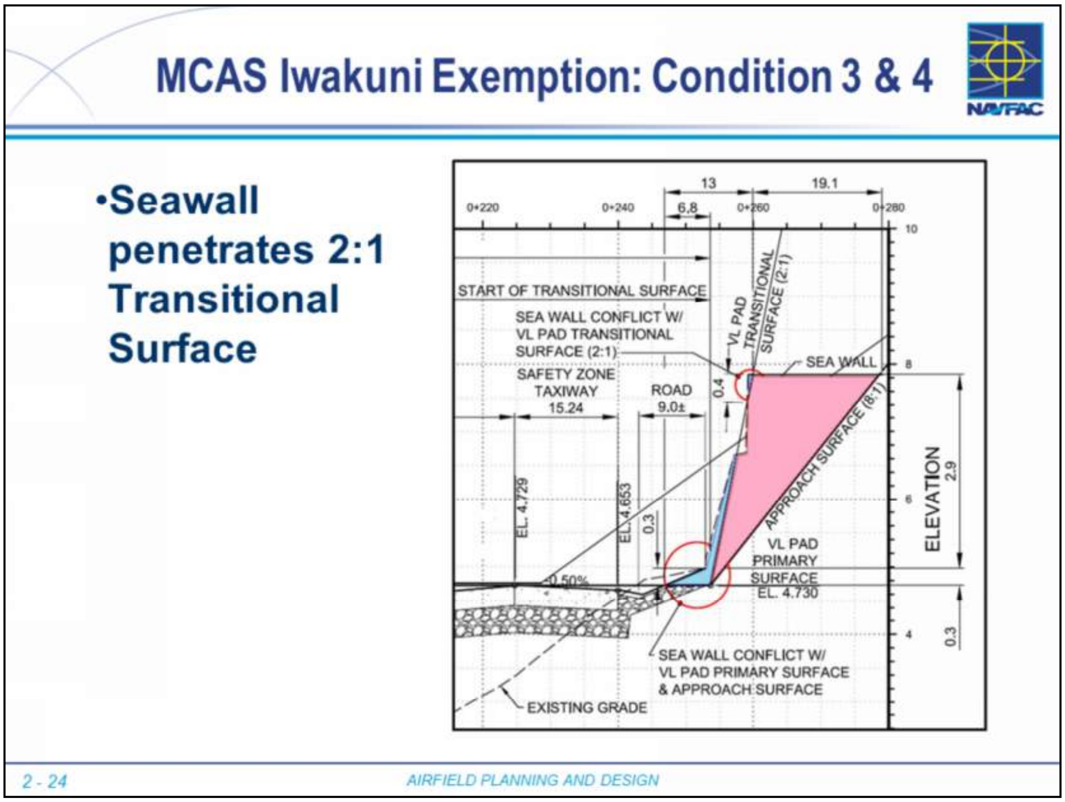
- Key Criteria for Compliance
  - Separation between Runway Centerline and VL Pad
  - Separation between Taxiway Centerline and VL Pad
  - 2:1 Transition Surface Upward from edge of Primary Surface (150-ft from center of Pad)
  - Maximum 5% Grade in Clear Zone
  - 8:1 Approach Surface to VL Pad



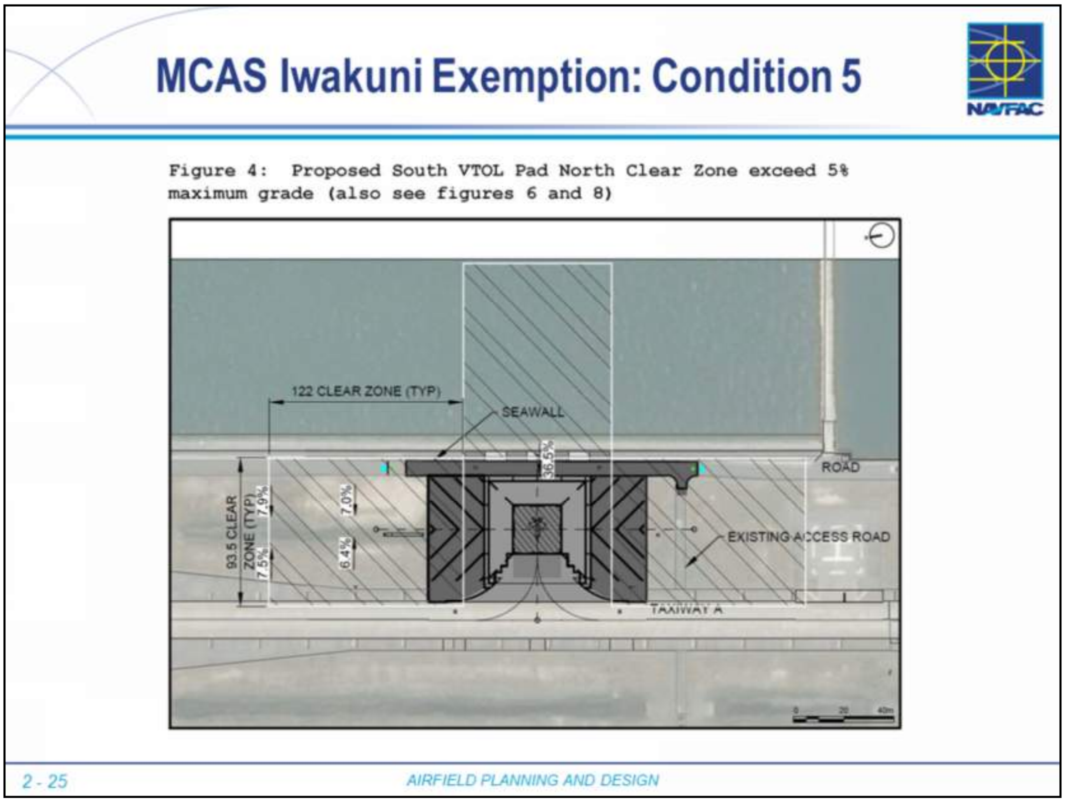
- Condition 1: VL Pad less than 1,000 ft from runway centerline (Table 3-2, Runway Lateral Clearance Zone)
- Justification: To achieve separation requires building into the sea – not feasible
- Mitigation: Air Traffic Control (ATC) will treat the VTOL pads (North and South), the helicopter runway (Helipads N and R), and Runway 02/20 as a single landing surface while any of the pavements are in use, with non-simultaneous operations for the runway when the South VTOL Pad is being utilized. ATC will develop minimum separation distances when both VTOL pads are being utilized, and utilizing the latest Risk Assessment, the VTOL Ops will be scheduled and operational internal controls will be utilized to ensure safe use of the South VTOL Pad in conjunction with other operations on the MCAS Iwakuni airfield.



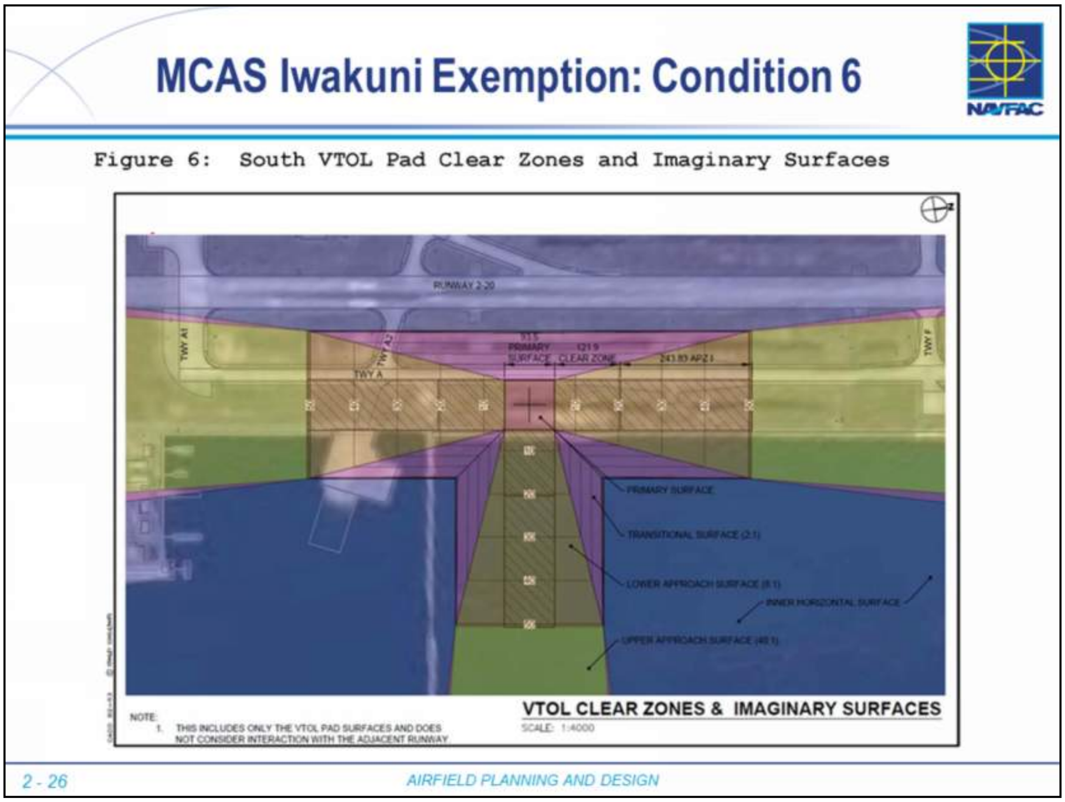
- Condition 2: VL Pad within Primary Surface (Table 3-7), therefore interferes with normal runway operations. The nose and tail of the aircraft are above the transitional surface approximately 2.9 meters (9.6 feet) and 4.5 meters (14.6 feet) respectively.
- Justification: To achieve separation requires building into the sea – not feasible
- Mitigation: ATC will treat the VTOL pads (North and South), the helicopter runway (Helipads N and R), and Runway 02/20 as a single landing surface while any of the pavements are in use, with non-simultaneous operations for the runway when the South VTOL Pad is being utilized. Additionally, once the aircraft is on the Pad, the aircraft will not remain in position on the Pad when the runway is being utilized.



- Condition 3: The seawall will penetrate the imaginary 2:1 transitional surface from the edge of the South VTOL Pad primary surface along the east side, penetrating approximately 0.4m (1.3 feet) horizontally and 0.4m (1.3 feet) vertically along the transitional surface for about 3.2m (10.5 feet) above the primary surface. The perimeter road on the western side of the seawall will also penetrate this surface by 6.8m (22.3 feet) horizontally and 0.3m (1.0 foot) vertically.
- Condition 4: The seawall will penetrate the imaginary 8:1 approach surface, for an eastern approach over the seawall, by approximately 19.1m (62.6 feet) horizontally and 3.2m (10.5 feet) vertically. The perimeter road on the western side of the seawall will also penetrate this surface by 6.8m (22.3 feet) horizontally and 0.3m (1.0 foot) vertically.
- Mitigation: Will get approach minimums from Naval Flight Information Group (NAVFIG), and ATC will develop procedures to mitigate risk of fixed objects penetrating the imaginary transitional surface. The seawall will be clearly marked and lighted as an obstruction, according to the standards set in the UFC.

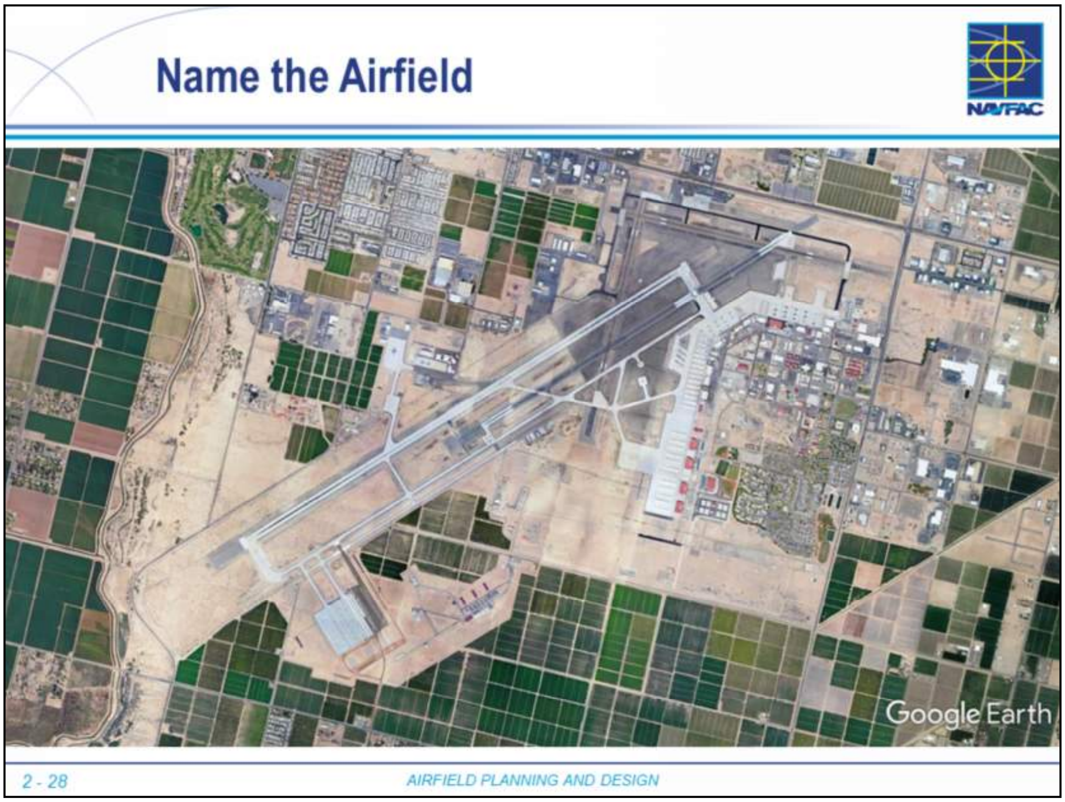


- Condition 5: Grades in the Clear Zone exceed maximum allowable 5%.
- Justification: Changing drainage system extremely challenging due to sea level and sea wall. New drainage system recently installed to prevent seawater intrusion/backup onto airfield. Adjusting inlet elevations was not feasible.
- Mitigation: A waiver is requested to allow operational use of the South VTOL Pad with a clear zone gradient that is greater than the maximum of 5% authorized by the UFC. The increased percent grade is due to the conditions and constraints of drainage required for removing storm water from the airfield. MCAS Iwakuni ATC and Air Operations will develop procedures to mitigate the risk of accidental landings in the clear zone areas with a gradient greater than 5%. There is no detrimental effects to any hot gas ingestion from this irregular feature near the pad.



- Condition 6: Sea Wall penetrates 8:1 approach surface from south.
- Justification: South approach needed as an option to recover aircraft, though expected use is less than 10% of VL Pad operations.
- Mitigation: MCAS Iwakuni ATC and Air Operations would like to keep the seaward approach available as an option. However, the intended use is for when the runway is temporarily closed due to an emergency, such as an incident at the Gear or a Foreign Object Damage situation. Having the option for a seaward approach to the South VTOL Pad would provide flexibility for ATC to safely recover aircraft. It is anticipated these conditions will be less than 10% of the time. Will request guidance from NAVFIG for approach minimums and ATC will develop procedures. The seawall will be clearly marked and lighted as an obstruction, according to the standards set in the UFC.

- Key Points of Section
    - UFC program established in 1990s to use industry standards and consolidate DoD criteria
    - Criteria managed by DoD, with Criteria Working Group established for every document
    - Documents stored on Whole Building Design Guide
    - Criteria Change Requests (CCR) available to suggest changes
    - UFC Exemption Process governed by MILSTD 3007G
    - Airfield Safety Waivers controlled by NAVAIR using IBONS
    - Exemptions and Waivers should only be pursued when no other options are feasible to avoid increasing risks



- VL Pad
- Compass Calibration Pad
- Parallel Runways
- Old “triangle” configuration

NAVFAC
Naval Facilities Engineering Command

Section 3
Airfield Planning

AIRFIELD PLANNING AND DESIGN
CRITERIA TRAINING

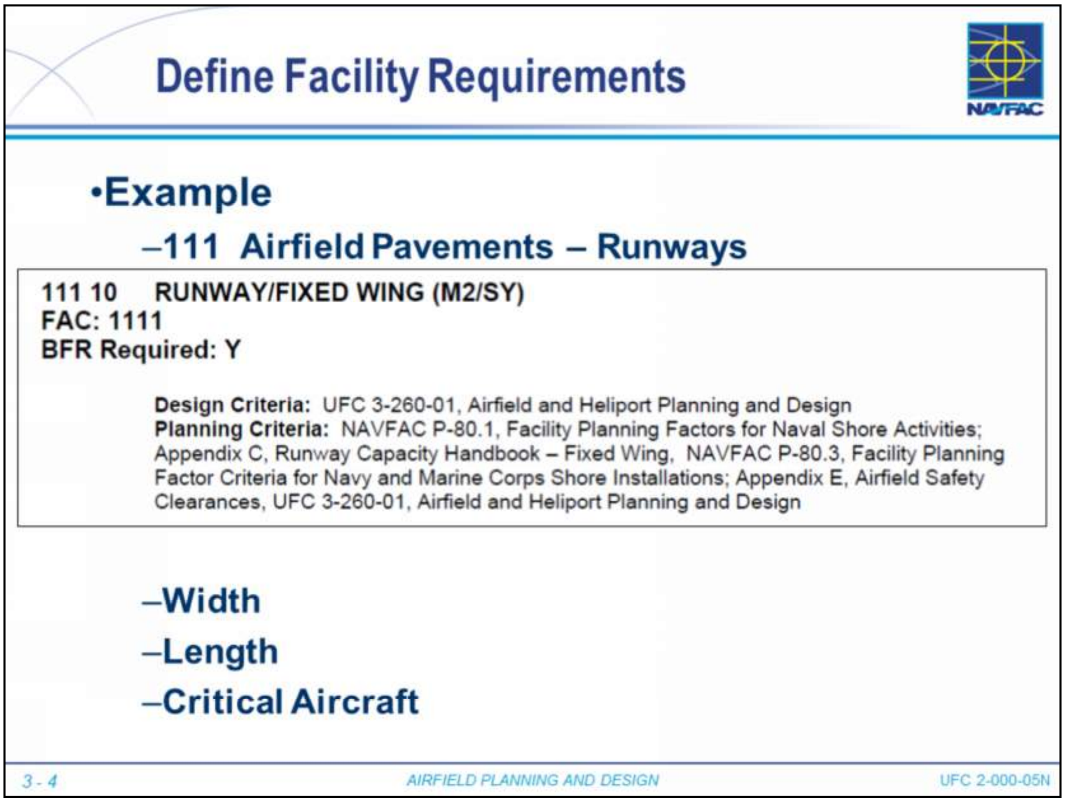
1/15/2024

Overview of Topics

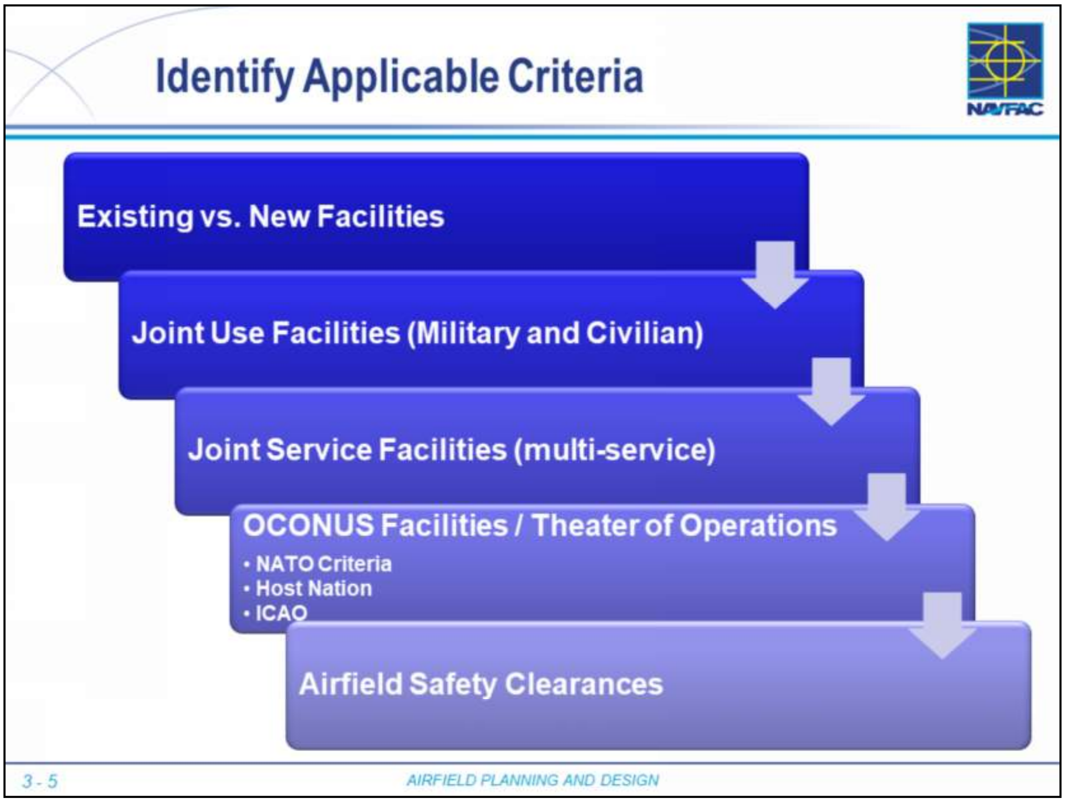
- Source Criteria
  - UFC 2-000-05N *Facility Planning For Navy And Marine Corps Shore Installations*
  - UFC 3-260-01 *Airfield And Heliport Planning And Design*
- Planning Process
  - Define Facility Requirements
  - Identify Applicable Planning and Design Criteria
    - DoD, Joint Service, Joint Use
    - CONUS and OCONUS
      - NATO Criteria
      - Host Nation
      - ICAO
  - Planning Considerations
  - Identify Potential Sites
- Site Approval Process

- UFC 2-000-05N defines the space planning factors, criteria and techniques for use in developing Base Facility Requirements (BFRs)
  - Planning Process assesses an activity's missions, functions and tasks in the context of base loading and requirements, then translates the output into infrastructure.
  - Each activity has its own Missions, Functions and Tasks
    - Missions: concise, unclassified general statements of the what the activity is to accomplish
    - Functions: workload derived from the main elements of the activity's mission
    - Tasks: Workload accomplished in connection with existing program policy directives or written tasking assignments
  - Aircraft Loading is the number of aircraft assigned to perform the tasks
  - Personnel Loading is the number of personnel assigned to perform the tasks

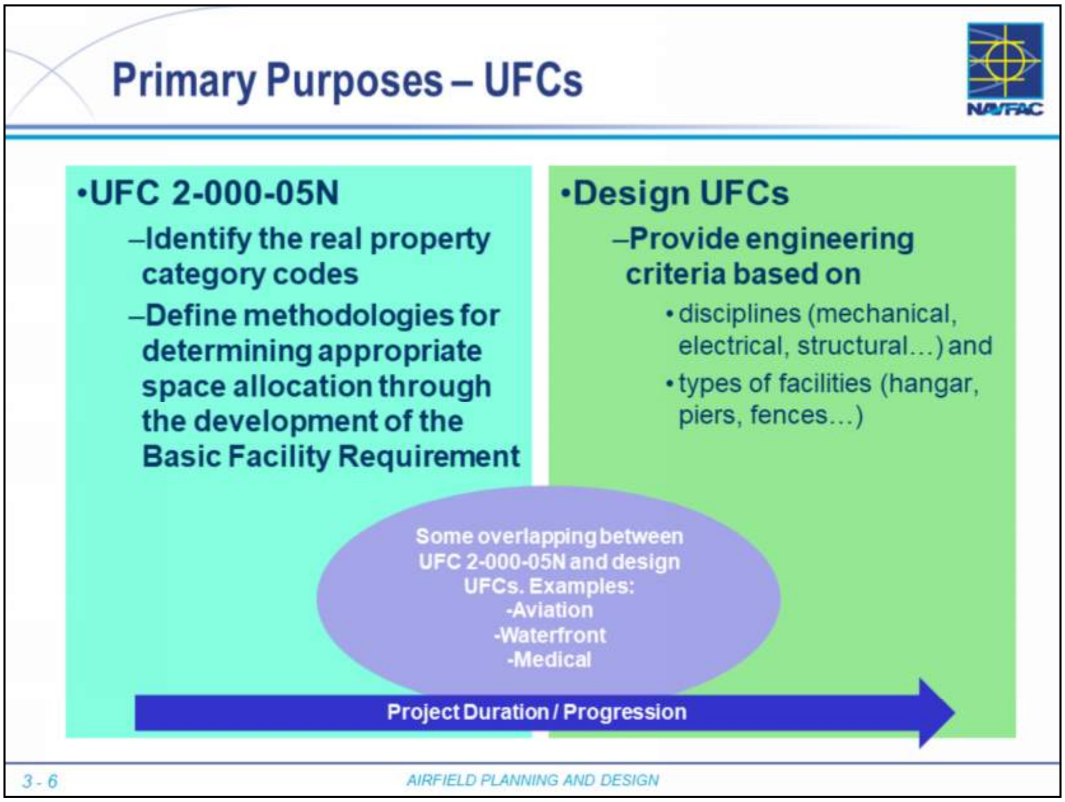
  - Criteria establishes methodology to appropriately and uniformly size facilities
  - Common Planning Standards leads to Uniformity in Facilities throughout the Navy



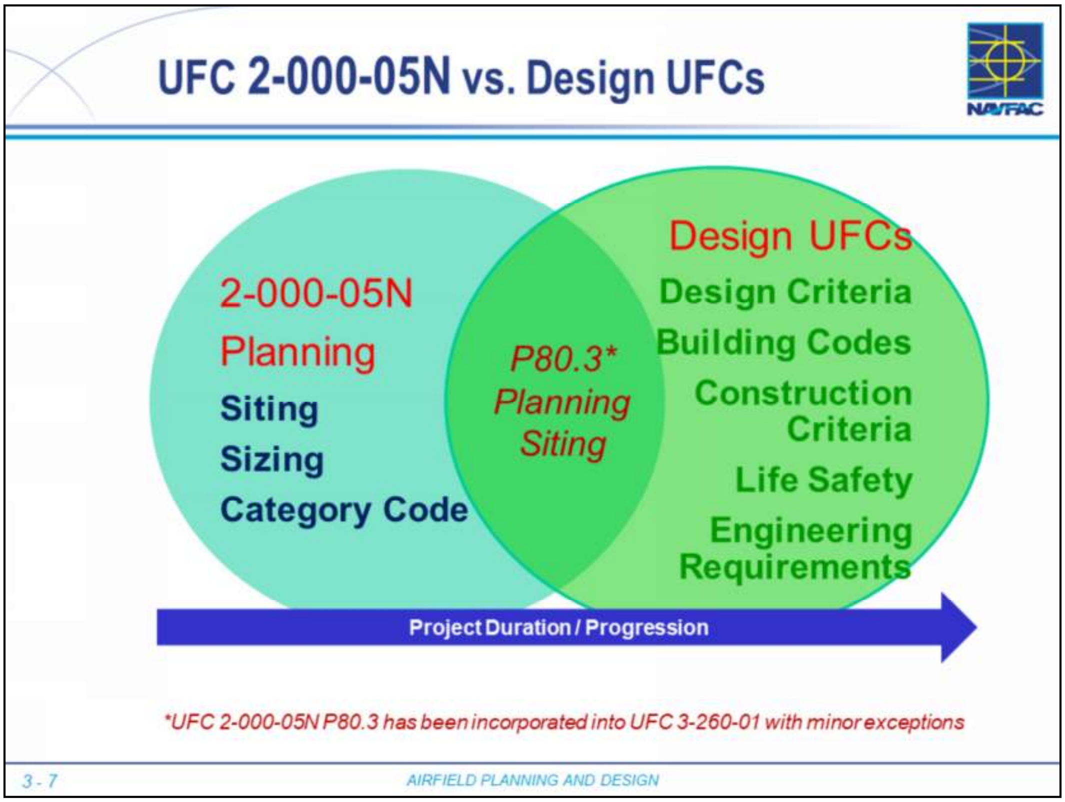
- Runways: prepared surfaces for the landing and takeoff of both fixed wing and rotary wing aircraft.
  - The number of runways and/or landing pads is determined by the expected traffic density, airfield mission, operational procedures and environmental factors.
  - Runway orientation is determined from analysis of wind data, terrain, noise levels generated, and local development conditions.
- Runway Width
  - Prior to 1981: 200-ft wide
  - After 1981, 200-ft wide for Class B, 75-ft wide for Class A, except trainers
- Runway Length
  - Long enough to accommodate a selected critical aircraft
- Critical Aircraft
  - Assigned to the installation or is to be supported by the installation
  - Requires the longest Takeoff Ground Run (TGR) or landing roll
  - Critical Aircraft for pavement design is a separate subject and will be addressed in Section 7
- Airspace – covered in both 3-260-01 and 2-000-05N
  - Check both sources – figures in 3-260-01 are more recently updated and generally easier to follow



- Modification of Existing vs New Construction
  - When existing facilities are modified, construction must conform to UFC 3-260-01 unless the criteria is waived
  - New construction must conform to UFC 3-260-01
- Joint Use
  - DoD Installations on FAA-controlled airfields must apply FAA criteria to facilities that are jointly used.
  - Military-only portions, such as aircraft parking aprons, must apply DoD criteria.
- Joint Service
  - One service will be designated as the primary airfield owner and responsible for airfield management and maintenance.
  - Rules for primary service will be applied to jointly used facilities
- OCONUS
  - Follow UFC first – always comply or waivers required
  - NATO Criteria project may additionally apply when project is funded by NATO at OCONUS location
  - Apply Host Nation Criteria when directed by SOFA or funded by Host Nation
  - ICAO Criteria may apply when required by the Host Nation
- Theater of Operations
  - US Army TM 3-34-34.48-2
  - UFC 3-260-01, Chapter 7 for C-130 and C-17 Landing Zones or FOBs in Chapter 8
- Airfield Safety Clearances
  - Defined in 2-000-05N, Appendix E (P-80.3) and UFC 3-260-01.



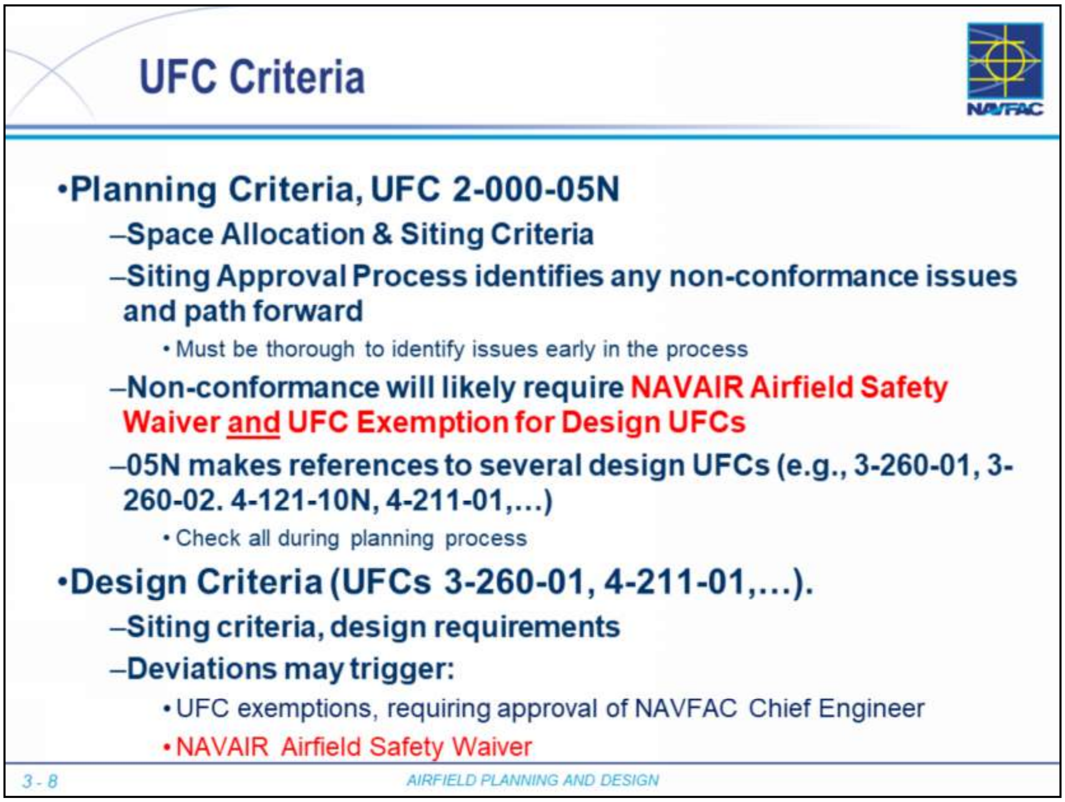
- 2-000-05N defines what to build
- Design UFCs (like 3-260-01, 3-260-02) define details and how to build
- Some overlap between planning and design



- Many airfield-specific parts of 2-000-05N have been incorporated into 3-260-01.
    - Appendix E (old P80.3) has mostly been incorporated, but Appendix E is more concise to Navy requirements.

- However, need to check both documents when planning on designing airfields.

- NOTE: Aircraft Parking Configurations Data for Navy is in 2-000-05N, not 3-260-01.



Overlap between criteria documents.

Planners at the FECs should not assume an Airfield Safety Waiver or UFC Exemption will be approved

Identify who are the experts?

UFC 2-000-05N vs. Design UFC Examples

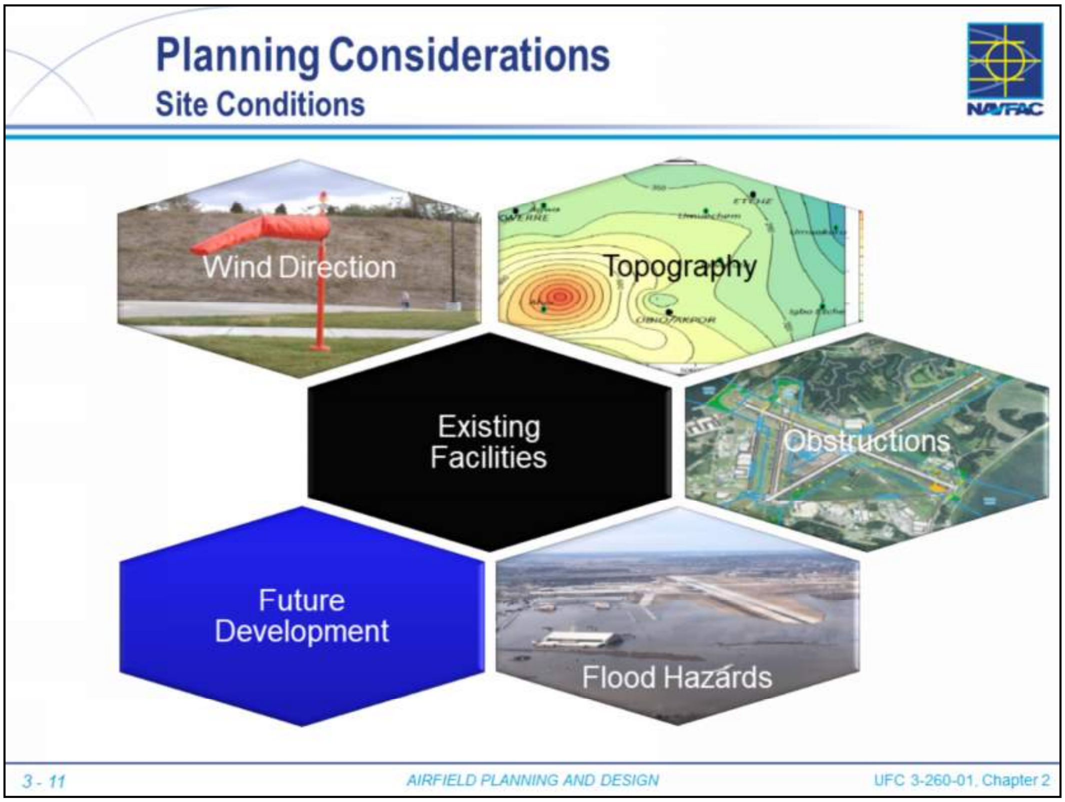
FACILITY	PLANNING CRITERIA	DESIGN CRITERIA
Aircraft Parking Apron	UFC 2-000-05N	UFC 3-260-01, Chapters 1, 6
	Category Code: 11320	UFC 3-260-02, Chapter 4
	Parking Distance	Concrete Design
	Parking Configuration	Shoulder Design
	Size	Subgrade
	Location	Grade
	Siting	Siting
Aircraft Hangar	UFC 2-000-05N	UFC 3-260-01
	Category Code: 21105/06/07	UFC 4-211-01
	Size	Mechanical
	Location	Utilities
	Siting	Fire Protection
		Security
		Architecture
		Structural
		Civil
		Interior/Exterior
		Siting

Example of the relationship between the Planning Criteria and the Design Criteria. Overlap between them both

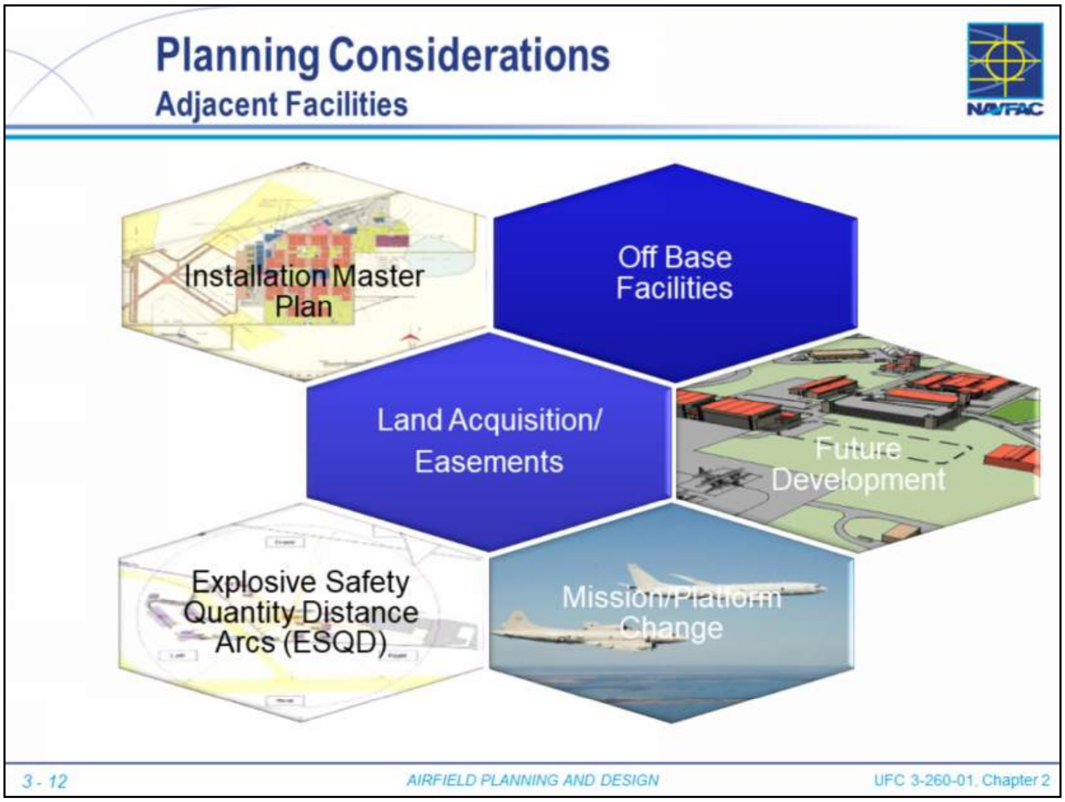
Planning decides how big and where.

Design decides specific requirements for facility components (loads, thicknesses, grades, etc.)

- Airfield Facility Planning process must consider a wide variety of issues when determining a site for a new facility.
    - Land Use Compatibility – guided by AICUZ
    - Topography
    - Airspace Clearances
    - Environmental
    - Access
        - Landside
        - Emergency Vehicles
        - Airside
    - Air Traffic Control Tower Sightlines

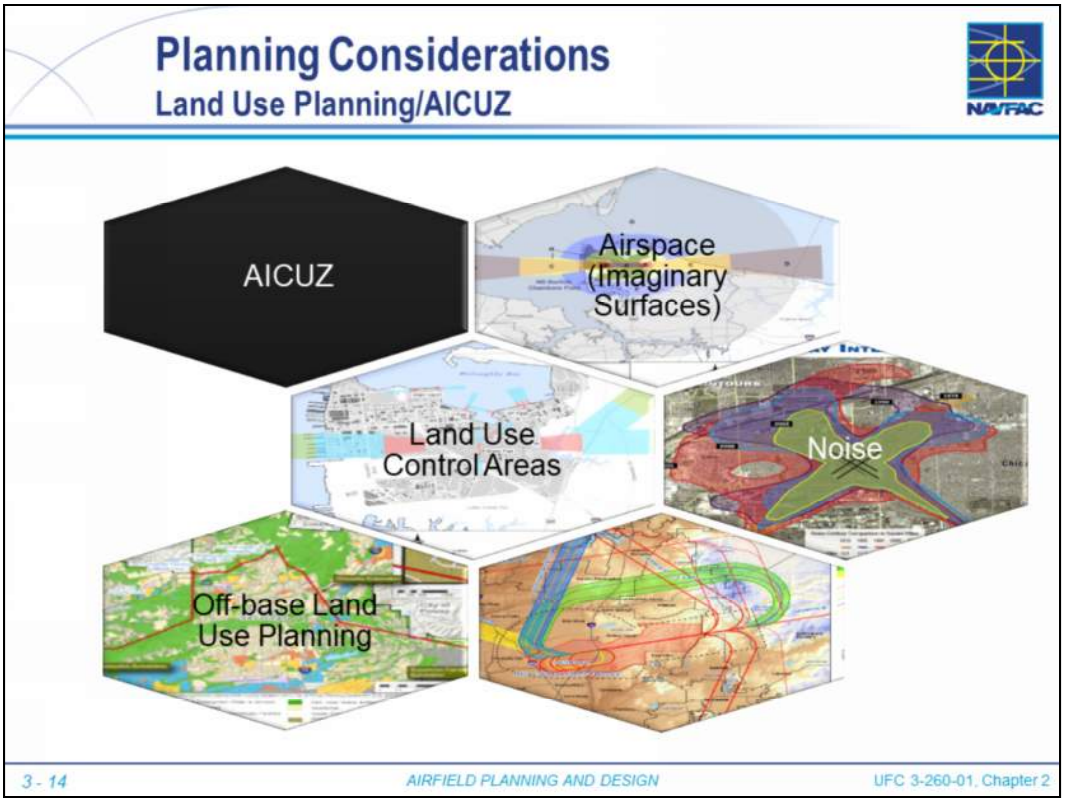


- Site Conditions
  - Wind
  - Topography
  - Existing Facilities
  - Flood Plains

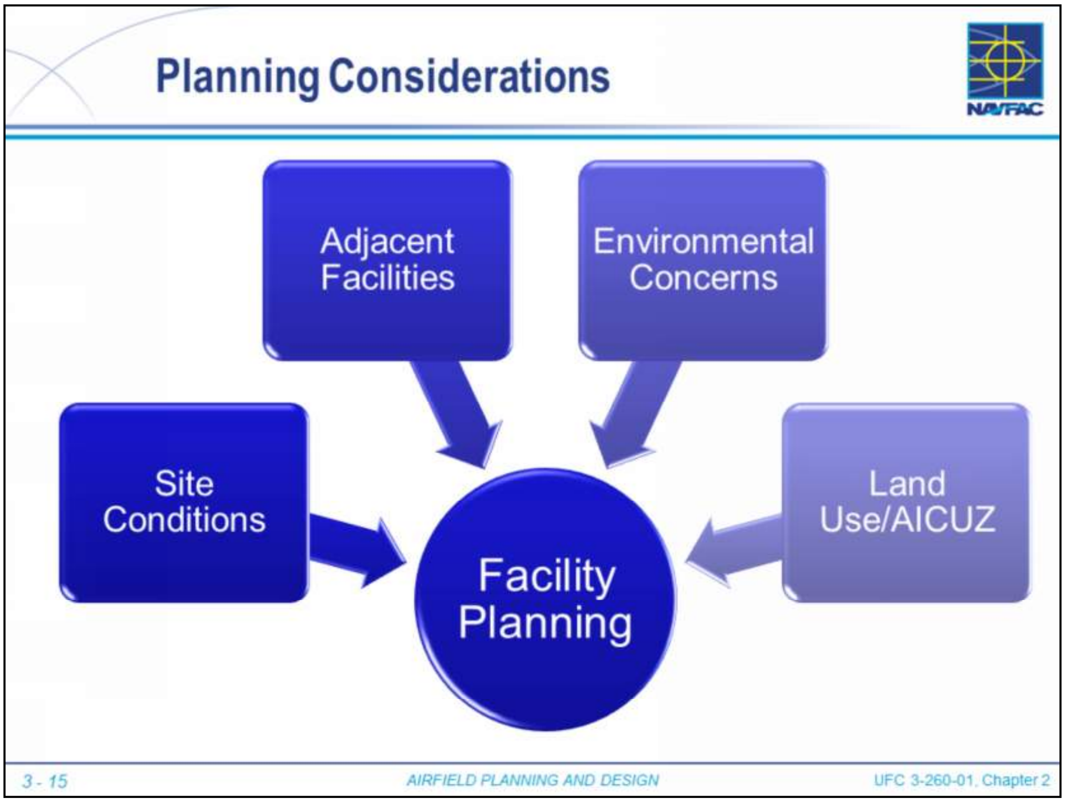


- Installation Master Plans
    - UFC 2-100-01, Installation Master Planning
    - NAVFAC, Naval Shore Infrastructure, Installation Development Plan Consistency Guide
- Off-Base Facilities
    - If development not controlled, may impact on-base siting
- Land Acquisition/Easements
    - Can be used to control development adjacent to Installation
- Future Development
    - Future planned developments (both on and off base) should be a consideration during the planning process
- Explosive Safety Quantity Distance Arcs (ESQD)
    - Munition Storage Areas and Combat Aircraft Loading Area (CALA) have Q-D Arcs (up to 1250’) that may impact where other facilities can be sited.
    - See NAVSEA OP-5 Ammunition and Explosives Safety Ashore for guidance

- Environmental
  - National Environmental Policy Act (NEPA) requires all Federal agencies to consider potential environmental impacts of proposed projects and activities
  - EA analyzes and documents the extent of environmental consequences of a proposed action
    - Results in Finding of No Significant Impact (FONSI) or EIS
  - EIS defines the impact and details measures required to minimize, offset, mitigate or avoid any adverse effects. ROD issued at conclusion.
  - CATEX – category of proposed action that does not individually or cumulatively have the potential for significant effect on the environment and does not require futher environmental analysis in an EA or EIS.

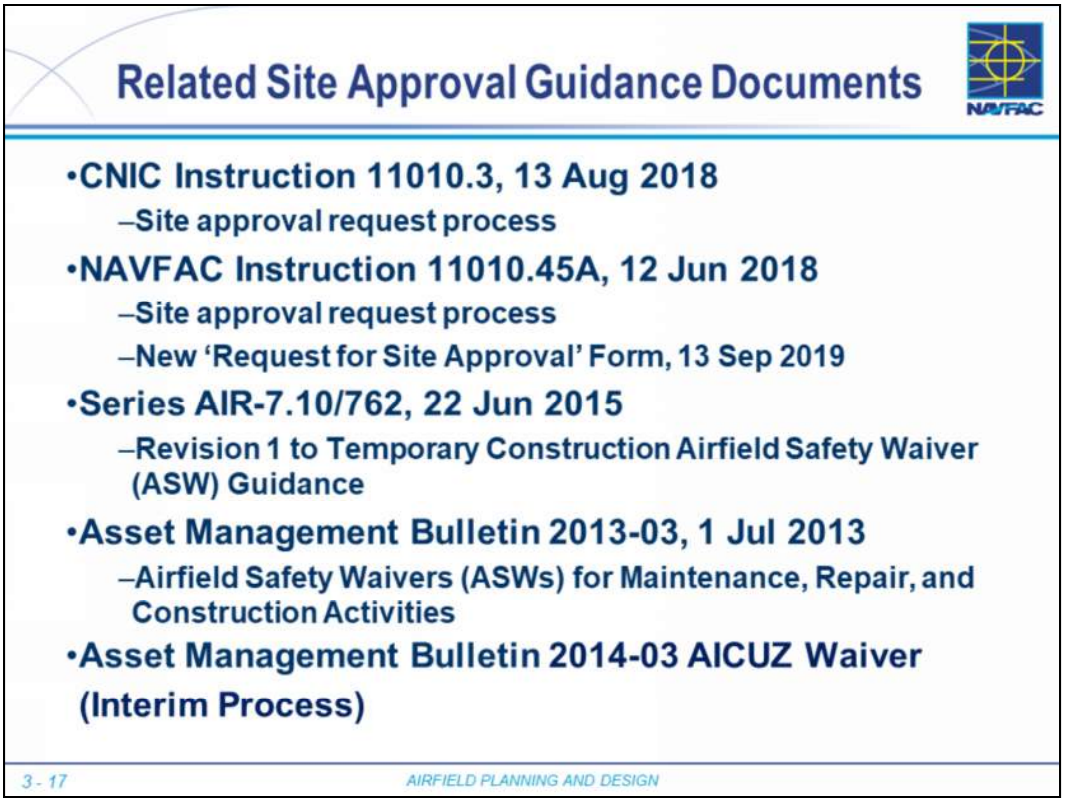


- Air Installations and Compatible Use Zones (AICUZ)
  - Governed by DoDI 4165.57 and codified by OPNAVINST 11010.36C/MCO 11010.16
  - Land use planning is a primary strategy for protecting a facility from problems that arise from aviation-generated noise and incompatible land uses.
  - Federal Agencies required to work with local, regional and state agencies to promote compatible uses both on and off the base.
  - AICUZ program promotes land use compatibility through active land use planning.
  - AICUZ documents disclose noise exposures and accident potential areas (zones) around an airfield based on future projected operations.
- Noise Studies
  - AICUZ program initiated to implement Federal laws concerning land compatibility from the perspective of environmental noise impacts.
- When required, an AICUZ Waiver Request can be submitted. Process defined in AM Bulletin 2014-03. See backup slides for details of the process.

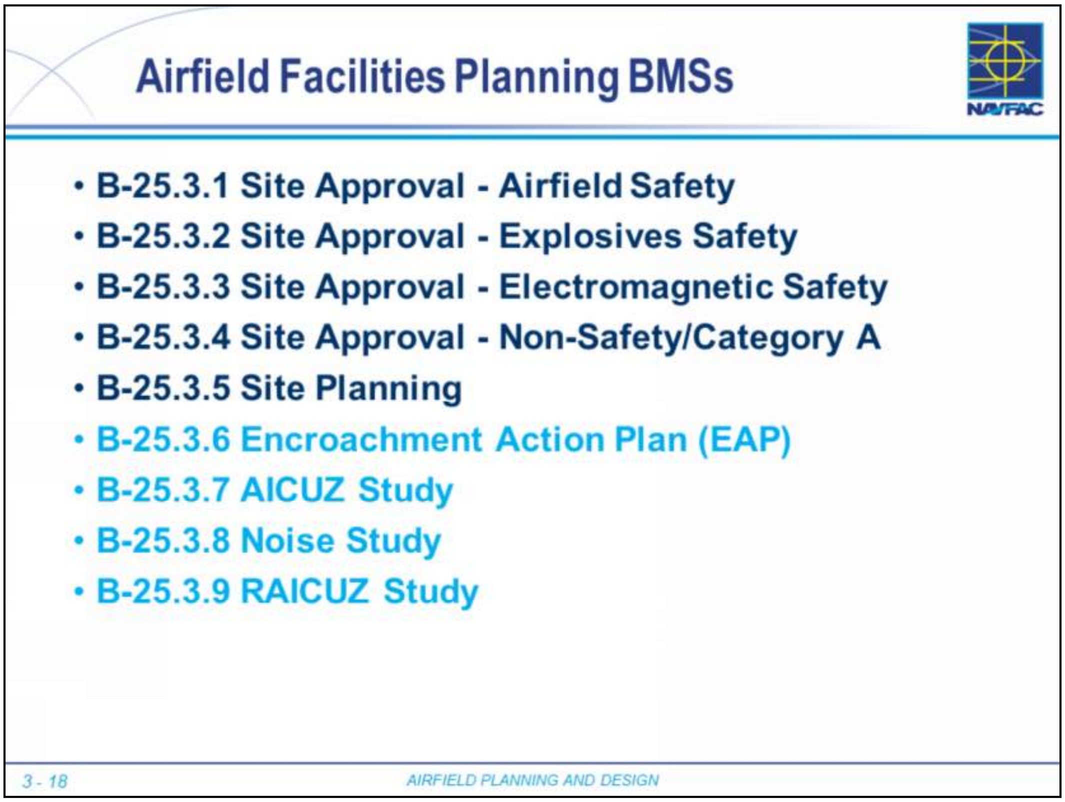


- In summary, there are many factors that influence facility planning.
    - All need to be considered from a lot of different angles.
    - All have different guidance documents – Federal, DoD and Local level rules may apply
    - Get all the issues on the table when moving into the site approval process

- The Siting Approval Process is clearly defined
  - Identifies all the issues and brings them together into one package for approvals
  - SAP Package gets approval from NAVFAC and other agencies



These are the many references that must be consulted during the Siting Approval Process



- BMS = Business Management Systems (step by step process like a Standard Operating Procedure)

- These are the BMS's related to airfields
- The processes are used to help identify the approvals that will be required

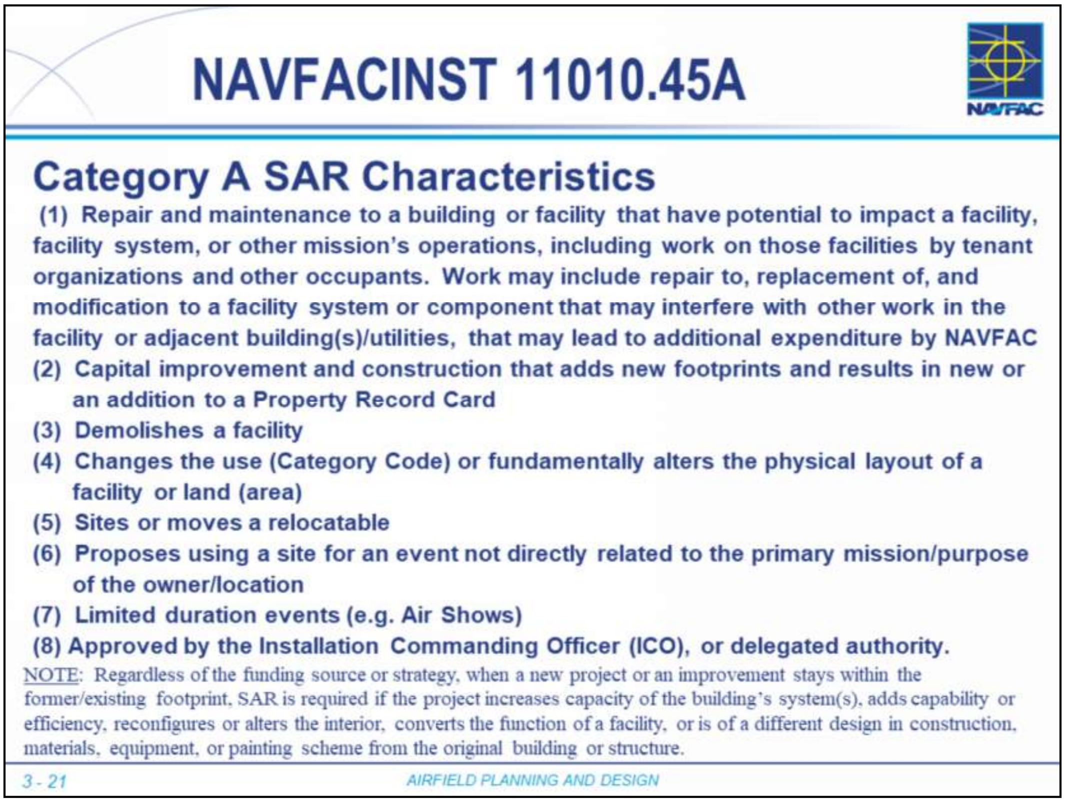
- BMS B-25.3.1 thru B-25.3.5 apply to every project.
  - BMS B-25.3.1 through B-25.3.4 Site Approval process for specific safety categories
  - BMS B-25.3.5 Site Planning is the Site approval process

- BMS B-25.3.16 thru B-25-3.9 are specific processes for a particular situation – likely consulted during the site approval process, if needed.
  - BMS B-25.3.6 through B-25.3.9 provide process/procedures for R/AICUZ, noise studies, and EAP document development. They support the site planning process.

- SAP Application required for
  - MILCON projects
  - Special Projects
  - Proposals/Events

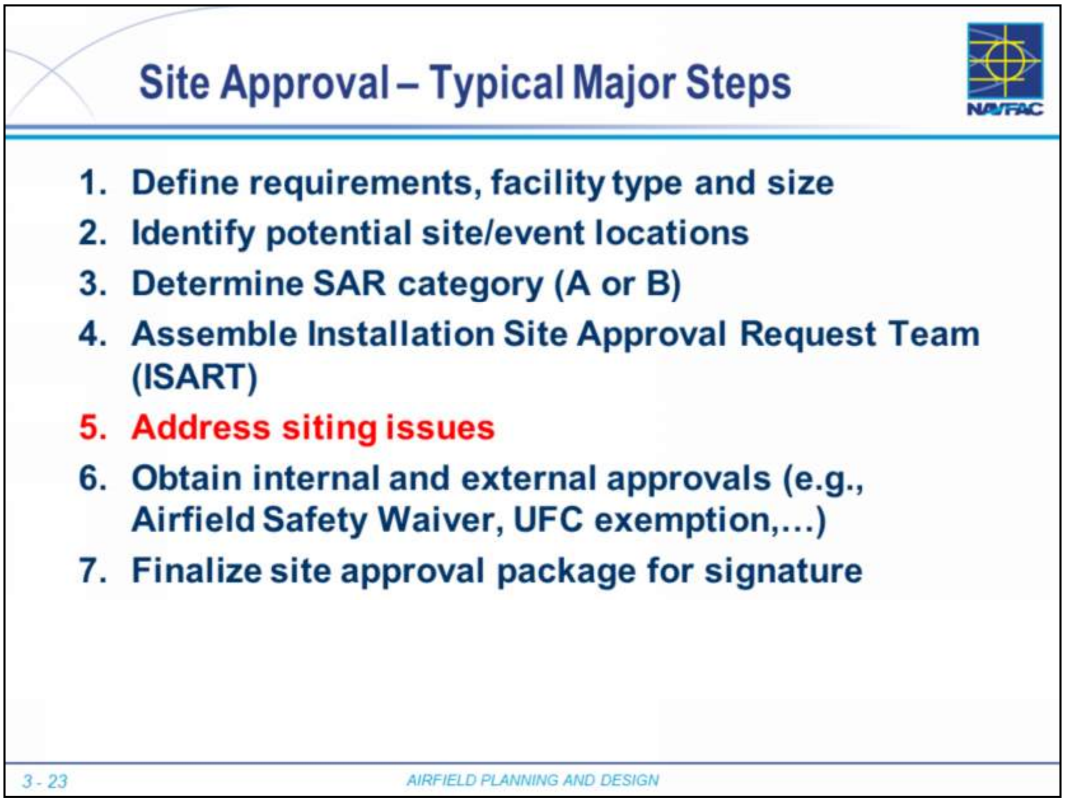
- Two SAR categories
  - A – ICO can approve
  - B – requires approval beyond ICO, such as NAVFAC CHEng, NAVAIR, etc. Anything safety-related is Category B

- All these requirements must be met to qualify as Category A

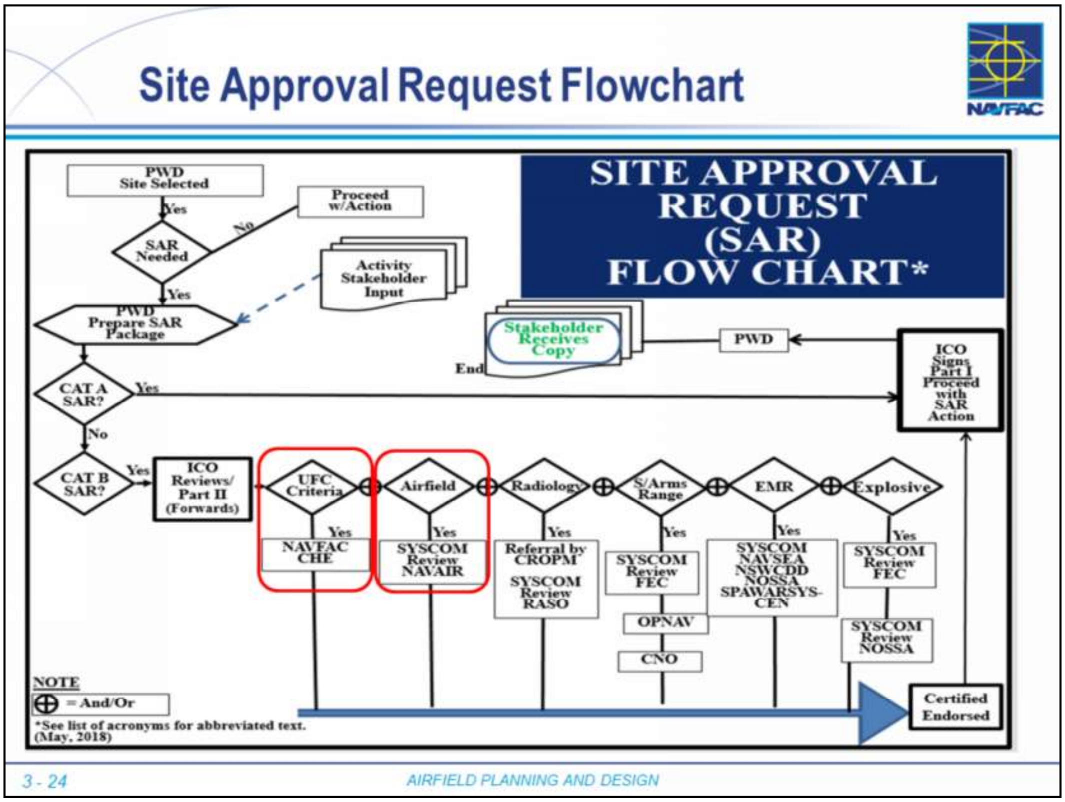


Additional Details for SAR Category A

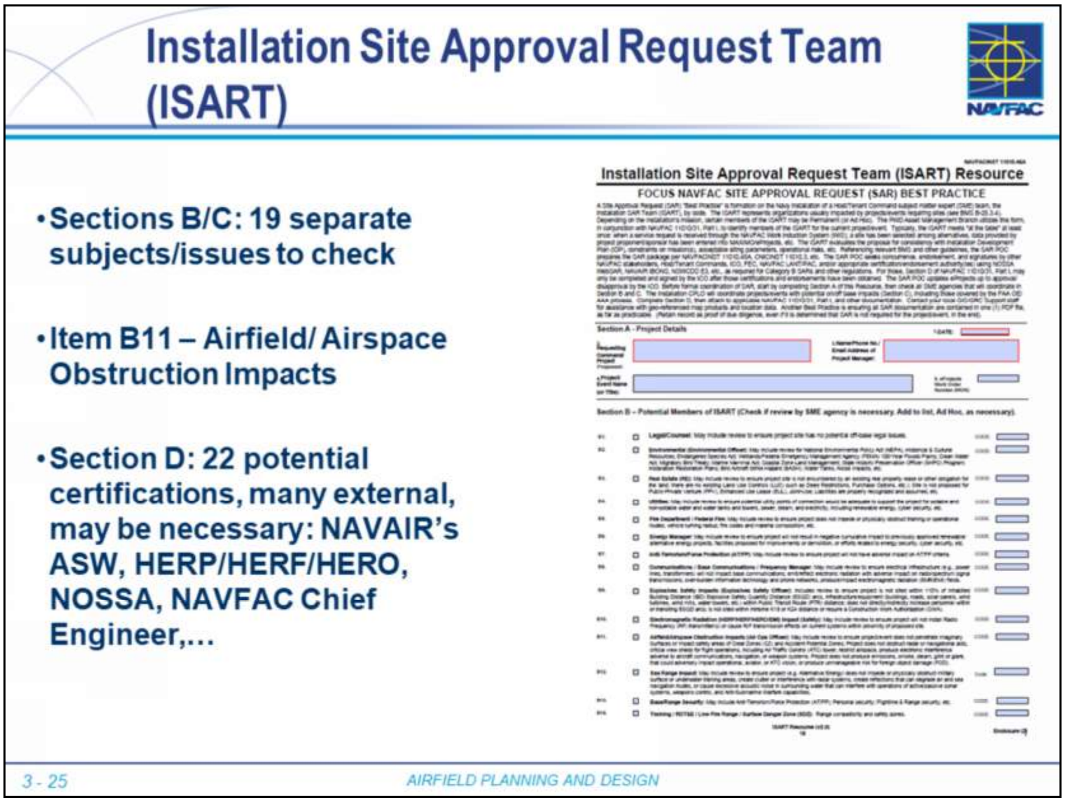
- If any of the following are impacted, then must be Category B SAR
    - Explosive Safety
    - Airfield Safety
    - Electromagnetic Radiation Safety (HERP/HERF/HERO)
    - Electromagnetic Radiation Safety (EMI)
    - Radiological Safety
    - Small Arms Range Safety
- If any UFC deviations identified, then automatically Category B



1. Define requirements, facility type and size
2. Identify potential site/event locations
3. Determine SAR category (A or B)
4. Assemble Installation Site Approval Request Team (ISART)
5. **Address siting issues – all issues must be thoroughly addressed during the planning process when there is still time to change course, as opposed to during design when the facility siting is complete, budget is set, and facility is wedged into a box.**
6. Obtain internal and external approvals (e.g., Airfield Safety Waiver, UFC exemption,…)
7. Finalize site approval package for signature



- Process is initiated by Public Works Department
- Cat A Site Approval Request (SAR) – local decisions and doesn't require waivers
- Cat B SAR –
  - Installation Commanding Officer reviews and requests input
    - UFC Criteria – NAVFAC Review Required
    - Airfield Safety – NAVAIR Review Required

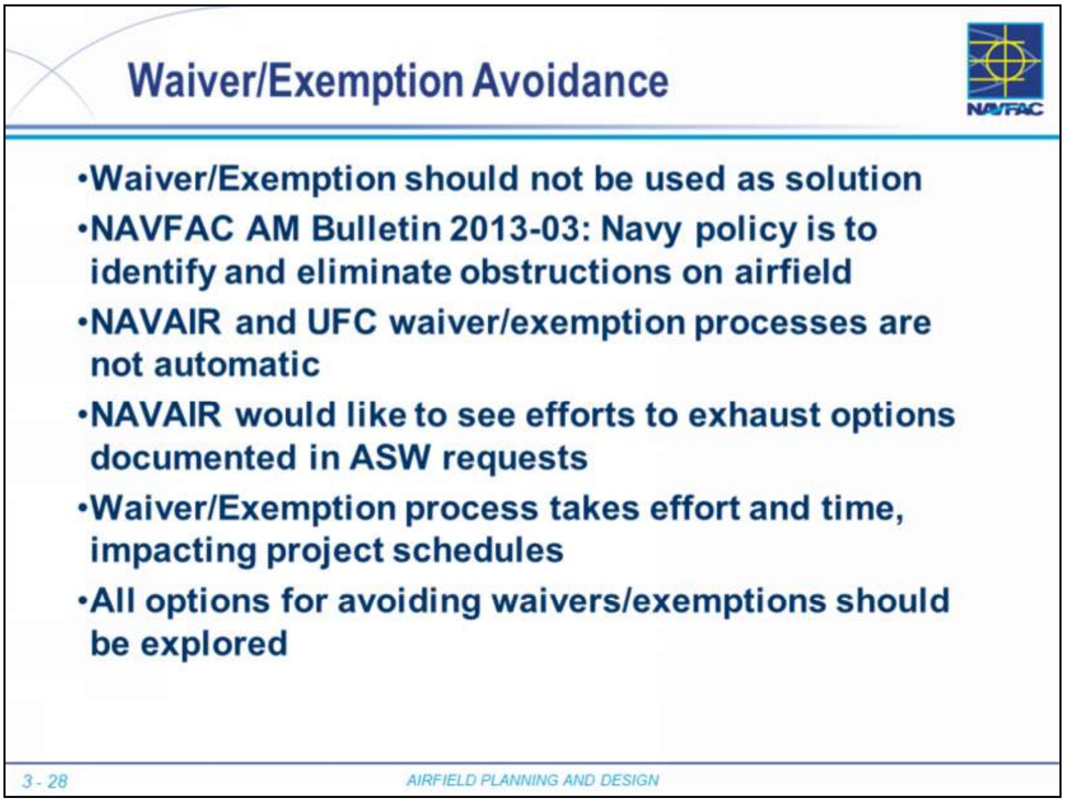


- ISART has a checklist to assist in the planning process
    - Very detailed
    - Triggers reminders of the various organizations that must be consulted during the SAP

Example Siting Challenge

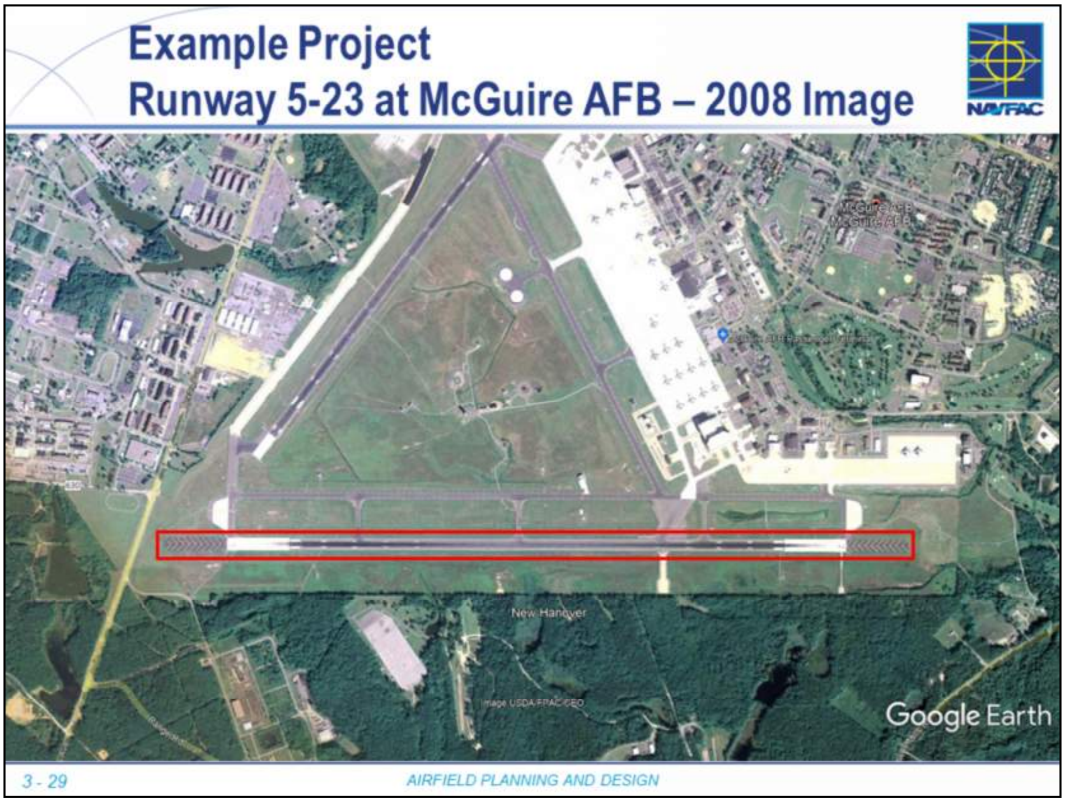
- Air Traffic Control Tower is a good example of a challenging facility to site on the airfield
  - Operational Requirements -
    - Unobstructed view to all runway surfaces from Tower Cab
    - ATCT controller eye level is critical –
    - Eliminate potential for obstructions due to parked aircraft
    - Connections to multiple facilities on the airfield (Lighting Vault, TACAN, Radar, ILS, Weather, etc.)
    - Avoid conflict with Airspace Imaginary Surfaces
  - All other planning factors/constraints already described in this chapter influence site
- UFC 3-260-01, Appendix B, Section 16 provides ATCT siting criteria.
- UFC 4-133-01 *Air Traffic Control and Air Operations Facilities* (June 2019) defines facility design requirements for ATCTs
- UFC 4-141-10N (old MIL-HDBK-1024/1) contains requirements for other Air Traffic Control Facilities, such as ATC communications, TACAN, PAR and other NAVAIDs, with specific siting guidance that planners should be know. Document is scheduled for update in 2020.

- 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
    - Automated Access Controls like Automated Pedestrian Turnstiles or Vehicle Gates
- Example Hangar & Apron shows two options for separating airfield from landside
    - Red – Airfield Perimeter fence terminates into building. Access Controls at roadway gates and entry into building
    - Yellow – Perimeter fence between parking lot and building. Access controls at driveways and sidewalk turnstiles
- 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.

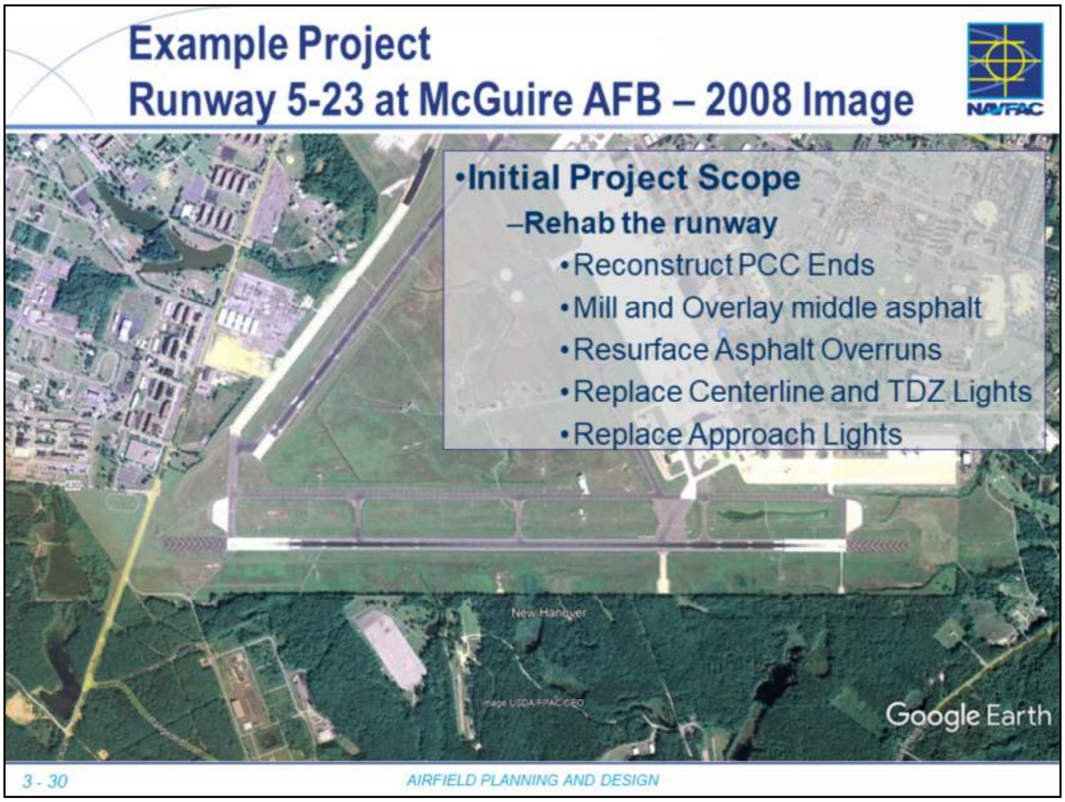


- Waiver/Exemption should be viewed as a last resort, not a first step
  - UFC
  - ASW
  - AICUZ
- Budget cannot be a sole justification for pursuing a waiver
- Planners need to be the gate keeper to force evaluation of all options
- Criteria Inquires? Contact NAVFAC AM office

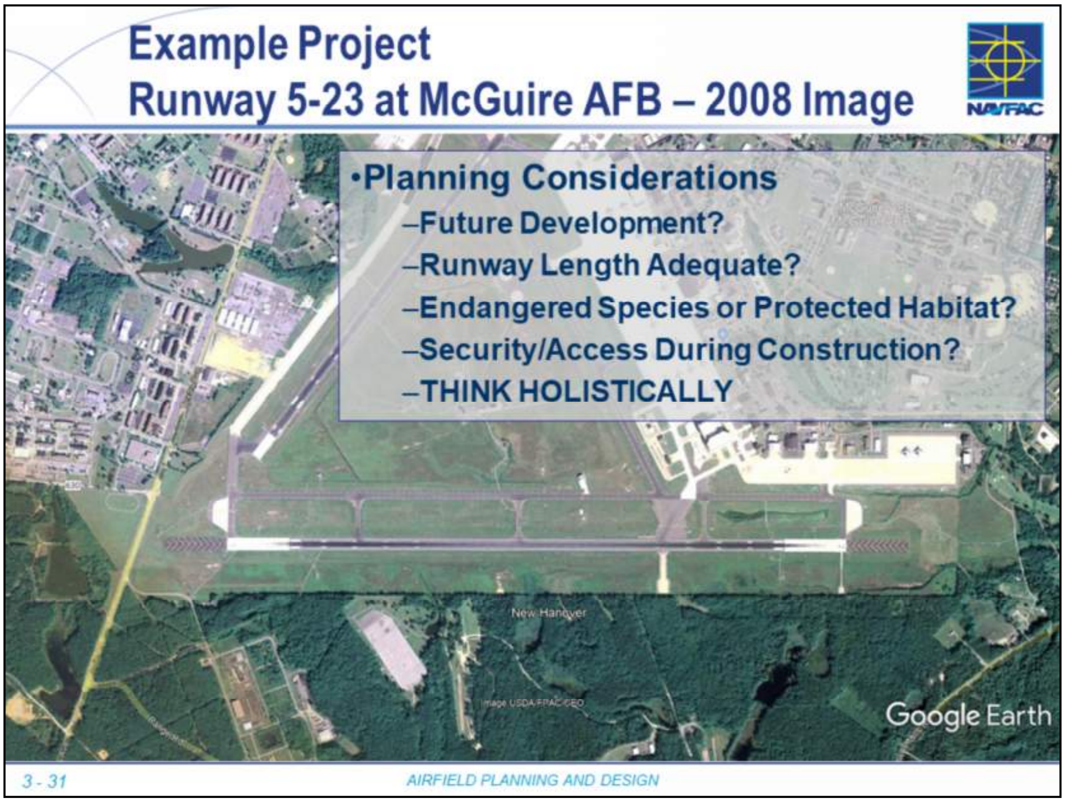
- REMEMBER
  - Exemptions/Waivers mean more risk is assumed by the approving authority. This is not desirable.
  - Need to evaluate cost vs. risk.



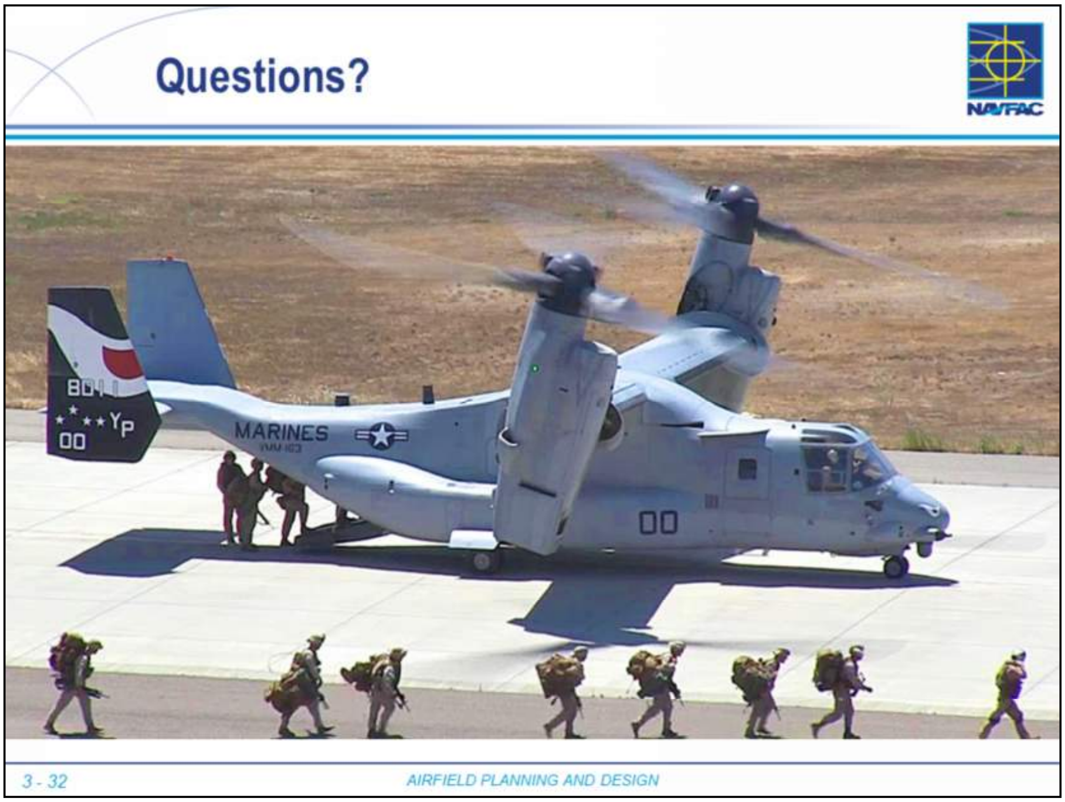
- For each following section in this class, we will try to apply what we have talked about to a particular project.
- 2008: McGuire AFB Runway 5-23
  - Low PCIs
  - Reconstruct/Rehab the pavements



- Initial Project Scope
  - Rehab the Runway
    - Reconstruct PCC Ends
    - Mill and Overlay middle asphalt
    - Resurface Asphalt Overruns
    - Replace centerline and TDZ Lights
    - Replace Approach Lights



- What are the planning items that should be considered when scoping the project and developing the programming documents?
    - Future Development. Are there plans for future development (aprons, hangars, etc.) that need direct access to the runway?
    - Runway Length. Does the current runway length meet the needs of the current and future missions? Is there room (land and airspace) to extend then length if needed?
    - Endangered Species or Protected Habitat? Need to do these investigations in the planning phase to determine the implications or constraints on design and construction.
    - Security and Access During Construction. A big airfield project moves very large quantities of materials (aggregates, soil, cement, pipes, etc.). Need to think during planning about how that material will get onto the base and where it will be stored during construction.
    - During planning, try to think BIG PICTURE about what should be included in the project and identified on the programming documents (and cost)



- UFC 2-000-05N is primary planning reference for airfields.
    - Defines Basic Facility Requirements depending on Missions, Functions and Tasks.
- Planning and Design UFCs have some overlap.   Use 2-000-05N Appendix E for aircraft parking configurations.
- Airfield Planning requires consideration of many different factors and many different agencies may have regulatory/permitting requirements.
- Start planning early to identify all potential constraints and/or conflicts.
- Site Approval Request has formal, well-defined process for approval.

- Main Parking Apron
- Hazardous Cargo Pad
- Constrained Site

Back-up Slides

Site Identification & Approval

REQUIREMENT: Complete site identification and approval documentation

- Verify that the site conforms to the installation development plan (IDP), RSIP & GSIP, as applicable; identify at least one backup site
- Provide the status of the site approval; attach current Site Approval **(i.e., signed or revalidated no later than March BY-3)**
- Identify any potential impacts from: adjacent ordnance facilities or operations, emitters, natural resources, or man-made constraints
- Identify any natural, historic or cultural resource constraints
- Provide a site plan with proposed project location indicating existing or proposed utility lines & points of connection, roadways & parking
- Describe any known or potential site or constructability constraints; identify any possible "showstoppers" **(i.e. things that would prevent BY execution)**
- Identify real estate action requirements: easements, legal interests, encumbrances, rights of way, leases, fee simple purchase; if applicable, real estate specialist certification is required
- Identify any AT/FP, adjacency, safety, and/or height restrictions
- Explain the siting rationale and proposed mitigation measures if the proposed project site(s) is in a 100-year flood plain
- State any issues if the site has explosive safety and/or electromagnetic radiation safety implications

Points of Contact (POC)

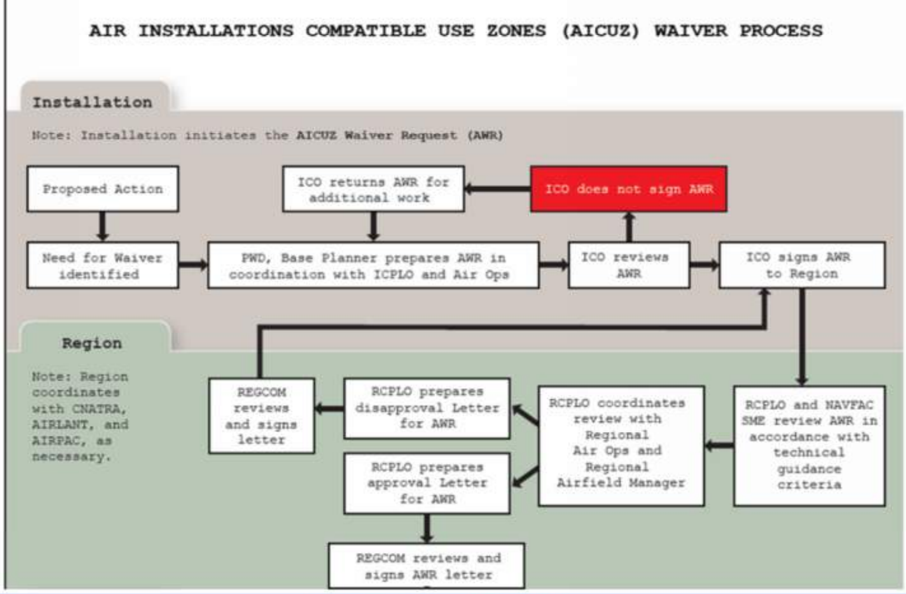
Airfield Safety (NAVAIR); Leroy Mattingly, Ph: (301) 757-2145
AICUZ (HQ); David Shizak, Ph: (202)685-9300
AICUZ SMEs (LANT); Bonnie Curtiss (757)322-4464, Tracey Shifflet (757-322-4332)
Explosives Safety (NOSSA); Mike Wiles, Ph: (301) 744-6013
EMR (HERP/HERF/HERO), (NSWCDD); Steven Springer, Ph: (540) 653-7494
EMR (EMI), NAVWAR/NIWC; Wayne Lutzen, Ph: (843) 218-5273
Radioactive Safety, OIC/RASO; Kevin Huhn: (757) 887-7560/4692
Radiological Safety (NAVFAC Safety - CROPM): Check with Installation
Small Arms Range Safety (NAVFAC LANT): Jeff Creekmore, (757) 322-4316
(NAVFAC PAC): Layne Hazama (808) 472-1276
ESS Help Desk/Training (EXWC/CI); Michael Oesterle, Ph: (805) 982-3398
MCAR/MSRC Training (NAVFAC LANT); Marshall Dugger, Ph: (757) 322-4981
HQ NAVFAC Asset Management/AM3/Program Lead: Kofi Newman, Ph.D., Ph: (202) 685-9305; (DSN: 325-9305)

SAR Webpage: https://hub.navfac.navy.mil/webcenter/portal/am/page1848

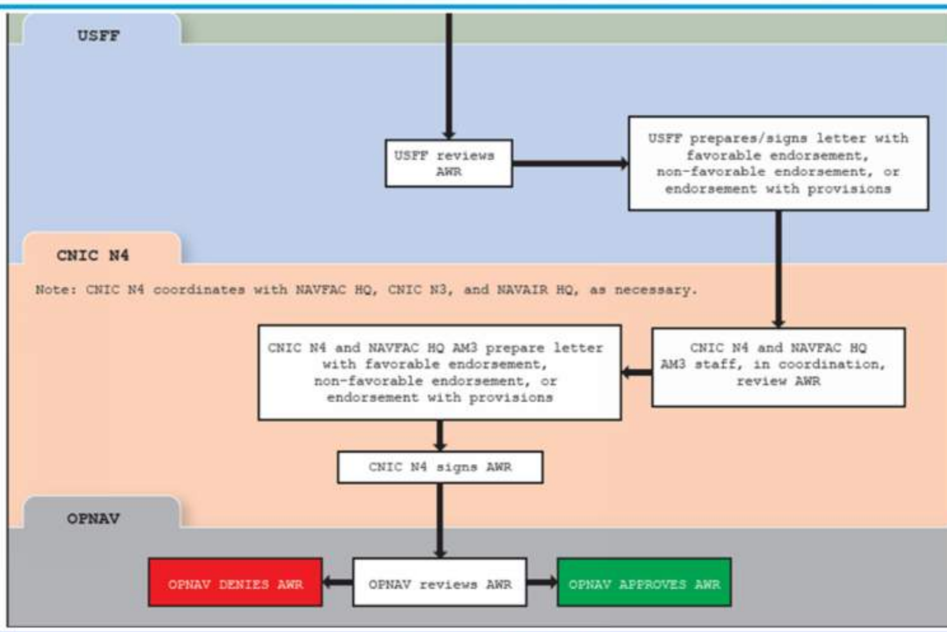
AICUZ Waiver Request

- AM Bulletin 2014-03 AICUZ Waiver Request Interim Process
- Required for proposed non-conforming uses on base within approved AICUZ Study Clear Zones, APZs and Noise Contours
- General Process
  - Installation initiates request
  - Region provides technical review
  - If validated, Region initiates waiver request to CNO via USFF and CNIC
  - NAVFAC HQ provides additional technical review
  - If approved by CNO, requires review every five years for validation of continuing requirement
  - Sample letters are included

AICUZ Waiver Request



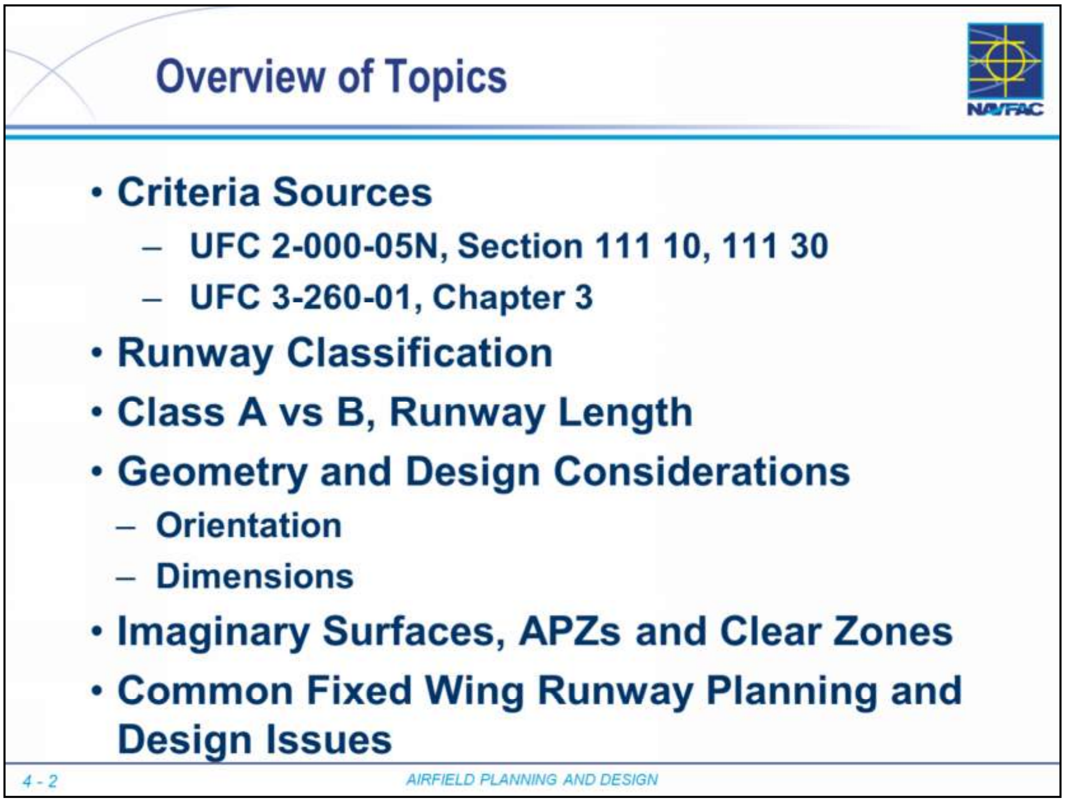
AICUZ Waiver Request



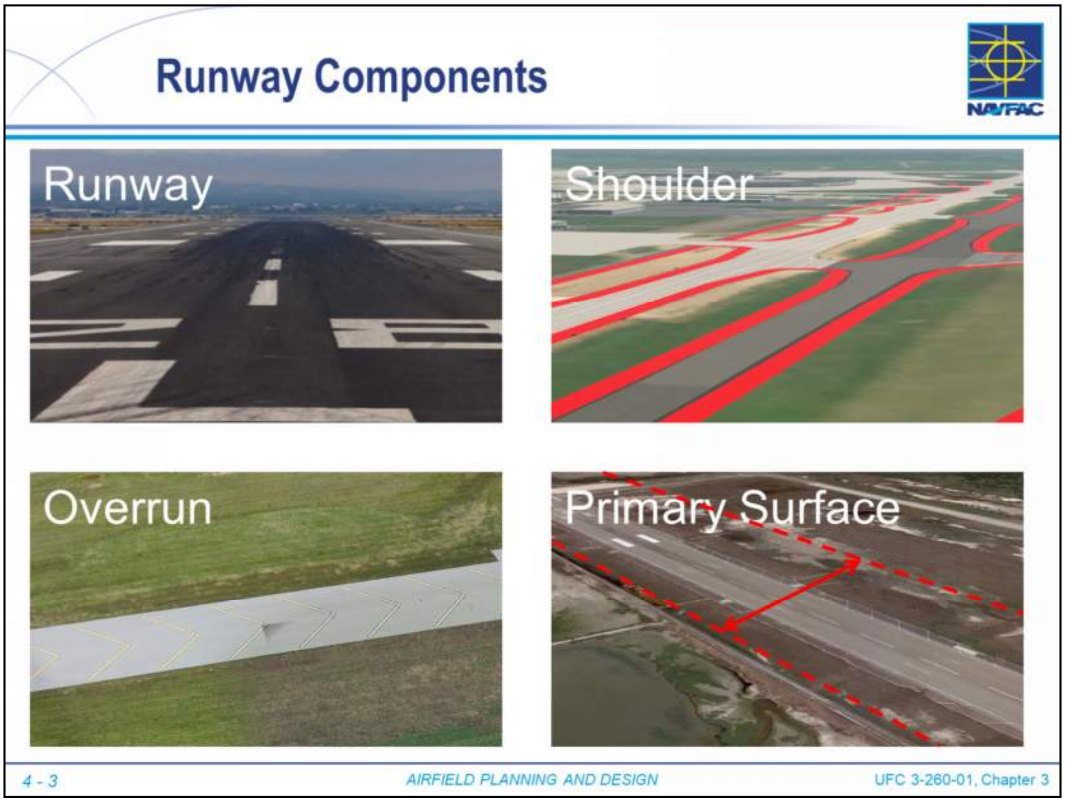
Section 4
Fixed Wing Runways

AIRFIELD PLANNING AND DESIGN
CRITERIA TRAINING

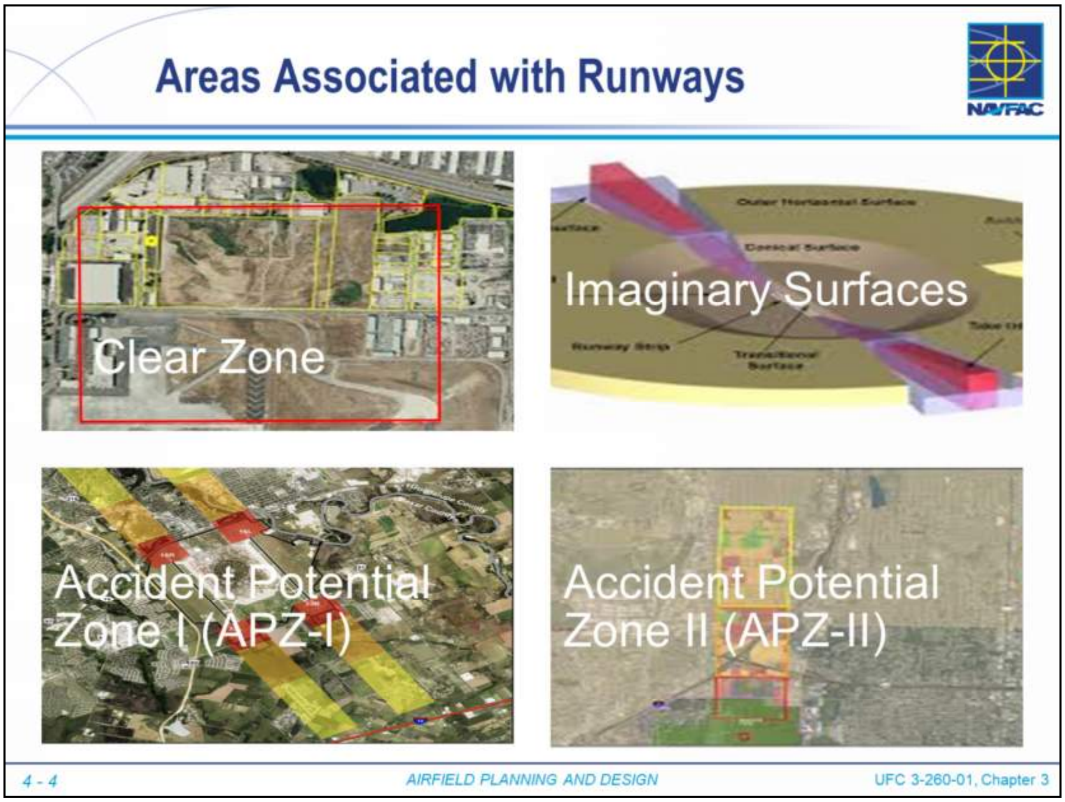
5/7/2023



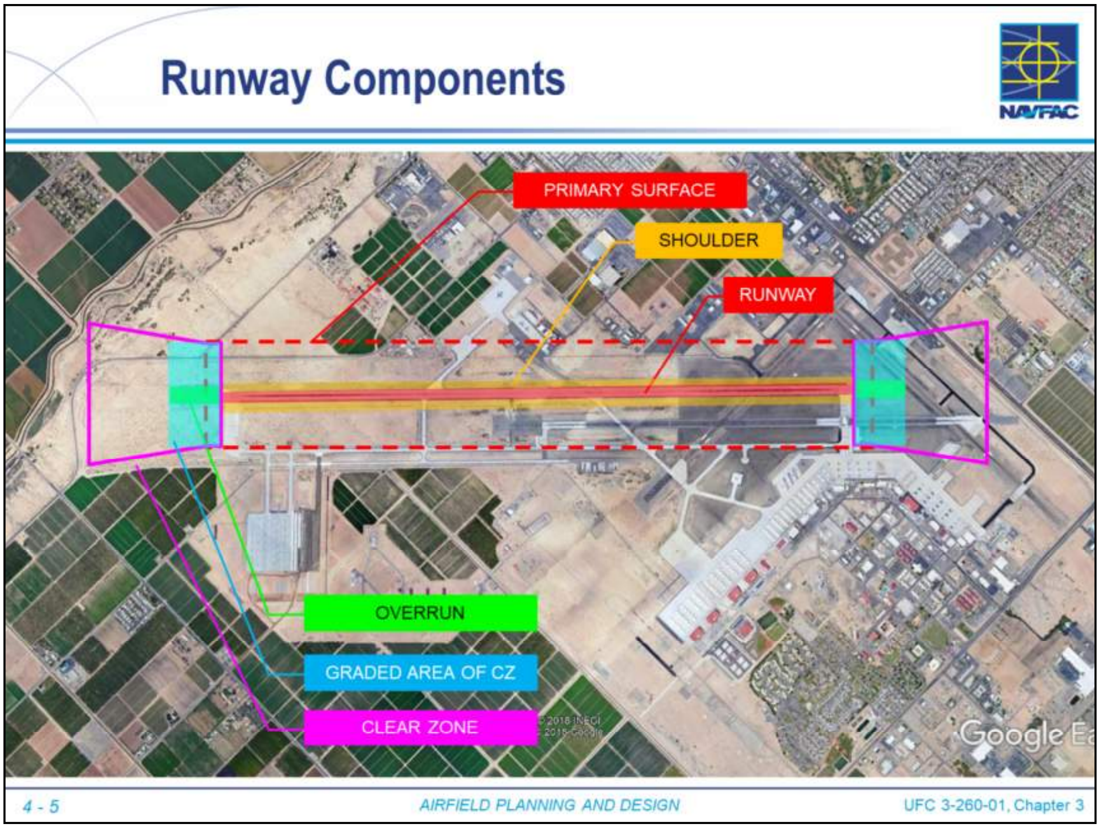
- Review list of topics to be covered during this Section of the Class



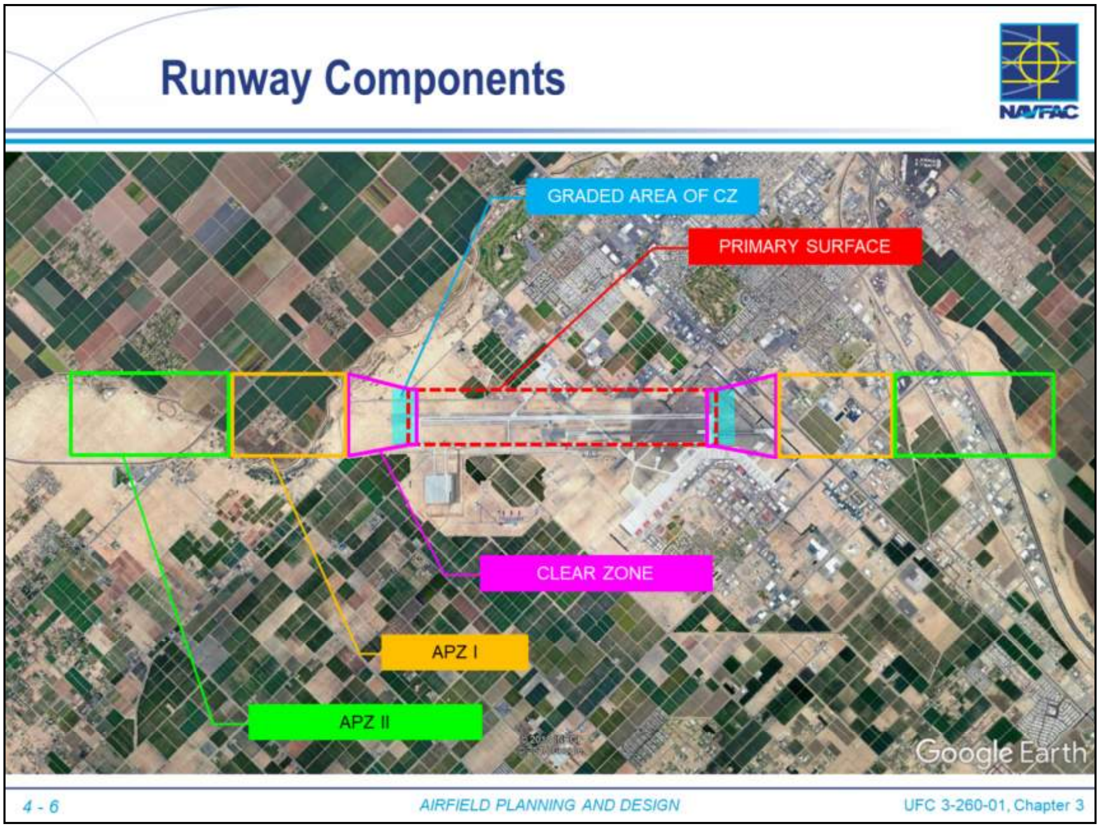
- Runway: A defined rectangular area of an airfield or heliport, with no curves or tangents, prepared for the landing and takeoff run of aircraft along its length.
- Shoulder: Prepared (paved or unpaved) area adjacent to the edge of an operational pavement.
- Overrun: Area the width of the runway plus paved shoulders extending 1,000-ft (Class A or B) from the end of the runway. This portion is a prolongation of the runway which is the stabilized area.
- Primary Surface: An imaginary surface symmetrically centered on the runway, extending 60.96 m (200 ft) beyond each runway end. The width varies depending upon the class of runway and coincides with the lateral clearance distance. The elevation of any point on the primary surface is the same as the elevation of the nearest point on the runway centerline.



- These terms are defined in both UFCs and the DoD/Navy AICUZ program
    - Per AICUZ Program, The area immediately beyond the usual runway threshold and along primary flight paths is designated the "Clear Zone." It is the area with the greatest potential for occurrence of aircraft accidents and should remain undeveloped. The Clear Zone is required for all active runway ends.
- Clear Zone: Surface on the ground or water beginning at the runway end and symmetrical about the runway centerline extended.
- Imaginary Surfaces: Surfaces in space established around airfields in relation to runway(s), helipad(s), or helicopter runway(s) that are designed to define the obstacle free airspace around the airfield. The imaginary surfaces for DoD airfields are the primary surface, the approach-departure clearance surface, the transitional surface, the graded area of the clear zone, the inner horizontal surface, the conical surface (fixed-wing only), and the outer horizontal surface (fixed-wing only).
- Accident Potential Zone I (APZ-I): Land Use Management Area beyond the Clear Zone that possesses a significant potential for accidents.
- Accident Potential Zone II (APZ-II): Land Use Management Area beyond APZ I that has a measurable potential for accidents.

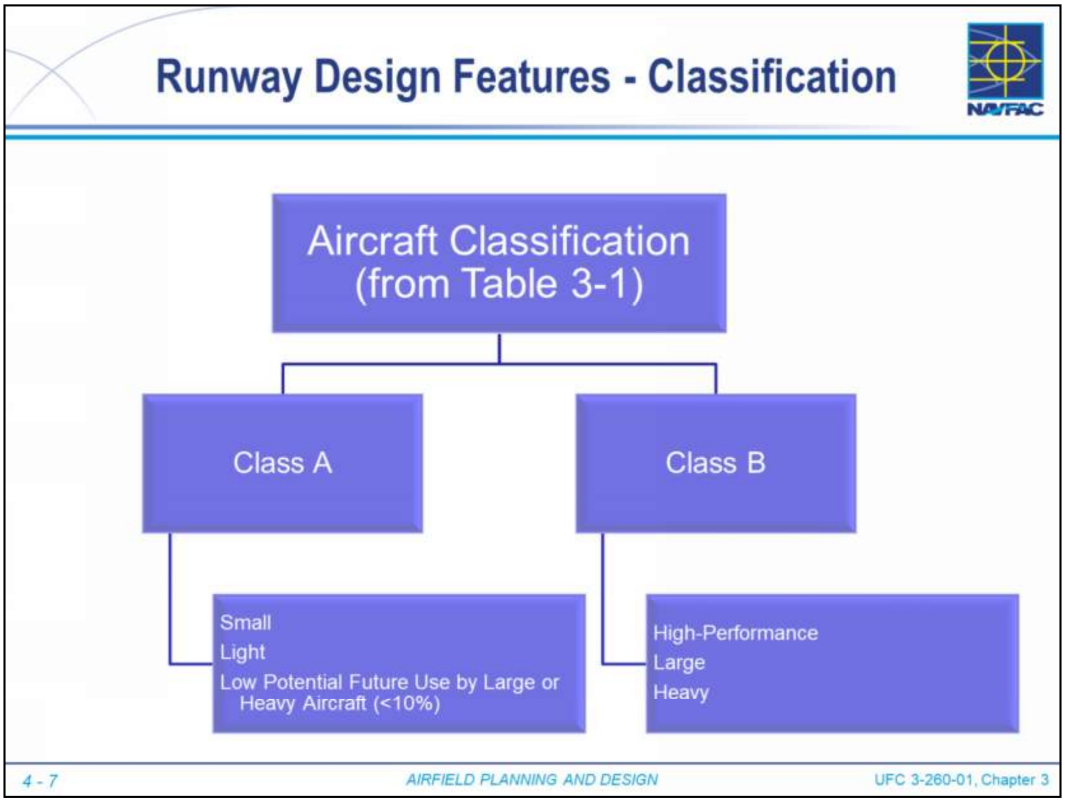


- MCAS Yuma aerial to illustrate the different features (each feature appears on a click)
  - •Runway (Red Shade)
  - •Shoulder (Gold Shade)
  - •Overruns (Green Shade)
  - •Primary Surface (Red Dashed)
  - •Clear Zone (Magenta Solid)
  - •Graded Area of Clear Zone (Light Blue Shade)



• MCAS Yuma now **zoomed out** to show Clear Zones and APZs (each feature appears with a click)

- •Primary Surface (Red Dashed)
- •Clear Zone (Magenta Solid)
- •Graded Area of the Clear Zone (Blue Shading) – max 10% grade
- •APZ-I (Gold) – a land use management area (AICUZ)
- •APZ-II (Green) – a land use management area (AICUZ)



- UFC 3-260-01, Table 3-1: lists aircraft by classification

UFC 2-000-05N, Para 110-2 States "All Navy and USMC supporting pavements such as taxiways, aprons, etc., shall be considered class B unless their use is totally dedicated to supporting a runway

which has been designated class A and the application of class A standard has been approved by Headquarters NAVFACENGCOM and NAVAIRSYSCOM."

- Class A
  - Small, light aircraft
  - Low potential future use by large or heavy aircraft (<10% of total operations)
  - HOWEVER, Class A can be used by C-17 and C-130 on a limited basis, as long as pavements can support.
  - APZ for Class A Runway is 5,000' long, 1000' wide
- Class B
  - High-performance, large, heavy aircraft
  - APZ for Class B Runway is 12,000' long, 3,000' wide (Navy and Air Force) or 1,000' wide (Army)
- Class A or Class B decision should **not** be made by designer or airfield manager. This decision should be made at a higher operational level.

Fixed Wing Runways

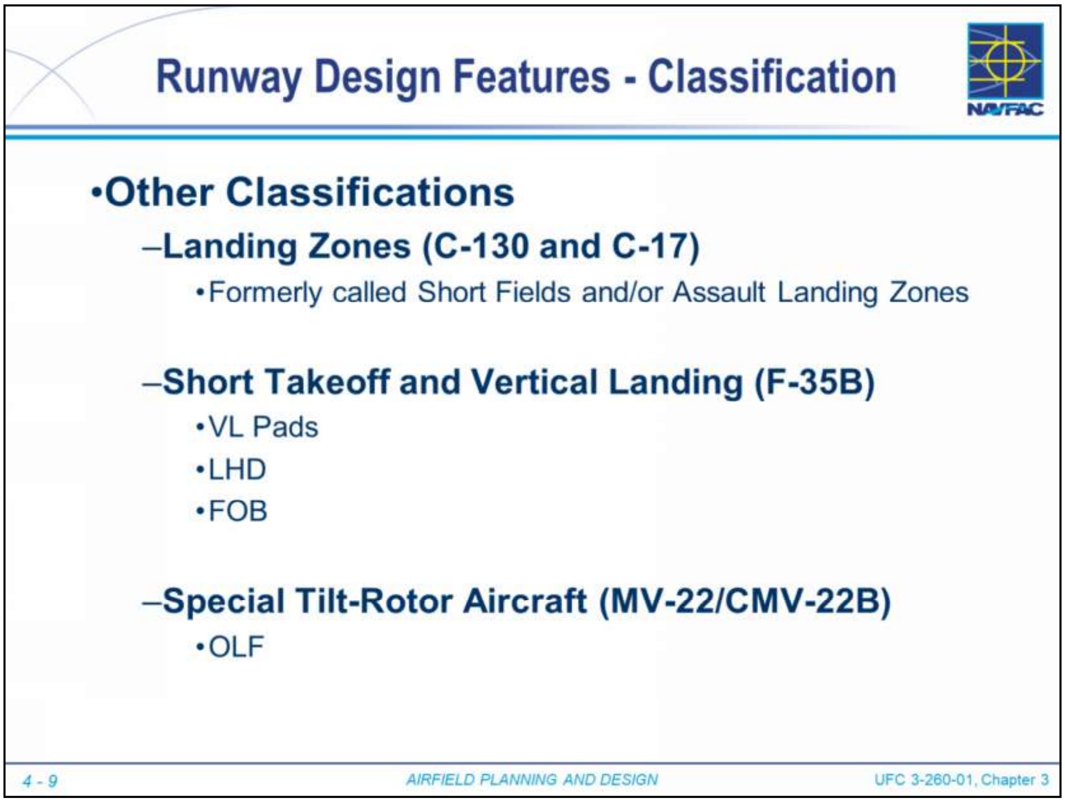
NAVFAC

Table 3-1. Runway Classification by Aircraft Type

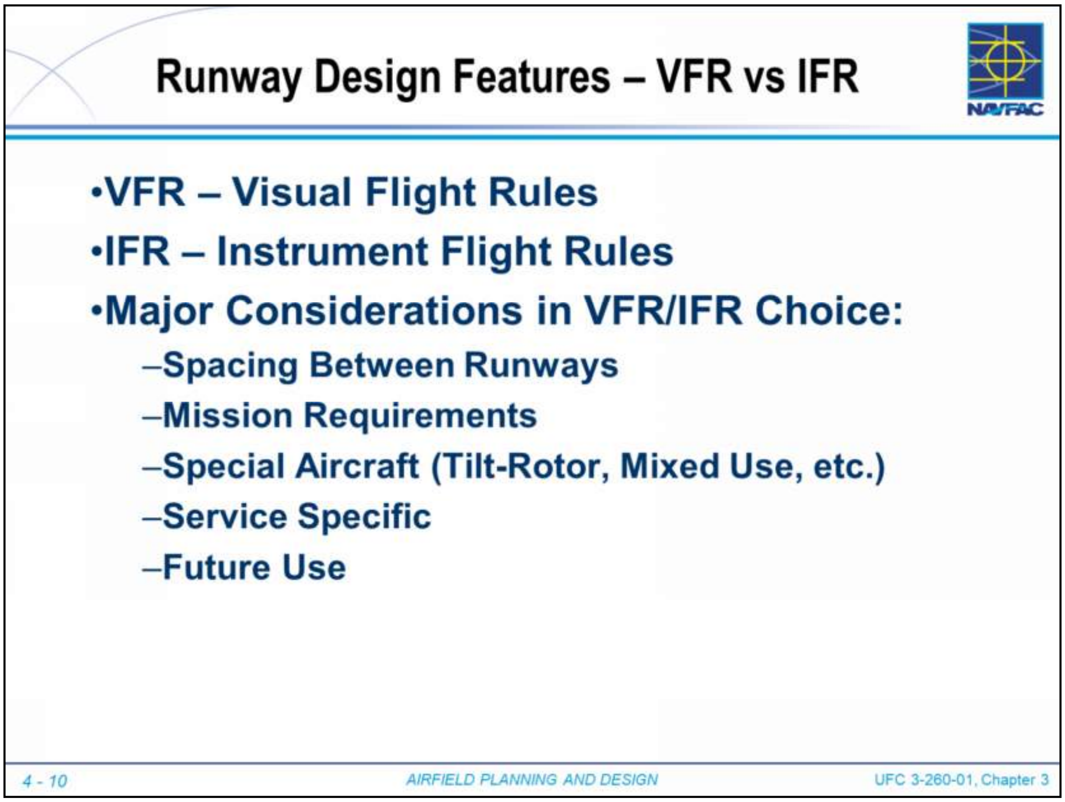
Runway Classification by Aircraft Type				
Class A Runways		Class B Runways		
C-1	OV-10	A-4	E-3	P-3
C-2	T-3	A-6	E-4	P-8
C-12	T-6 (Navy)	EA-6B	E-6	RQ-4
C-20	T-28	A-10	E-8	RQ-9
C-21	T-34	AV-8	EA-18	MQ-4
C-22	T-41	B-1	R/F-4	S-3
C-23	T-44	B-2	F-5	T-1
C-26	U-21	B-52	F-15	T-2
C-37	UC-35	C-5	F-16	T-6 (Air Force)
C-38	UV-18	C-9	E/F/A-18	T-38
E-1	V-22	KC-10	F-22	T-43
E-2	DASH-7	KC-135	F-35	T-45
MQ-1	DASH-8	KC-46		TR-1
		C-17		U-2
		C-27J		VC-25
		C-32		
		C-40		
		C-130		
		C-135		
		C-137		

4 - 8 AIRFIELD PLANNING AND DESIGN UFC 3-260-01, Chapter 3

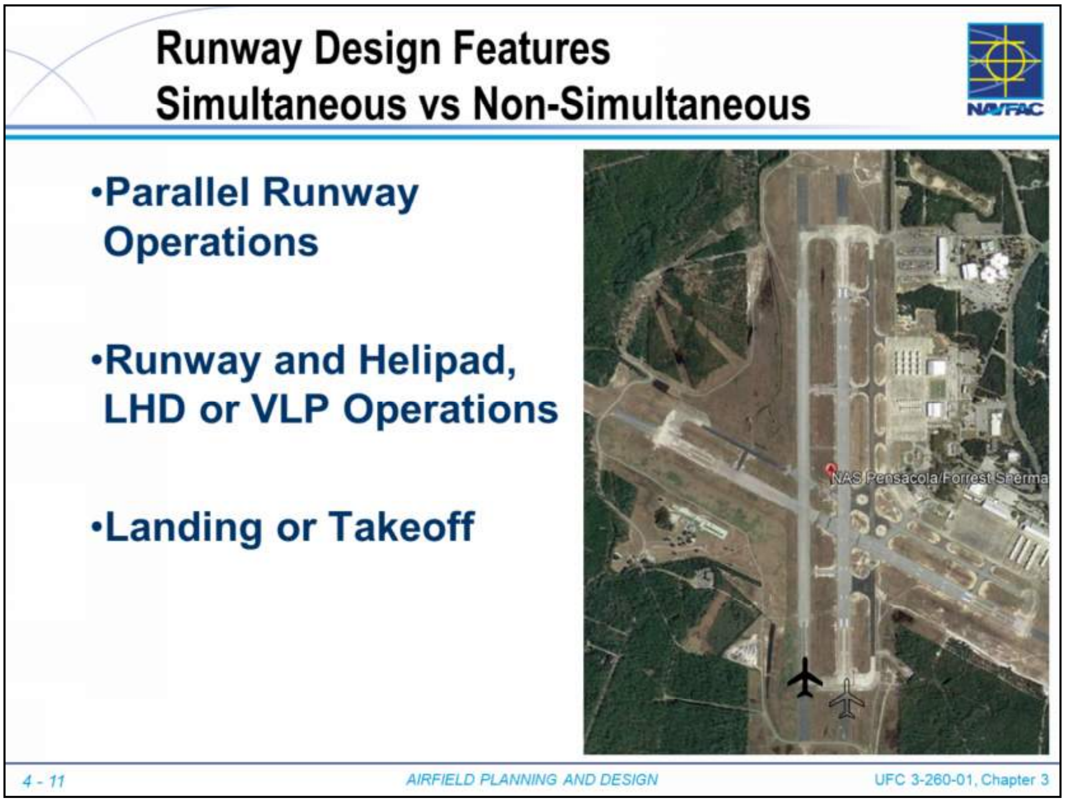
- Table 3-1: lists a/c by classification
- Class A
    - Small, light aircraft
    - No potential future use by large or heavy aircraft
- Class B
    - High-performance, large, heavy aircraft



- Landing Zones – special case runway for C-130s and C-17s – will be covered in Section 7 of this class
- STOVL Facilities – special use runways for aircraft with vertical landing capabilities (F-35B) – will be covered in Section 8 of this class
- MV-22/CMV-22B
    - Can operate in both fixed wing and rotary wing modes
    - When operating as fixed wing, this Section applies
    - When operating as rotary wing, next Section applies
    - UFC 3-260-01, Para 1-2.2.4 "*At permanent shore establishments, the V-22 will be considered a fixed-wing aircraft for the purposes of determining facilities requirements.*"
        - Chapter 3 for fixed wing
        - Chapter 4 for rotary wing
        - Chapter 6 for aprons



- Fixed Wing Runways also classified as either VFR or IFR
    - VFR – Visual Flight Rules.
        - No electronic NAVAIDs to assist with landing
        - Just lights (including PAPIs (Precision Approach Path Indicator) or VASIs (Visual Approach Slope Indicator))
    - IFR – Instrument Flight Rules
        - Electronic NAVAIDS assist with approach procedures
            - Localizer & Glideslope Instrument Landing Systems most common
        - IFR requires protecting airspace over a larger area because operations occur in reduced visibility
- Major Considerations in VFR/IFR Choice
    - Spacing between parallel runways for VFR Class B = 1,000 ft
    - Spacing between parallel runways for IFR Class B = 2,500 ft (simultaneous operation, dep-dep or dep-arr)
    - Spacing between parallel runways for IFR Class B = 4,300 ft (simultaneous approaches)
    - Mission Requirements (increased use in low visibility)
    - Special Aircraft
    - Service Specific Requirements
    - Future Use – plan now for future capabilities (e.g. only VFR now, but IFR in future)



- Simultaneous Operations
  - Two aircraft approaching, landing or taking off at the same time on parallel runways.

- Can also apply to Runway/Helipad or Runway/VLP Operations

- Applies to landing (arrival) or takeoff (departure)

Runway Design Features
Simultaneous vs Non-Simultaneous

NAVFAC

•Impacts Distance Between Two Runways or Runway/Helipad, Runway/VLP

–Depart-Depart

–Depart-Arrival

–Arrival-Arrival

UFC 3-260-01
4 February 2019

Table 3-2. Runways

Item		Class A Runway	Class B Runway	Remarks
No.	Description	Requirement		
15	Distance between centerlines of parallel runways	213.36 m (700 ft)	304.80 m (1,000 ft)	VFR without intervening parallel taxiway between the parallel runways. One of the parallel runways must be a VFR only runway.
		632.46 m (2,075 ft)		VFR with intervening parallel taxiway.
		762.00 m (2,500 ft)		IFR using simultaneous operation (depart-depart) (depart-arrival)
		1,310.64 m (4,300 ft)		IFR using simultaneous approaches
				For separation distance between fixed-wing runways and rotary-wing facilities, see Table 4-1.

4 - 12 AIRFIELD PLANNING AND DESIGN UFC 3-260-01, Chapter 3

•Type of Operations Allowed changes the separation requirements between facilities

•For Runways

- •VFR Class A = 700 ft
- •VFR Class B = 1000 ft
- •IFR Depart-Depart or Depart-Arrival = 2500 ft
- •IFR Arrival-Arrival = 4300 ft

•Runway-Helipad

- •Simultaneous VFR = 1000 ft
- •Non-simultaneous VFR and IFR = 700 ft
- •IFR Depart-Depart or Depart-Arrival = 2500 ft
- •IFR Arrival-Arrival = 4300 ft

•Runway-LHD

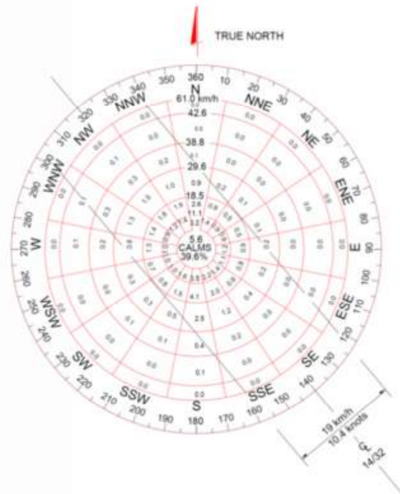
- •Simultaneous VFR = 1000 ft
- •Non-simultaneous VFR and IFR = 700 ft

•Runway-VLP

- •Simultaneous VFR for Class A = 700 ft
- •Simultaneous VFR for Class B = 1000 ft
- •Non-simultaneous VFR and IFR = 200 ft
- •IFR Depart-Depart or Depart-Arrival = 2500 ft
- •IFR Arrival-Arrival = 4300 f

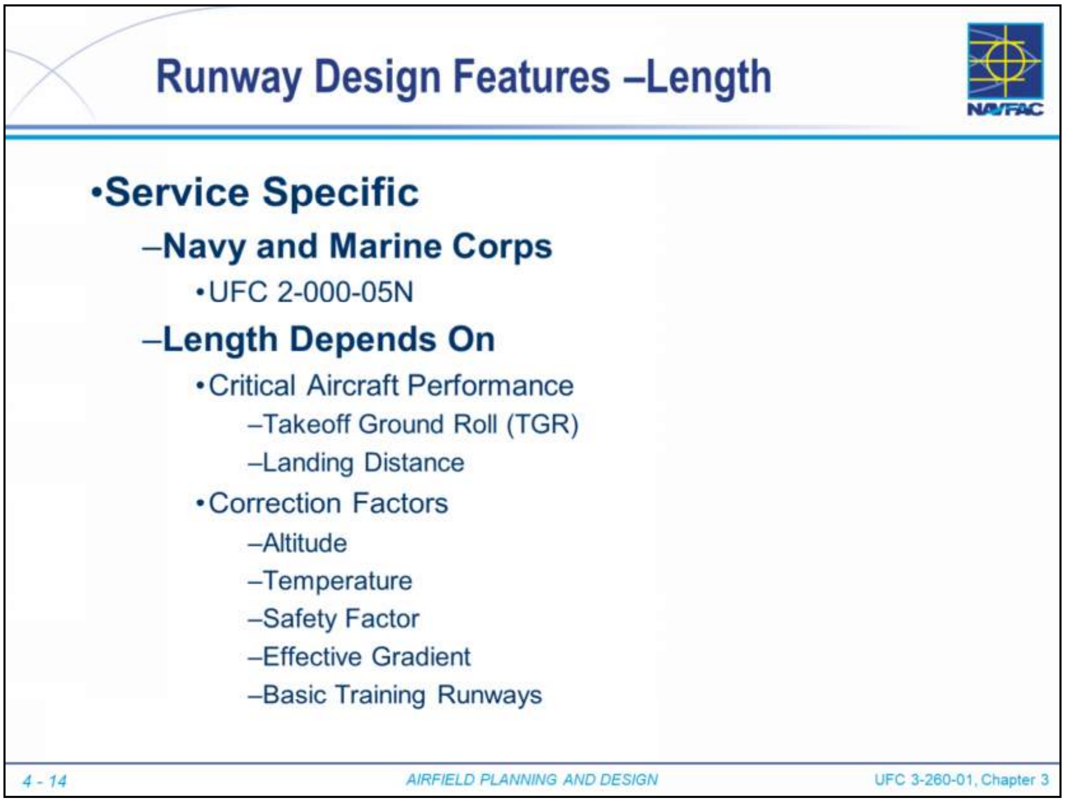
Runway Design Features – Orientation

Figure B4-4. Windrose Analysis

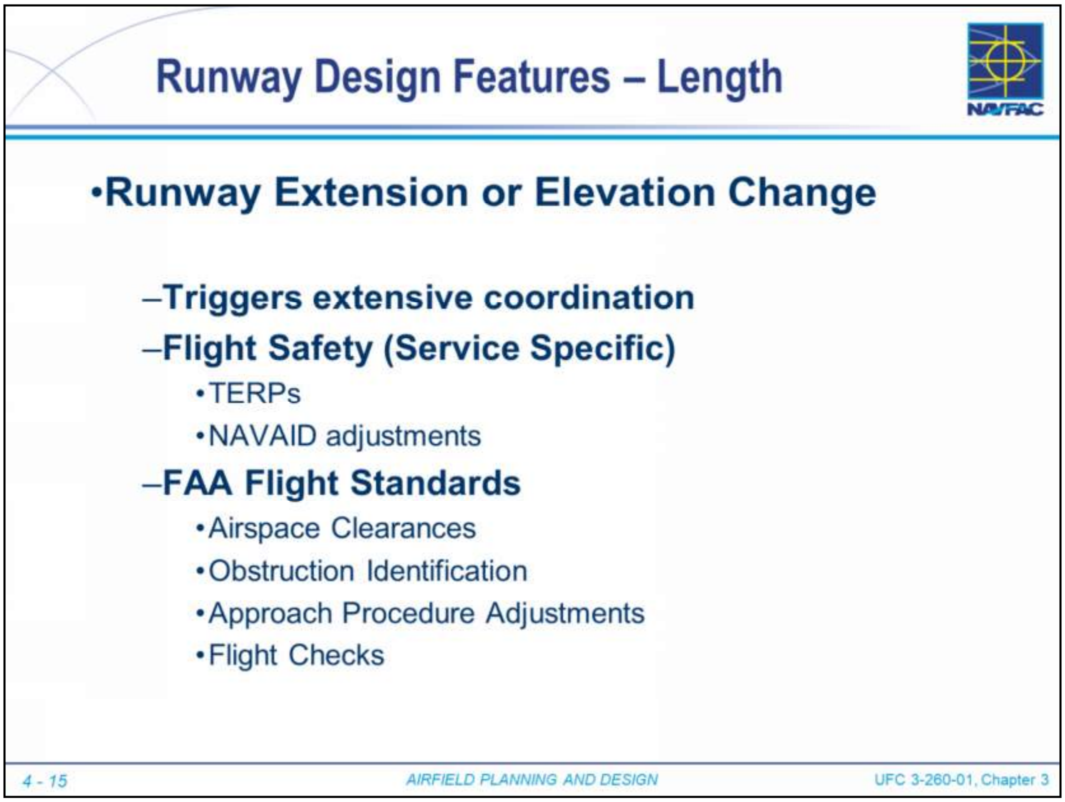


NOTE: A runway oriented 140° to 320° (true) would have 3.1 percent of winds exceeding the design crosswind component of 19 km/h.

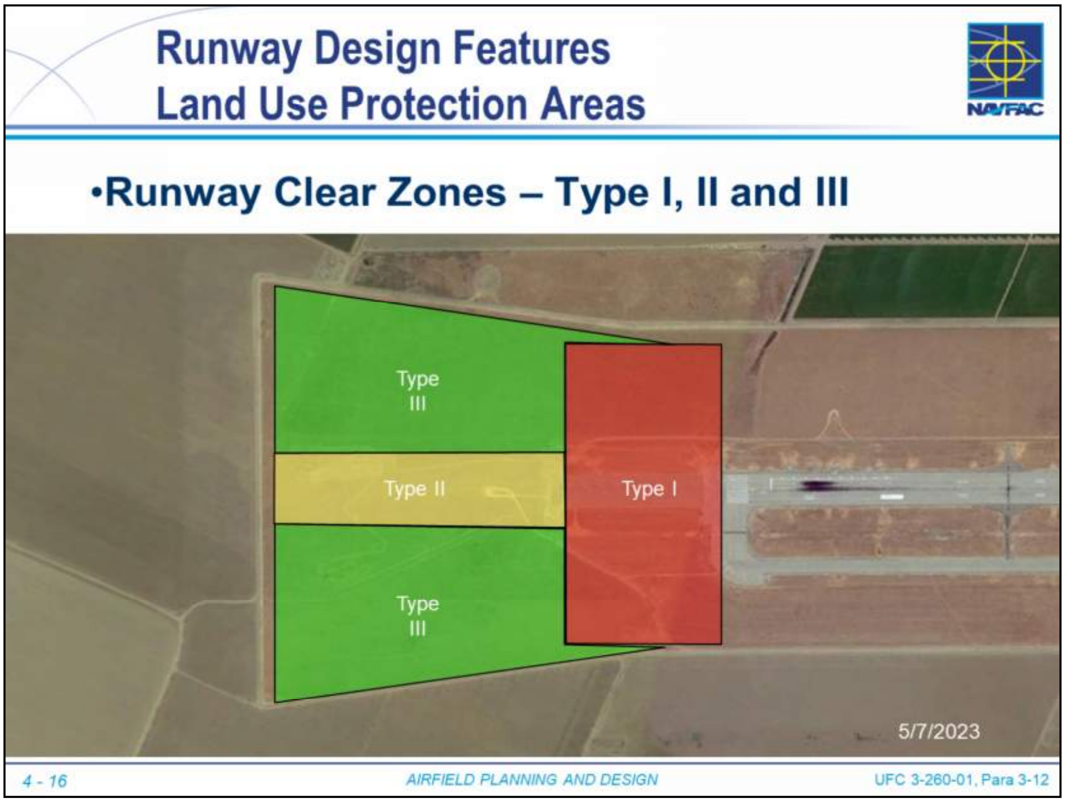
- Wind Coverage
  - Direction & Velocity
- Appendix B, Section 4
  - Guidance for Analysis of Wind Data



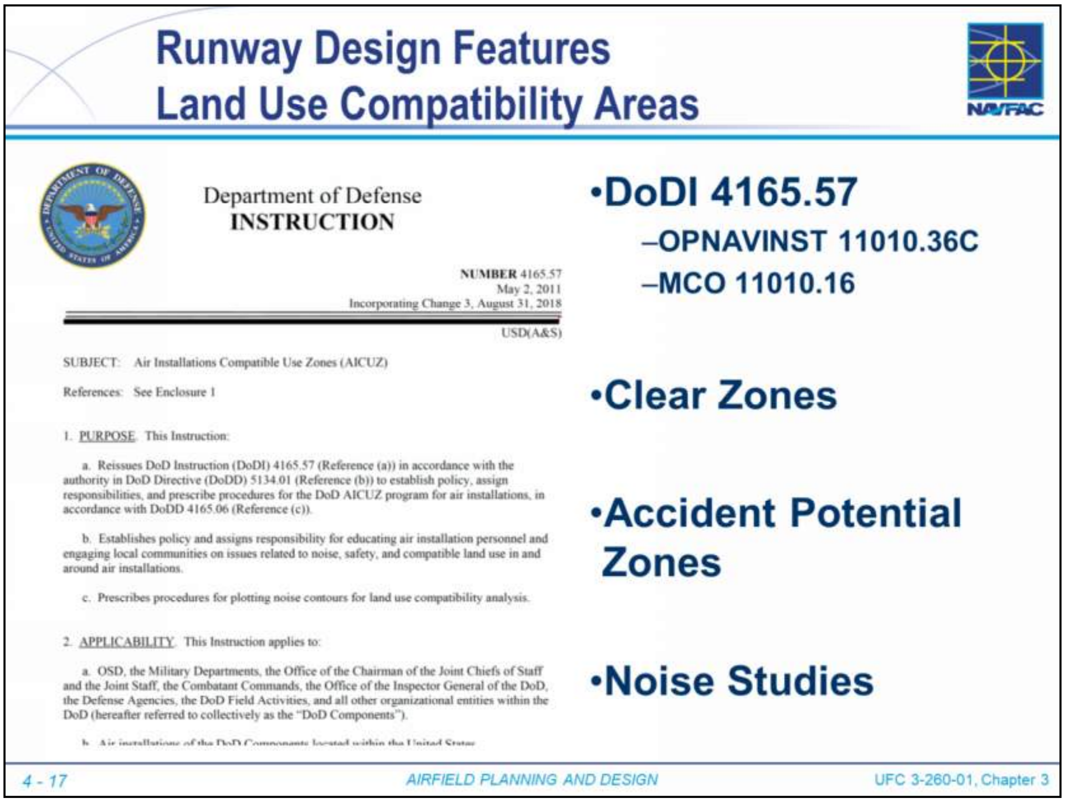
- Runway Length
  - Navy and Marine Corps
    - UFC 2-000-05N used to determine length
    - Table 11110-1 for TGR and Landing Distances
  - Length Depends On
    - Critical Aircraft Performance – Takeoff Ground Roll (TGR) or Landing Distance – whichever controls
      - TGR defined in 2-000-05N "the distance an aircraft requires to lift off at a given gross weight on a level runway surface at sea level (Barometric pressure 29.92 inches Hg.) with 59 degrees Fahrenheit ambient temperature and under conditions of zero wind. The TGR in most cases is the controlling characteristic.
    - Correction Factors
      - Altitude. Increase runway length (TGR or landing roll) by 1.1 percent for each 30.5 meters (100 feet) the site is above sea level. See Table 11110-2 for altitude correction factors.
      - Temperature. Increase above result by 0.66 percent for each degree F the anticipated mean high temperature is above 59 degrees F.
      - Safety Factor. Multiply the above result by 1.6 for all runways except those at Air Training Command air installations where a safety factor of 2.0 shall be applied.
      - Effective Gradient. Increase the above result by 10 percent for each 1 percent of effective gradient. Effective gradient is the maximum difference in elevation along the centerline of the runway divided by the runway length and expressed as a percent.
      - Round Off. Final runway length is the result of the foregoing calculations rounded off to the next higher 30.5 meters (100 feet).
      - Basic Training Runways. At basic training runways used by T-34 aircraft, 305 meters (1,000 feet) shall be added to the computed runway requirement. The additional runway length is required to practice precautionary emergency landings.
  - Army
    - Class A – uses Table 3-3 (dependent on average temperatures and elevation above sea level
    - Class B – since Army doesn't have Class B aircraft, Army Class B runway length is determined by using service through TRANSCOM
  - Air Force
    - MajCom will determine required length.



- Changes to runway thresholds
  - Extension
  - Elevation Change
- Triggers significant coordination within DoD and FAA
  - Flight Safety needs to be very involved
  - TERPs (Terminal Instrument Procedures) flight paths need to be re-evaluated and re-published
  - Adjust NAVAIDS
  - Runway Extension may change required height of control tower
- FAA Flight Standards
  - Airspace Clearances must be checked
  - Obstructions must be identified (and eliminated if bust airspace)
  - Like TERPs, must also update FAA's published flight procedures
  - Schedule flight checks prior to re-opening



- •Runway Clear Zones (NAS LeMoore)
  - •Clear Zones are <u>required</u> and should be owned or protected under a long-term lease.
  - •Clear Zones possess a high potential for accidents and are subject to severe land use restrictions.
  - •Per AICUZ, the Clear Zone is the area with greatest potential for aircraft accidents and should remain undeveloped.
    - •Land Use Control Area intended to protect both flight safety and property on the ground
    - •Land Use is governed by DoDI 4165.57 and OPNAVINST 11010.36C/MCO 11010.16
  - •Geometry defined in DoDI 4165.57, and further defined in UFC 3-260-01, Table 3-5 and Para 3-12
    - •Service Specific - Navy uniquely has Clear Zones I, II and III
      - •CZ I (Red) – 1,000' long x 2000' wide (1,500' if built prior to 1981)
        - •Cleared, Graded and free of above-ground objects
      - •CZ II (Yellow) – 2,000' long x 500' wide
        - •Graded and Cleared of above-ground objects
      - •CZ III (Green) – 2,784' wide at end
        - •Objects cannot penetrate the approach-departure surface
    - •Class A or B-dependent



- Purpose of DoD Instruction 4165.57, Air Installation Compatible Use Zones (AICUZ)
    - •Protect the health, safety and welfare from noise and hazards through compatible development in the airport environment.
    - •Program was instituted by the DoD to address the problem of land development surrounding military air installations.
    - •Provides for the development and implementation of a plan to determine those land areas for which development should be significantly influenced by the operation of the airfield.
    - •These land areas are then designated as the AICUZ for that installation.
    - •Source Document for Accident Potential Zones

•Codified within OPNAVINST 11010.36C/MCO 11010.16 (currently under revision)

•Clear Zones

- •Class A Runway. Rectangular area immediately beyond the end of the runway and outward along the extended runway centerline for a distance of 3,000 feet, 1,000 ft wide.
- •Class B Runway. Trapezoidal area immediately beyond the end of the runway and outward along the extended runway centerline for a distance of 3,000 feet. 1,500 feet in width at the runway threshold and 2,312 feet in width at the outer edge. Flare starts at 200 feet from end of runways, and the 3,000-feet Clear Zone length starts at runway end.

•Accident Potential Zones

- •APZs are land use protection zones defined within the AICUZ program.
- •Higher probability for accident, so certain uses are not compatible
- •Table 3-6 and Figure 3-6 define geometry
- •Service Specific – Navy has its own dimensions
- •Dependent on Class A or Class B
- •APZs I and II are just beyond the Clear Zone that still possesses a measurable potential for accidents.
    - •Class A: APZ I: 2,500' x 1,000', APZ II: 2,500' x 1,000'
    - •Class B: APZ I: 5,000' x 3,000', APZ II: 7,000' x 3,000'
- •DoD cannot make local land use decisions, but can work with local and other gov't agencies to promote compatible land use.
- •Acquisition programs can be pursued through fee or easements.
- •Navy and Marine Corps Installations have Community Planning and Liaison Officers (CPLOs) that perform this type of coordination.

•AICUZ studies also have Noise Contours developed through a Noise Study.

- •Similar land use controls are desired on and off base for uses that are not compatible with high noise contours (e.g. residential, schools)

•AICUZ training has recently been uploaded to Navy e-Learning

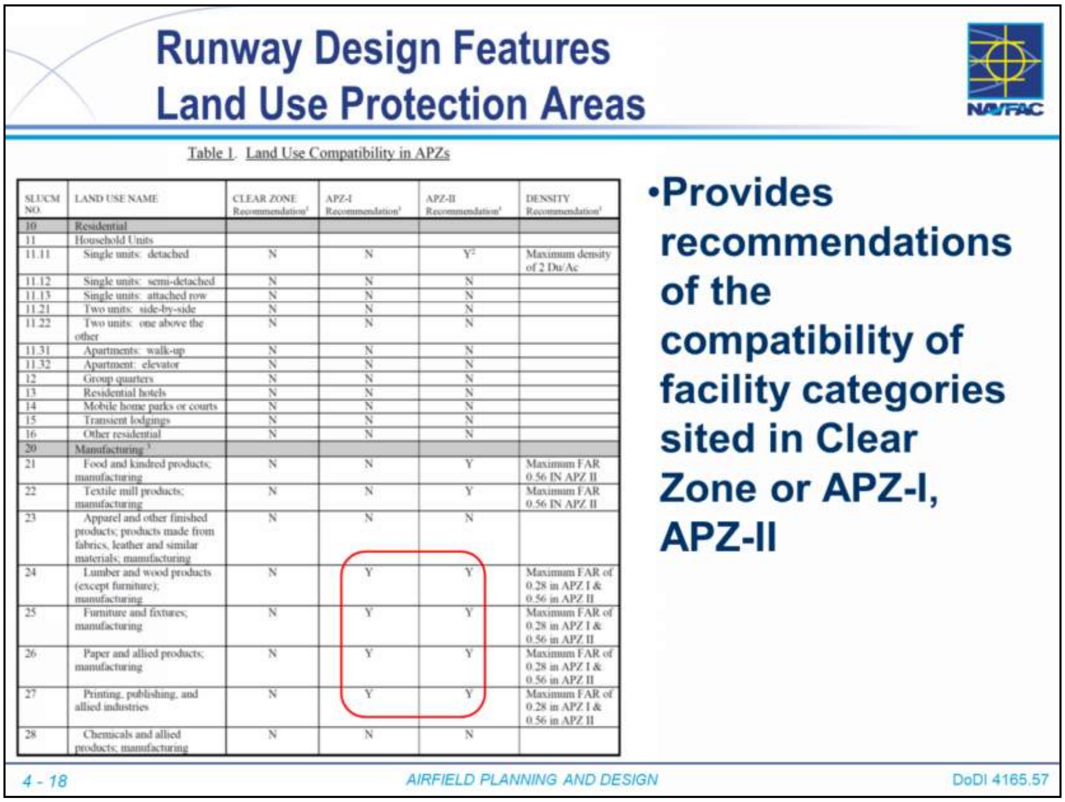


Table 1. Land Use Compatibility in APZs

SLUCM NO.	LAND USE NAME	CLEAR ZONE Recommendation[1]	APZ-I Recommendation[1]	APZ-II Recommendation[1]	DENSITY Recommendation[1]
10	Residential				
11	Household Units				
11.11	Single units: detached	N	N	Y[2]	Maximum density of 2 Du/Ac
11.12	Single units: semi-detached	N	N	N	
11.13	Single units: attached row	N	N	N	
11.21	Two units: side-by-side	N	N	N	
11.22	Two units: one above the other	N	N	N	
11.31	Apartments: walk-up	N	N	N	
11.32	Apartment: elevator	N	N	N	
12	Group quarters	N	N	N	
13	Residential hotels	N	N	N	
14	Mobile home parks or courts	N	N	N	
15	Transient lodgings	N	N	N	
16	Other residential	N	N	N	
20	Manufacturing [3]				
21	Food and kindred products; manufacturing	N	N	Y	Maximum FAR 0.56 IN APZ II
22	Textile mill products; manufacturing	N	N	Y	Maximum FAR 0.56 IN APZ II
23	Apparel and other finished products; products made from fabrics, leather and similar materials; manufacturing	N	N	N	
24	Lumber and wood products (except furniture); manufacturing	N	Y	Y	Maximum FAR of 0.28 in APZ I & 0.56 in APZ II
25	Furniture and fixtures; manufacturing	N	Y	Y	Maximum FAR of 0.28 in APZ I & 0.56 in APZ II
26	Paper and allied products; manufacturing	N	Y	Y	Maximum FAR of 0.28 in APZ I & 0.56 in APZ II
27	Printing, publishing, and allied industries	N	Y	Y	Maximum FAR of 0.28 in APZ I & 0.56 in APZ II
28	Chemicals and allied products; manufacturing	N	N	N	

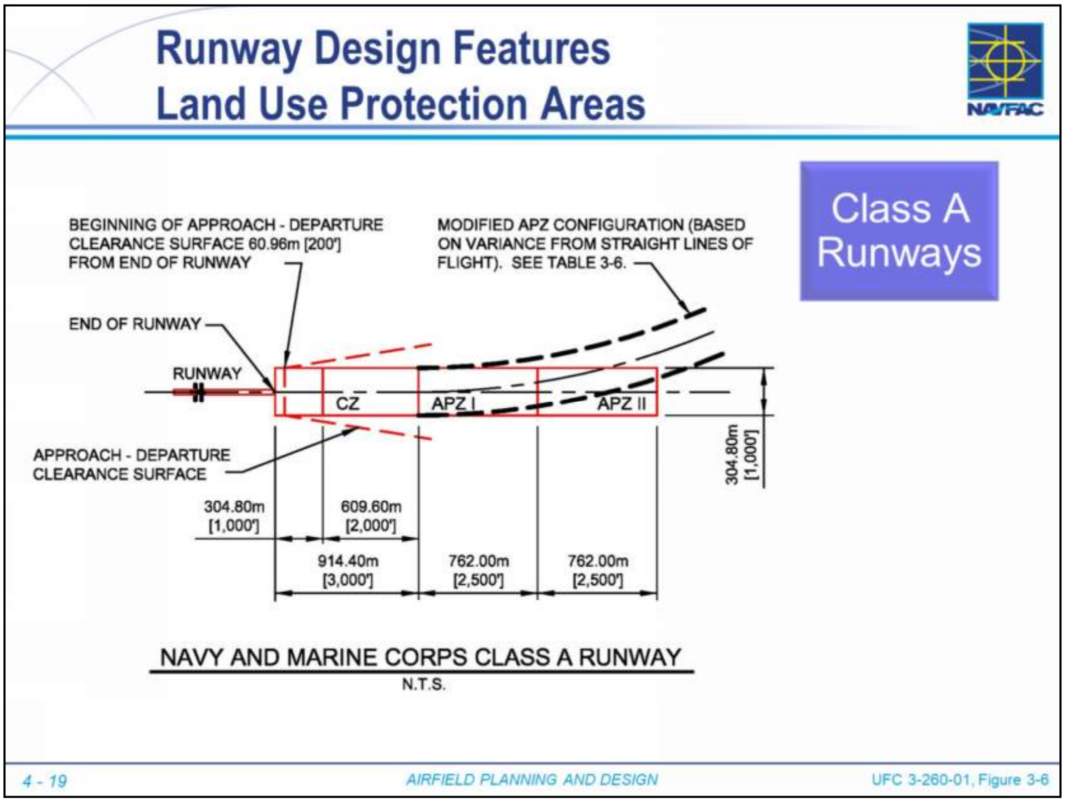
•DoDI includes Table 1 – multiple pages
- •Lists all facilities types
- •Indicates whether the facility type can be located in:
  - •Clear Zone
  - •APZ-I
  - •APZ-II
  - •In some cases stipulates the maximum density

- •Similar tables included in OPNAVINST 11010.36C/MCO 11010.16

- •Very detailed tables, with some surprising categories
- •Used to inform the local governments of the risks
- •In many/most communities, AICUZ will be used to justify land use controls

- •Highlighted Red – items permitted like manufacturing (lumber, paper, printing) in APZ II and III are noisy and low population density – therefore very compatible.

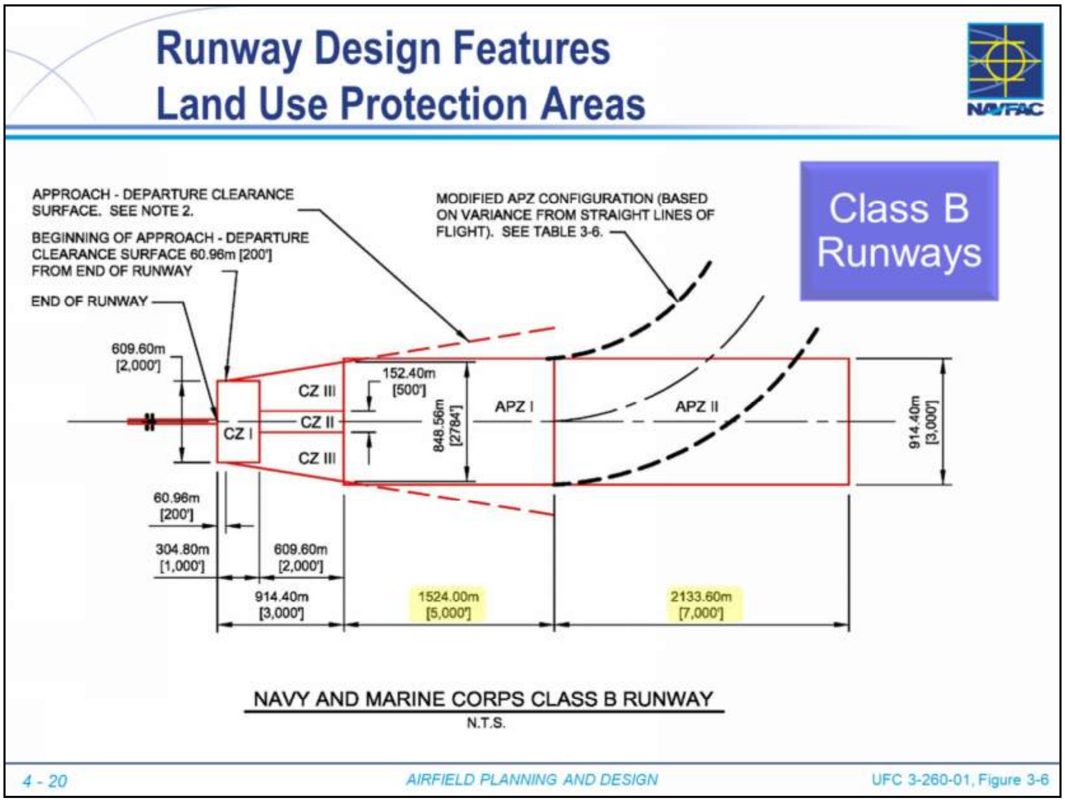
- Separate tables also provided for land use compatibility within Noise Zones 1 through 3.
  - Noise Zone 1 is less than 64 DNL/CNEL, Noise Zone 2 is between 65 and 74 DNL/CNEL, and Noise Zone 3 is greater than 75 DNL/CNEL.



• Figure 3-6 from UFC 3-260-01

•**Class A** Runways for Navy

- •Length and width are smaller compared to Class B



• Figure 3-6 from UFC 3-260-01

•**Class B** Runways for Navy

  •Length and Width Larger than Class A

Runway Design Features
Land Use Protection Areas

4 - 21 AIRFIELD PLANNING AND DESIGN UFC 3-260-01, Figure 3-6

- Review the areas shown in previous figures on an actual airfield – MCAS Beaufort – Class B Airfield
- Clear Zones I, II, III - extends 3,000’ from threshold (Green)
- APZ I – extends 5,000’ from Clear Zone (Magenta)
- APZ II – extends 7,000’ from APZ I (Red)

Runway Design Features
Land Use Protection Areas – Chambers Field

Comparison of 1999 and 2009 AICUZ APZs

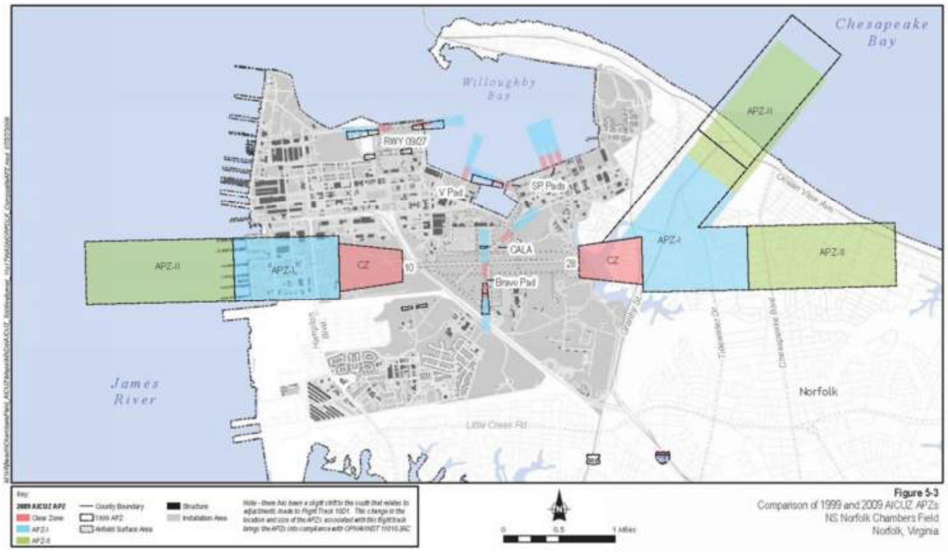
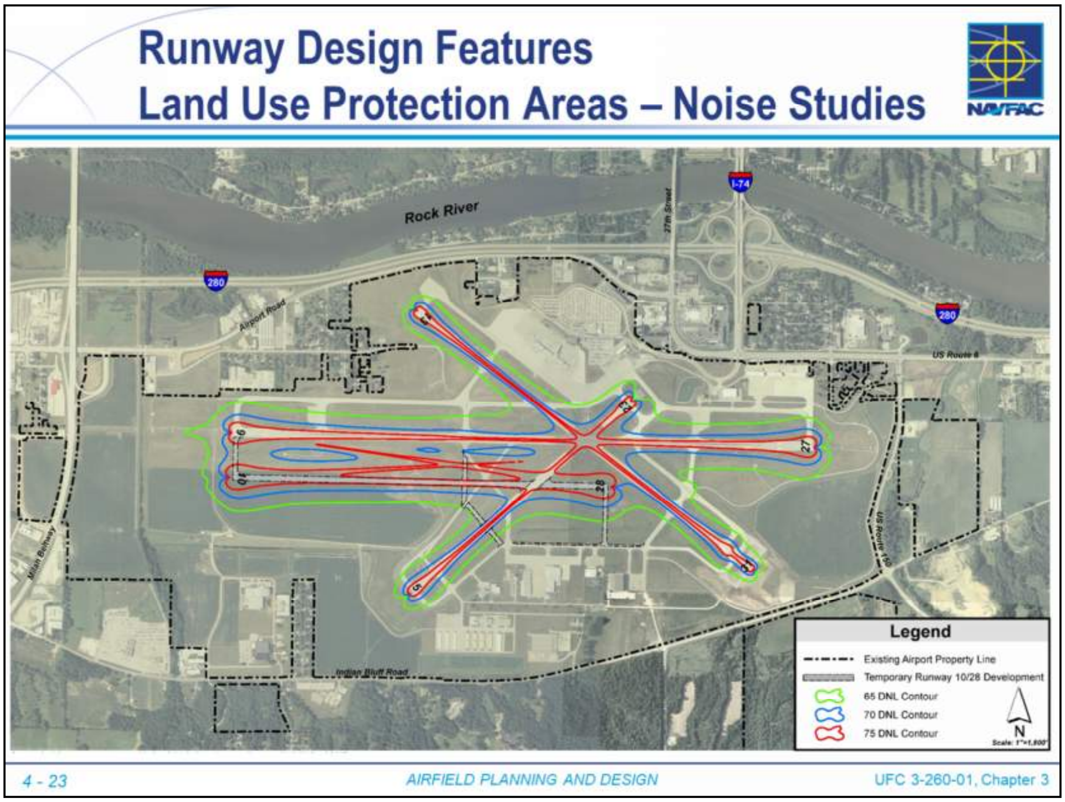


Figure 5-3
Comparison of 1999 and 2009 AICUZ APZs
NS Norfolk Chambers Field
Norfolk, Virginia

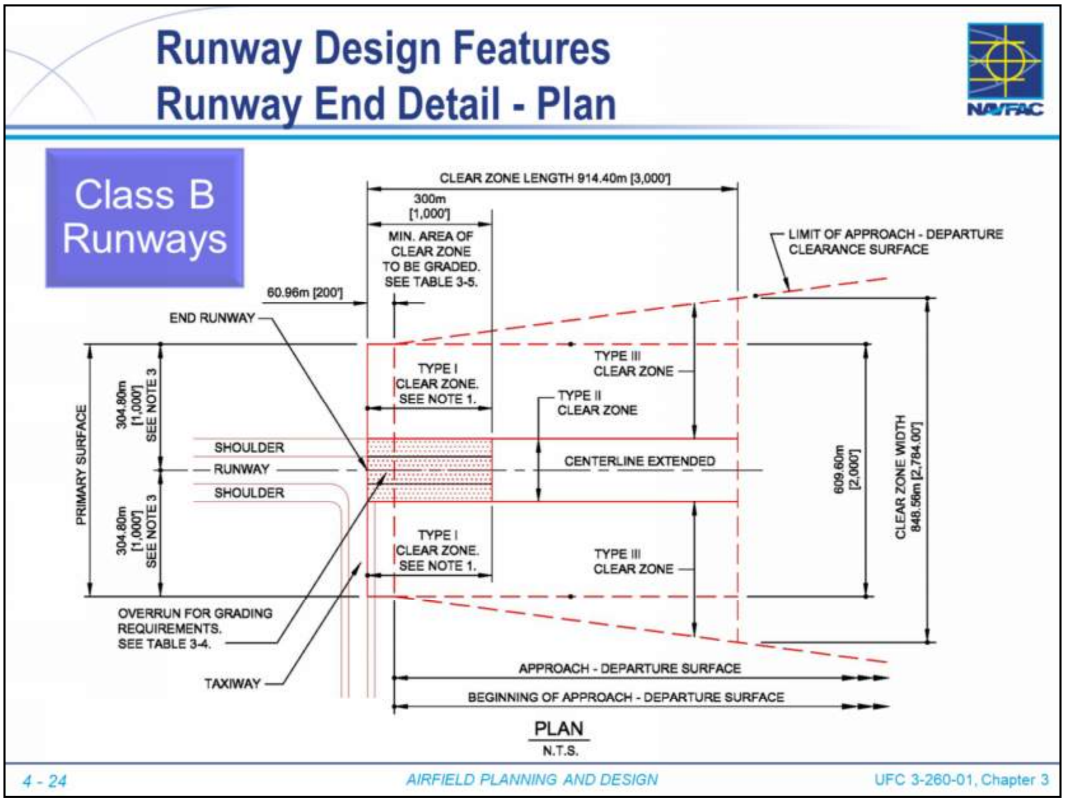
- Chambers Field, Naval Station Norfolk
- Example APZs and Clear Zones



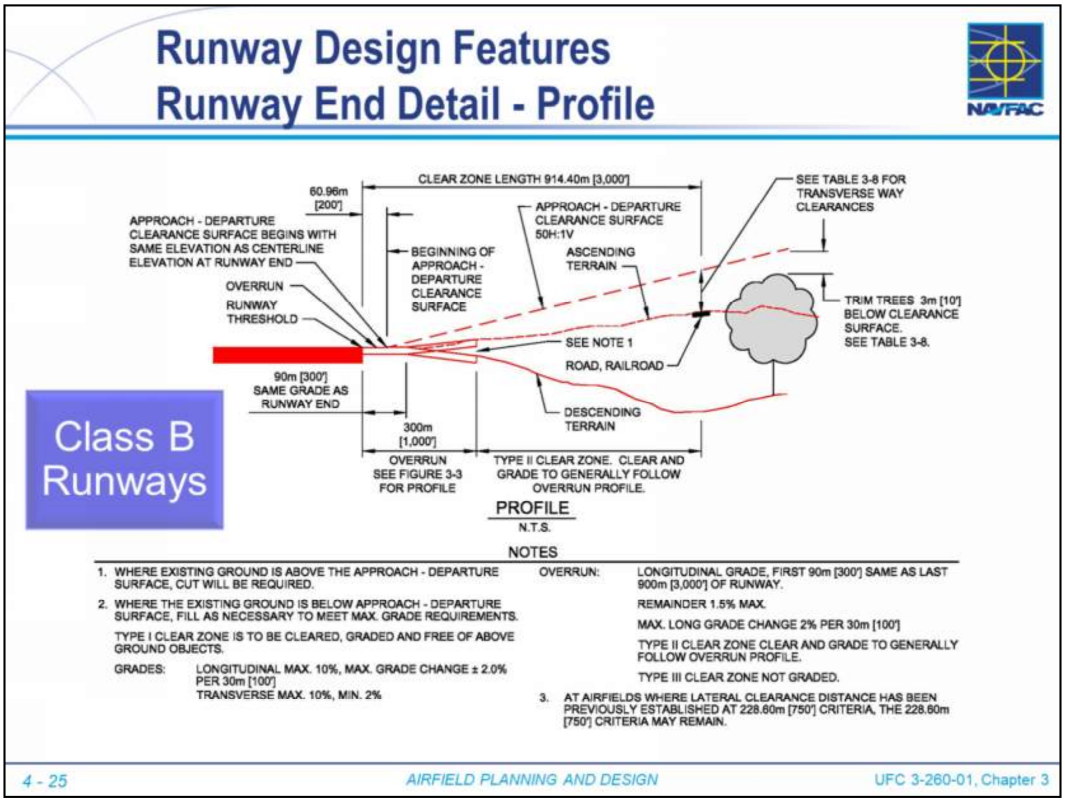
- AICUZ studies also have Noise Contours developed through a Noise Study.
  - •Similar land use controls are desired on and off base for uses that are not compatible with high noise contours (e.g. residential, schools)

• Image illustrates example noise contour modeling for proposed construction (new parallel runway)

  - •DNL = **D**ay-**N**ight Average Noise **L**evel

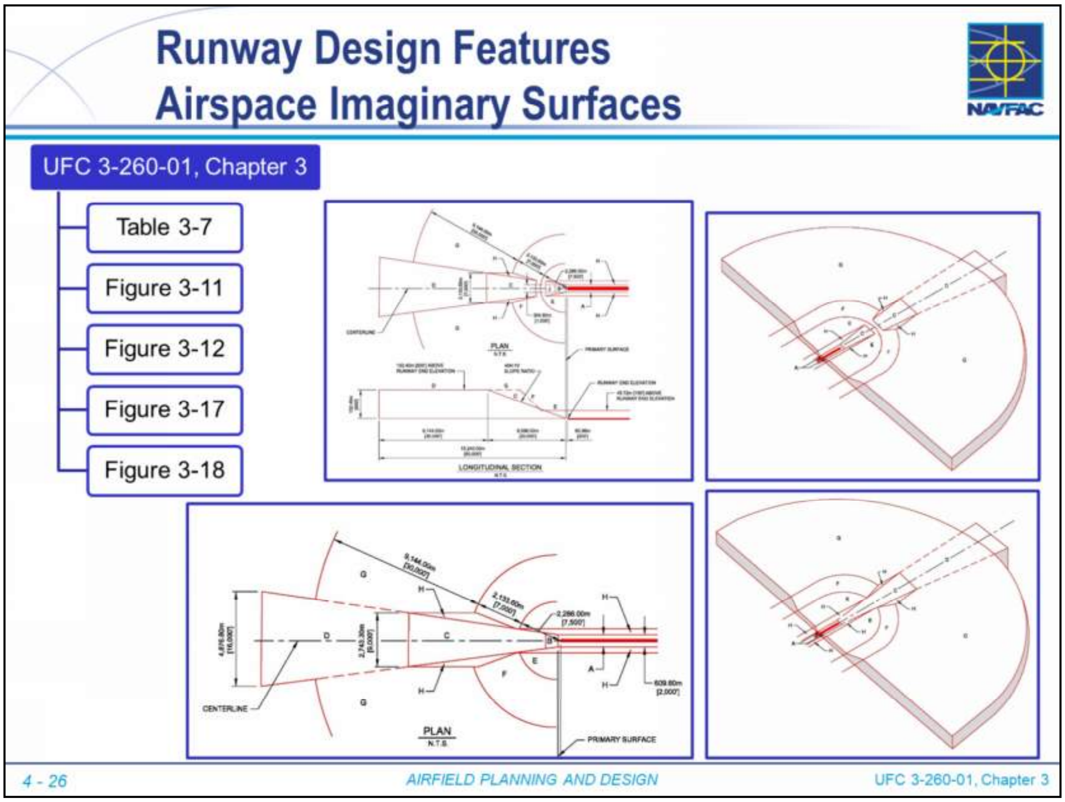


- Figure 3-16 combines multiple features to show inter-relations
  - Navy Class B Runways
  - Primary Surface
  - Clear Zone Width
  - Graded Area of the Clear Zone
  - Type I Clear Zone
  - Type II Clear Zone
  - Type III Clear Zone

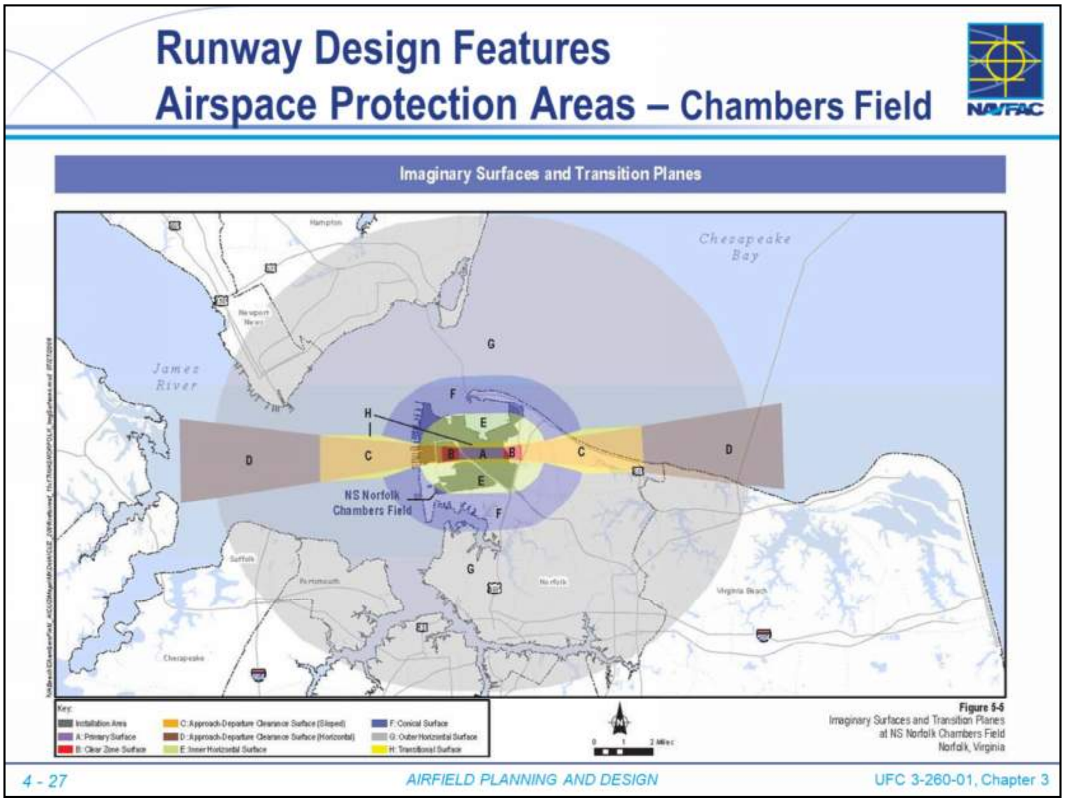


•Bottom half of Figure 3-16 shows

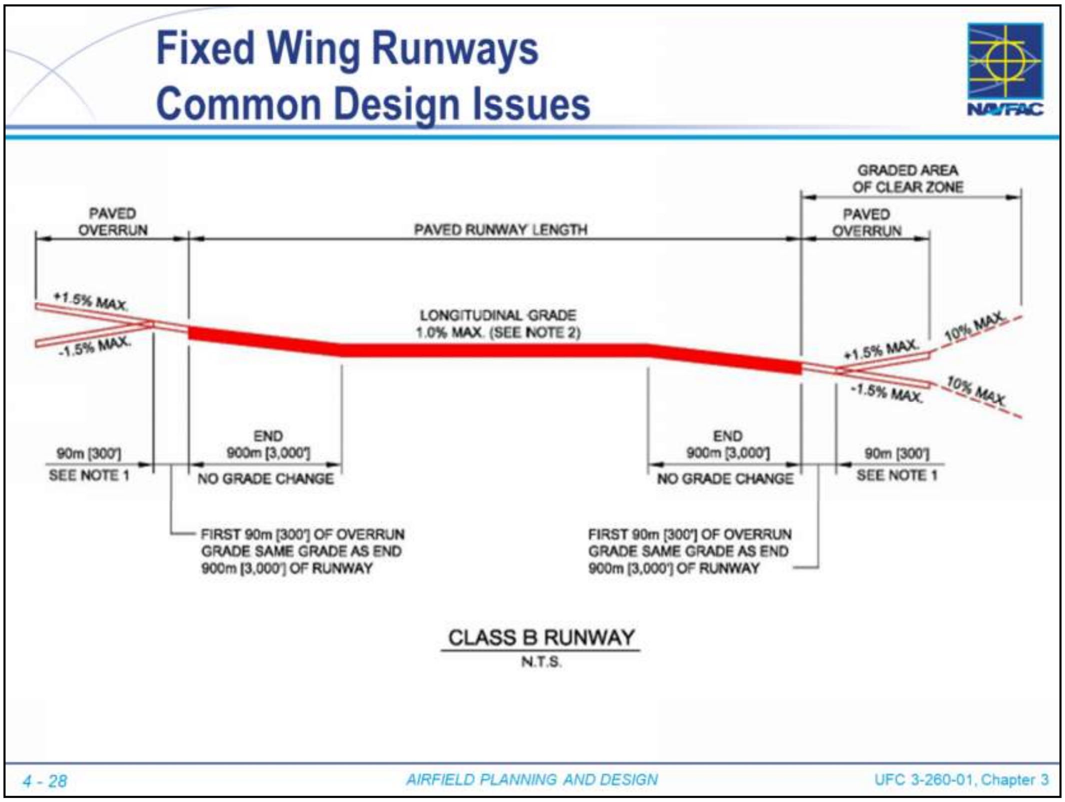
- •Longitudinal Profile of runway end Class B, Navy
- •Overrun
- •Graded Area of Clear Zone
- •Approach-Departure Clearance Surface starts 200’ after threshold, 50H:1V
- •Imaginary surface Minimum Clearances detailed in Table 3-8
  - •Interstate Highway = 17 ft
  - •Other public Road = 15 ft
  - •Private or military road = 10 ft
  - •Railroad = 23 ft
  - •Waterway = Height dependent on watercraft
  - •Trees = trim 10-ft below imaginary surface



- Imaginary Surfaces – define the area that must be protected for safe air operations
  - Obstacles identified and programmed for removal
  - Must be protected from encroachment through avigation easement or zoning restrictions
  - Surface defined in Table 3-7 and illustrated in Figure 3-18
  - Dependent on Class A or Class B
  - Dependent on VFR or IFR from Class A
- Figure 3-12 – Class A IFR Airspace Imaginary Surfaces
  - Plan and Profile
  - Note: ADCS extends 50,000’ from runway end
  - Cross-section of the same Class A IFR runway also included in UFC (not shown here)
- Figure 3-11 Illustrates Class A IFR Runway Imaginary Surfaces in <u>orthometric</u> (3D) project
  - Can be fairly complex surfaces
  - Inner Horizontal surface at 150 ft above runway, extends 7,500’ in all directions
  - Outer Horizontal surface at 500 ft above runway, extends 44,500’ in all directions
- Figure 3-18 Illustrates Navy Class B IFR Airspace
  - Plan, Profile and Cross-section included in UFC
  - ADCS extends 50,000’ from runway end
- Figure 3-17 Illustrates Class B Navy Runway Imaginary Surfaces in <u>orthometric</u> (3D) project



- Chambers Field, Naval Station Norfolk Study – example airspace areas



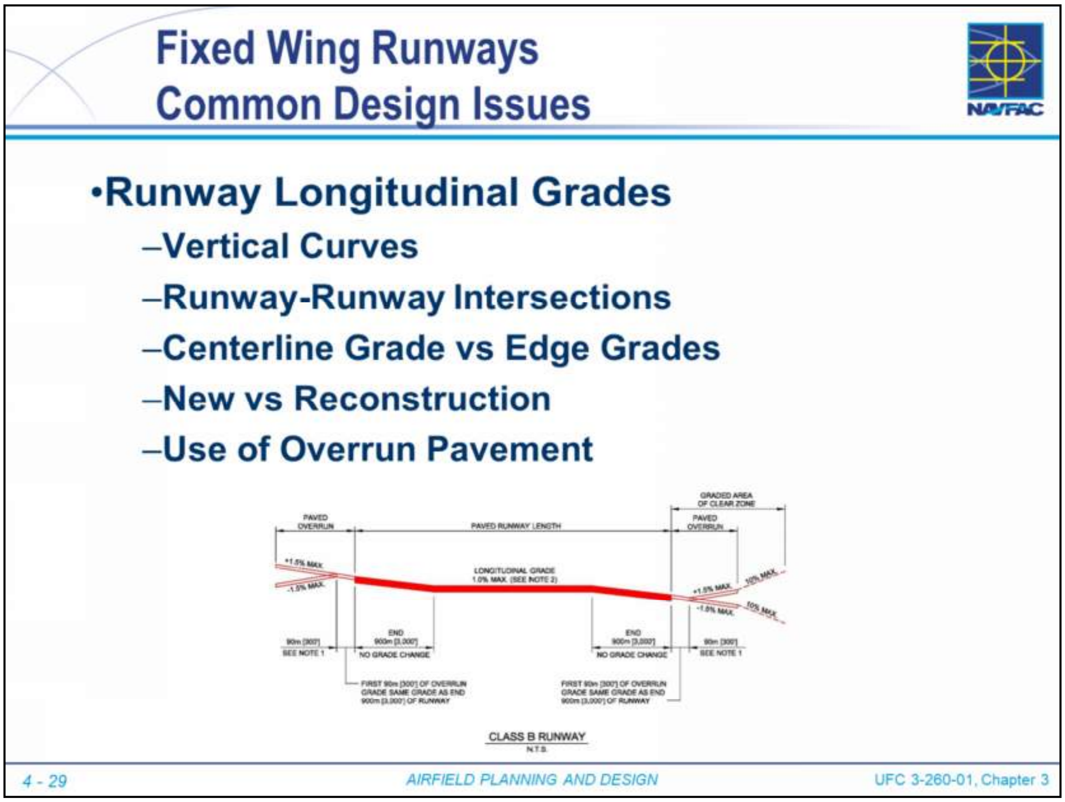
• UFC 3-260-01, Figure 3-3. Runway and Overrun Longitudinal Profile

- •First and last 3,000' – no grade change
- •First 300' of overrun must match runway end grade
- •After 300', max grade change is 2.0% per 100 ft

•Caution:

- •If overrun grade is downward or flat, then terrain goes up at 10% at end of overrun, terrain could penetrate the 50:1 ADCS within just a few hundred feet

•Designer must call out all longitudinal grade situations that do not meet criteria in the design report.



•Longitudinal Grades

- •Grade transitions require vertical curves for smooth surface
  - •Max rate of change is 0.167% in 100 ft (600-ft per 1% change)
- •Minimum 1000' between two PIs
- •Runway-Runway intersections
  - •Choose one runway as the primary and make it smooth with flattened crown
  - •Intersecting runway must transition across the crown
- •Edge of runway can transition 0.4% per 100-ft at runway intersection

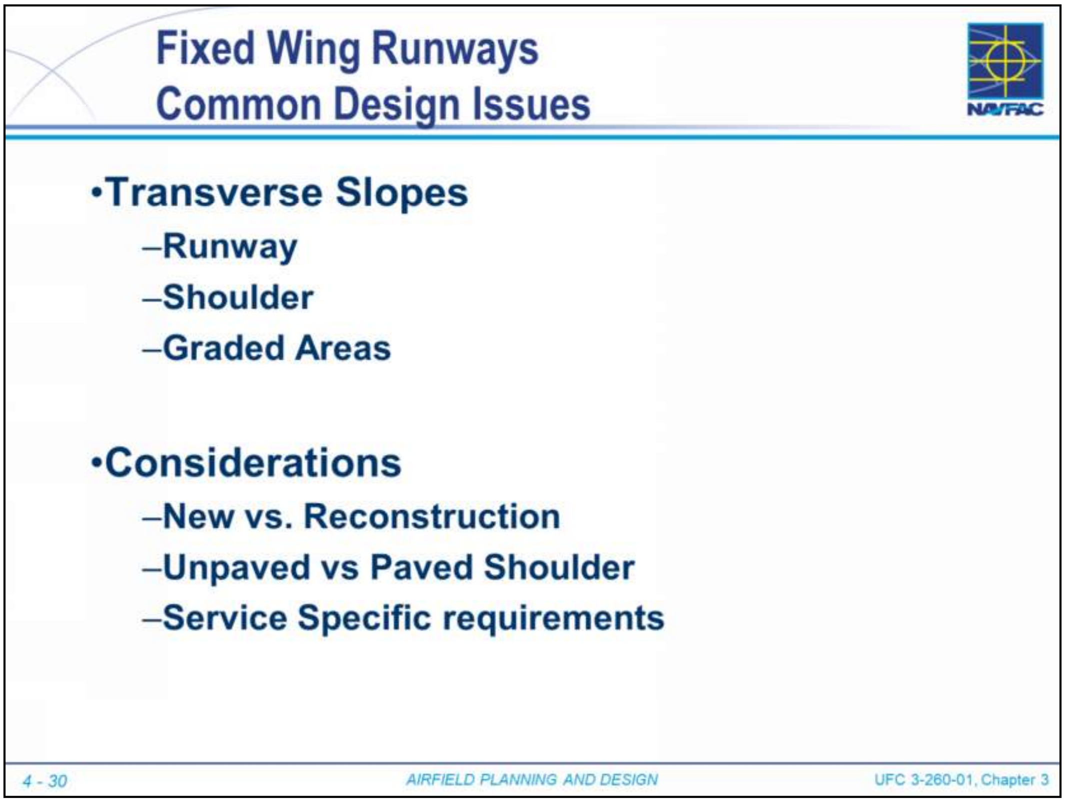
•New: meet all grade criteria

•Reconstruction: Sometimes very costly to meet all requirements, such as no grade change in first or last 3,000'

•Need to evaluate costs and benefits, then discuss with SMEs

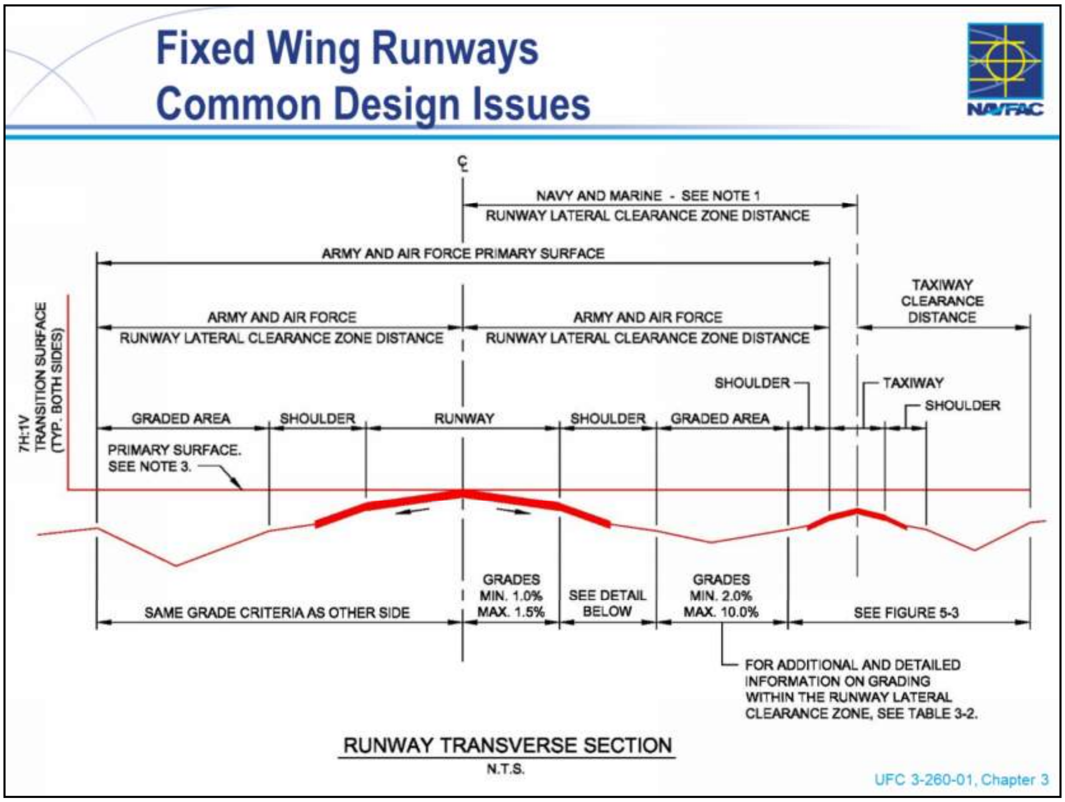
•Overrun Pavements: Sometimes full-strength overruns used to extend available takeoff distance.

- •Non-standard.
- •Need strong justification.
- •Affects markings
- •Affects lighting
- •May create jet blast hazards

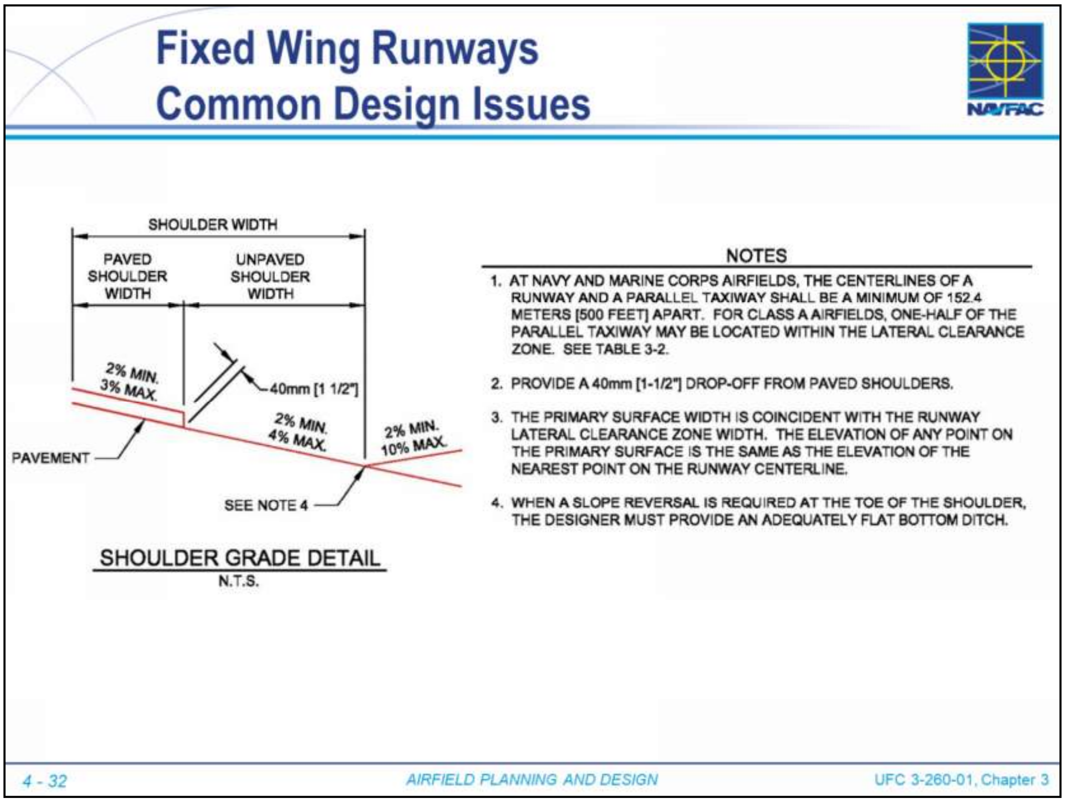


- Transverse Slopes (UFC 3-260-01, Table 3-2)
  - •Runway: 1% to 1.5%. Usually max slope is used to promote drainage
  - •Shoulder: 2% to 3% for paved portion. 1.5” edge dropoff, then 2% to 4% down in unpaved shoulder
  - •Graded Area: 2% to 10%, up or down, but stay lower than runway centerline elevation

•Considerations
  - •New: Build to criteria
  - •Reconstruction: Always try to correct the grades – usually build a crown into the flat runway
    - •Not required to convert a single-slope runway into a crowned runway
  - •Paved Shoulder: Sometimes hard to get minimum slopes on reconstruct, but they are needed for good drainage.
  - •Unpaved Shoulder: Often too flat to meet minimums. Flat better than slope reversal with ditch? No ponding.



- Figure 3-1. Runway Transverse Sections and Primary Surface
  - Illustrates allowable grades on runways and adjacent surfaces
  - Primary Surface is at runway centerline elevation
    - Ground surfaces may penetrate the primary surface, provided all grading criteria are met (Note 7 of Figure 3-2)



- Figure 3-1
  - •Detail of shoulder dropoff
  - •1.5” dropoff at edge of paved shoulder
    - •Top of turf should be 1.5” down, not soil prior to laying sod
    - •Designed to promote drainage off edge
    - •Eventually grass grows up and over pavement edge, creating a slow-draining dam

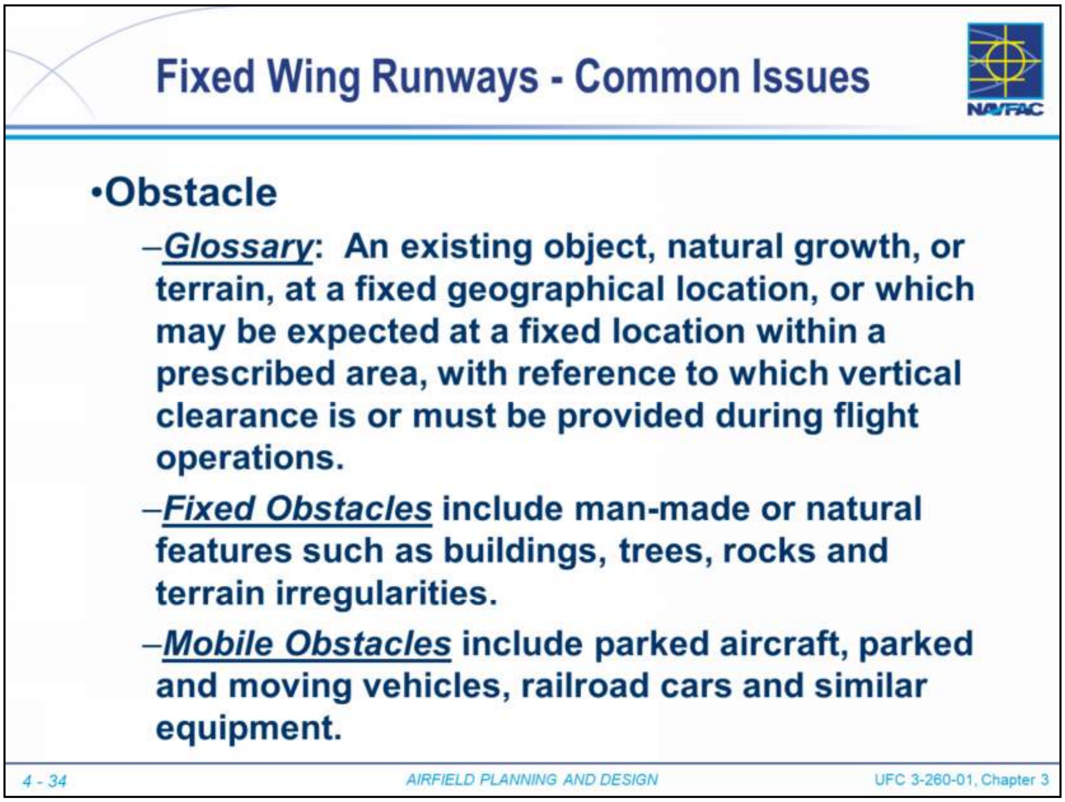
•Clear Zone – Area to be free of obstructions. Rough grade and turf when required.

•Graded Area of Clear Zone

- •Must also be relatively smooth, with grades 2% to 10% (exclusive of overrun grades)
- •1,000 ft long, same width as primary surface
- •No vertical headwalls, no flared end sections
- •Type I Clear Zone must be cleared, graded and free of above ground objects
  - •2,000’ wide, 1000’ long, centered on runway
- •Type II Clear Zone will be graded and cleared of all above-ground objects except airfield lighting.
  - •500’ wide, 2000’ long, centered on runway

•Chambers Field, Naval Station Norfolk Clear Zone may have issues, 1981 rule applies

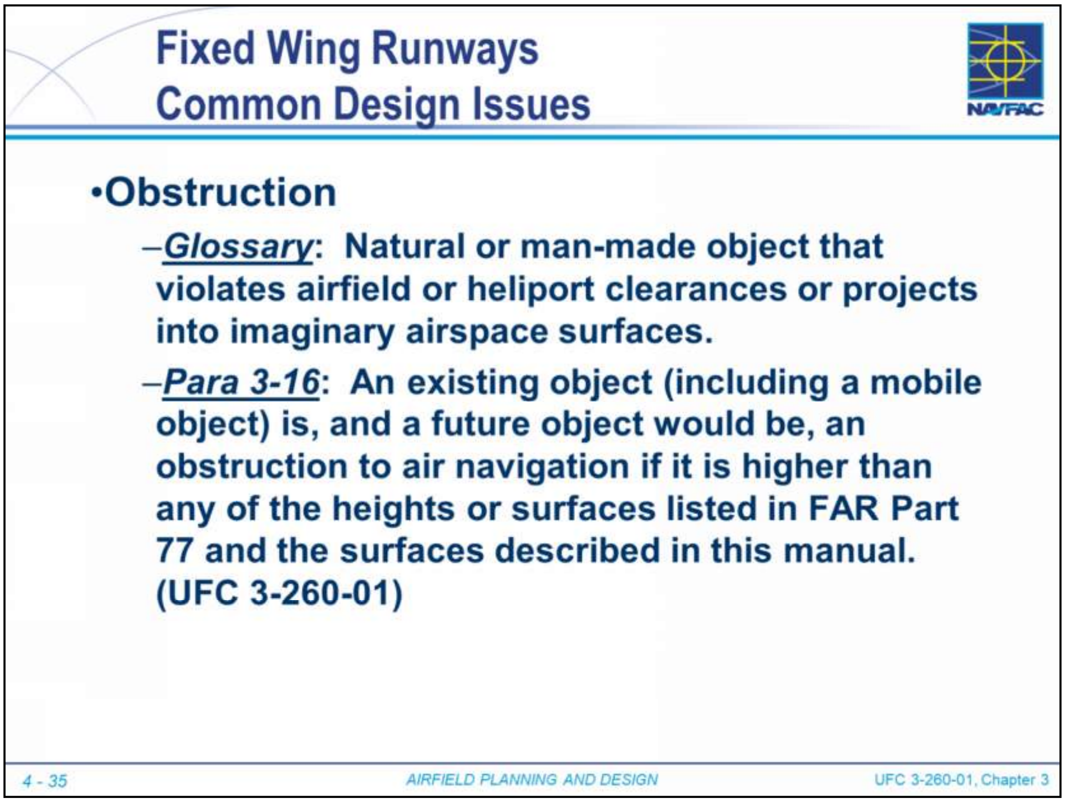
- •I-564 passing under runway
- •Threshold moved at this end so it could be moved farther away from obstructions at the opposite end.



- Obstacles – definition on slide from UFC 3-260-01
    - •Must be identified, but does not necessarily violate airspace.
    - •Flight plans can be built around obstacles to avoid them (example: cell tower away from base, but near flight path)
    - •If DoD controls the obstacle and it can be removed, it should be removed.
    - •If not possible to remove, may be marked with hazard lighting, in some cases.
    - •Need airspace evaluation and hazard analysis for determination

•Taxiing aircraft are not considered obstacles (but parked aircraft can be)

•Vehicles in performance of official duties, such as emergency vehicles, maintenance vehicles and inspection vehicles, are not considered obstacles only when authorized by Airfield Management and operating the vehicle in accordance with local driving rules and regulations.



- Obstructions (definition on slide from UFC 3-260-01)

  - Must be identified and removed.
  - If not possible to remove, may be marked with hazard lighting, in some cases.
  - Need airspace evaluation and hazard analysis for determination

- Common Potential Obstacles
  - •Sign – Obstacle. Fixed by function and frangible.
  - •BAK-12 Fairlead Beam. Obstacle. Fixed by function and strict grading requirements around beam
  - •Glide Slope Antenna. Obstacle, but could be obstruction if imaginary surface is penetrated. (ASW not required per UFC 3-260-01, Para 2-11)
  - •Approach Lights. Obstacle. Fixed by function and frangible
  - •Fence. Obstacle. Can be designed to be frangible (but may not meet security requirements for keeping vehicles from crashing fence.
  - •Localizer Shelter. Obstacle. Fixed by function. (ASW not required per UFC 3-260-01, Para 2-11)
  - •Approach Light. Obstacle. Fixed by function and frangible. (ASW not required per UFC 3-260-01, Para 2-11)
  - •Flared End Section. Obstacle. Has a vertical face. Therefore, not allowed in graded area of clear zone or graded areas adjacent to runway.

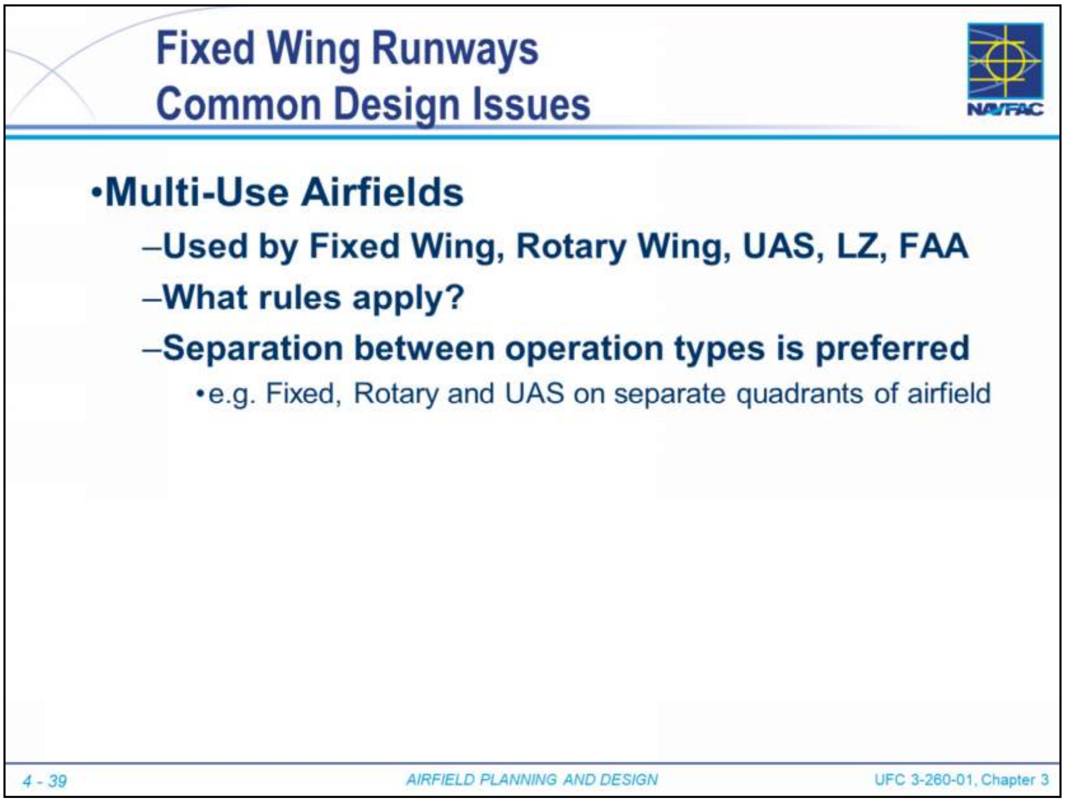
• Common Potential Obstructions

- •Wind Turbines – Light
- •Cranes – Flag and Light
- •Cell Towers – Paint and Light
- •Radio Towers – Paint and Light
- •Churches or Buildings -light
- •Water Towers – Paint and light
- •Trees – must be cut minimum 10-ft below imaginary surfaces and regularly trimmed.

•Other Considerations

- •Radar Interference (Solid Buildings – ILS reflections)
- •Solar Panel Glare Problems

- APZs
  - •Harder to control, because usually extend off base property
  - •Must work with local community to prevent new construction of incompatible facilities
  - •On Base – apply full land use controls.
  - •Off Base – several options to control
    - •Purchase land in fee
    - •Purchase land use restriction easement - purchase right to prevent development/construction within airspace above a defined elevation.
      - •Example – Airport purchase an easement on the air above a piece of property adjacent to an airport to prevent construction of any buildings on the site higher than 20 ft, corresponding to the height of the 7:1 transitional surface passing over the property.
    - •Zoning to restrict development - Community Planning and Liaison Officer (CPLO) coordinates with local organizations (Cities, Counties, Planning Commissions, etc.) on behalf of Base Commanding Officer to develop standards for development that are compatible with the airfield environment.
  - •Why so many golf courses around airports?
    - •Very compatible land use.

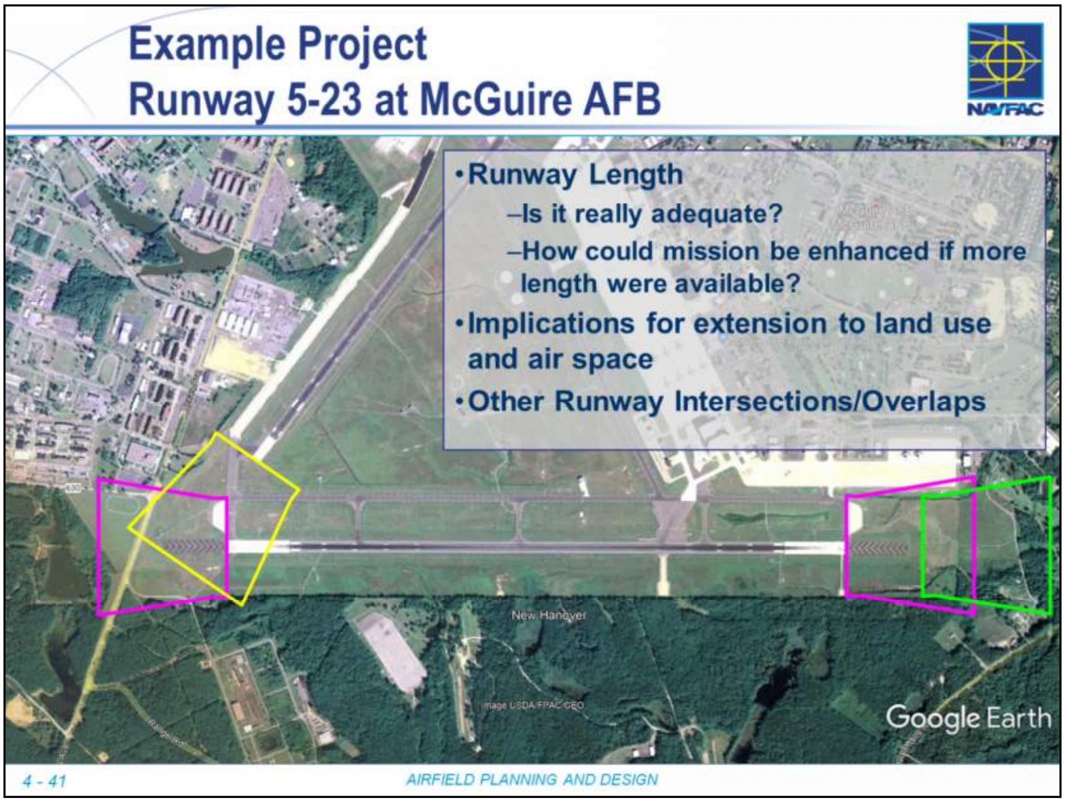


- Multi-use Airfields
    - Not uncommon to have a mixture of operations on a military airfield
        - Fixed Wing
        - Rotary Wing
        - UAS
        - LZ
        - FAA
    - What rules apply? Usually depend on who owns or who is paying
- Separate/segregate the types of operations as much as possible

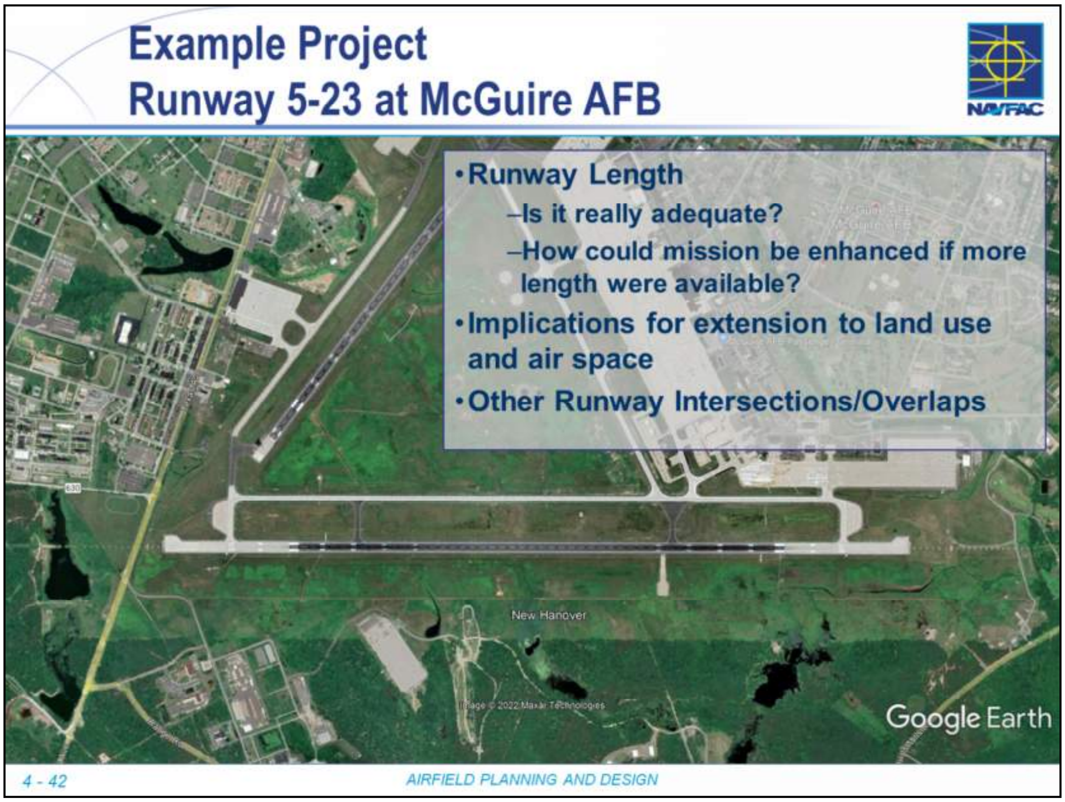
Fixed Wing Runways Common Design Issues

- Aircraft Parking
  - Parking ramp extends into Clear Zone
  - Arm/De-Arm Pads in Clear Zone
  - Tails can be Obstruction for Air Traffic Control Tower

- Aircraft Parking Aprons, especially at old bases, can fall within newer expanded Clear Zone
- Verify Parked Aircraft Tails do not penetrate imaginary surfaces
- Old Arm-DeArm Pads often fall within the Clear Zone
- Also need to check sightlines from the Air Traffic Control Tower when siting a new apron – the aircraft may not be within the Clear Zone, but tails can obstruct view from the tower.



- Runway Length: Check with operators to see if their mission is restricted due to runway length
    - Example at McGuire – add takeoff length by making overrun full strength – increase max takeoff weight for tankers and cargo aircraft weight during high temps. Eliminate secondary stop to take on fuel at base with longer runway. Figure this out during planning, not during construction.
- Takeoff/Landing Threshold Relocation
    - Moves the Clear Zone and APZs. Might create problems
- Runway Width: Verify meets criteria. Add shoulders?
- Runway Longitudinal Profile and Cross Slopes: Does the existing meet criteria. What will it take to change? Decide during planning/programming whether to include significant grade changes in the project scope.
- Intersections and Overlaps
    - Identify the constraints that will apply during construction



- Result: During construction, change order made to build full-strength overruns with turnarounds.
    - Does not change the landing or takeoff thresholds. Therefore, airspace, clear zones and APZs do not change
    - Changed the details for the approach light installation
    - Required relocation of Localizer antennas

Questions?

4 - 43 AIRFIELD PLANNING AND DESIGN

- Key Points of Section
  - UFC 3-260-01 is primary reference for Fixed Wing Runways
  - Runway is not just the pavement, it’s also defines the land use control areas and Airspace
  - Everything on the airfield is dependent on the runway
    - Horizontal Separation
    - Vertical Clearance
  - Grading Criteria is very detailed and strict.

- Parallel Runways with paved overruns
- Where are potential development sites on this airfield?
- What are the radial cuts through the trees in northeast quadrant?

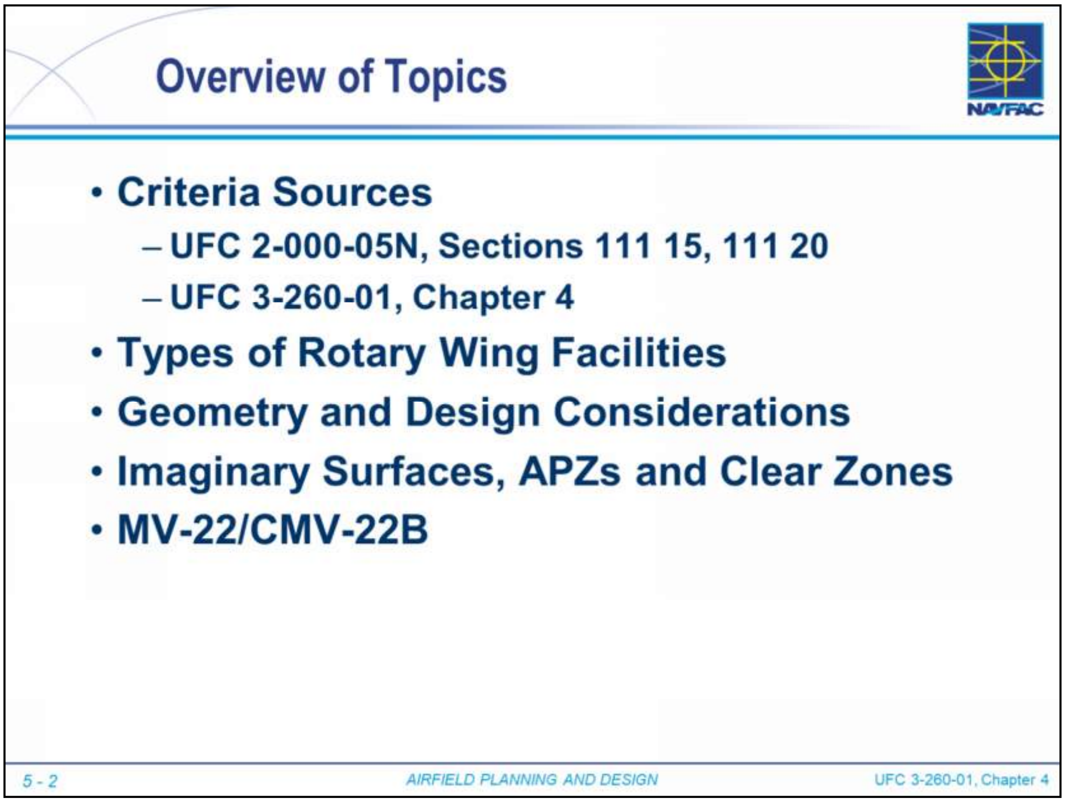
NAVFAC
Naval Facilities Engineering Command

Section 5
Rotary Wing Helipads and Other Facilities

AIRFIELD PLANNING AND DESIGN CRITERIA TRAINING

5/7/2023

UFC 3-260-01, Chapter 4



- Review topics to be covered in this section

- Criteria Sources
    - UFC 2-000-05N has requirements
    - UFC 3-260-01 Chapter 4 also has dimensional and airspace requirements

- This section focuses on Navy rotary wing facilities only. Other services are different and defined in UFC 3-260-01, but only focusing on Navy due to time constraints.

- Types – Navy doesn't distinguish helo pads by helo size (unlike Army). Instead, VFR vs IFR causes size change
    - Special Case: Single direction ingress/egress primary surface expands from 150' square to 300' square because helicopter is forced to rotate 180-degrees in place over helipad.

- Session will review the following regarding Rotary Wing Facilities
    - Key Features and Terminology
    - Shoulders
    - Common Issues

Design Features/Terminology

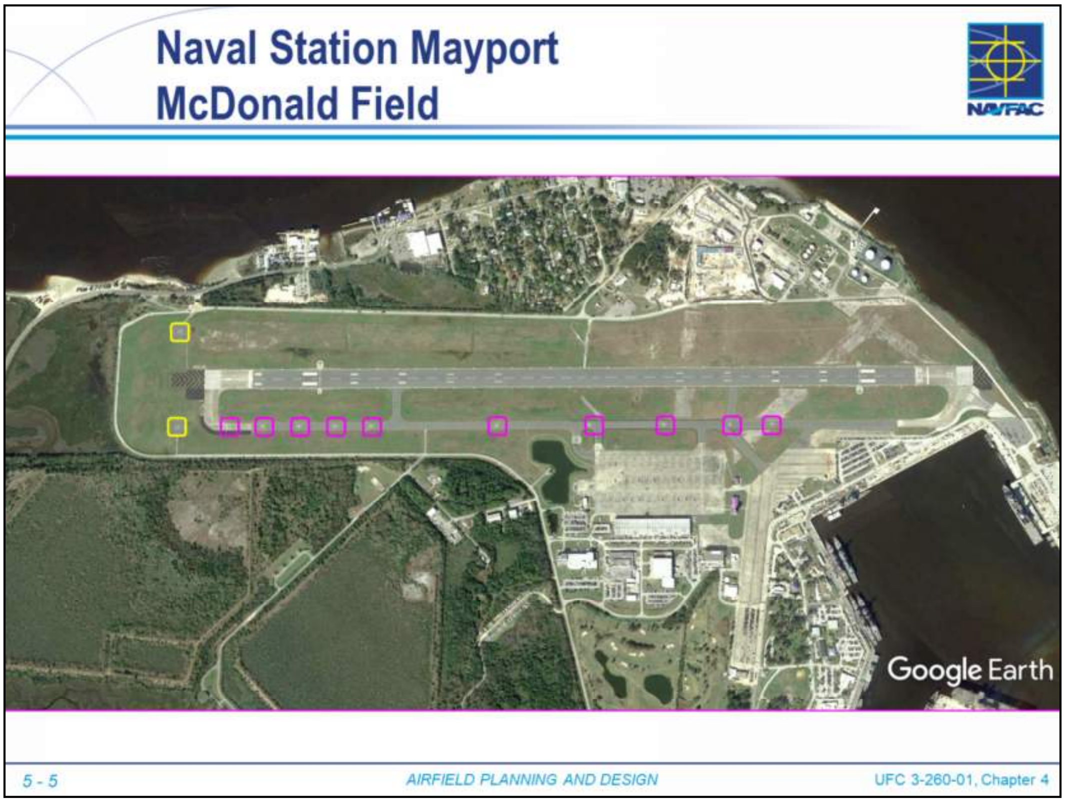
•Rotary Wing Runways

Table 4-1. Rotary-Wing Runways

Item No.	Description	Requirement	Remarks
1	Basic length	490 m (1,600 ft)	For Army and Air Force facilities, use basic length up to 1,220 m (4,000 ft) in elevation above mean sea level (AMSL). Increase basic length to 610 m (2,000 ft) when above 1,220 m (4,000 ft) in elevation above MSL. For Navy and Marine Corps facilities, basic length to be corrected for elevation and temperature. Increase 10% for each 300 m (1,000 ft) in elevation above 600 m (2,000 ft) MSL and add 4.0% for each 5 degrees C (10 degrees F), above 15 degrees C (59 degrees F) for the average daily maximum temperature for the hottest month.

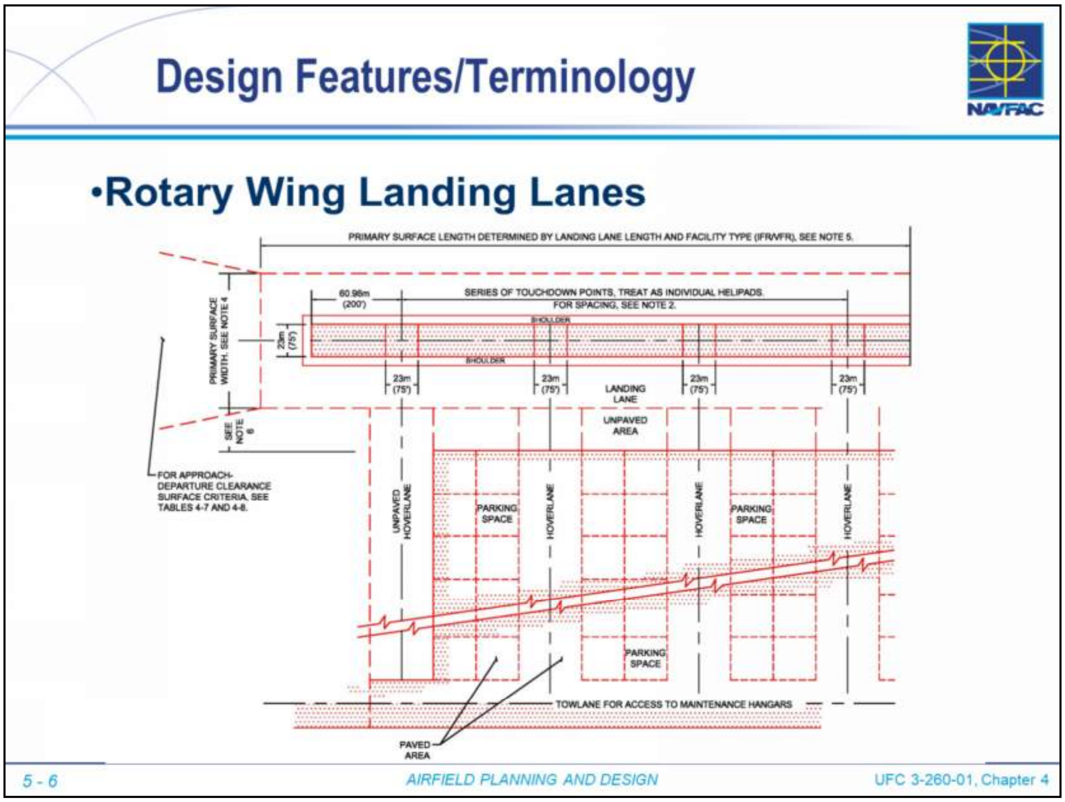
• Chapter 4, Para 4-3

• Rotary-wing runway allows for a helicopter to quickly land and roll to a stop, compared to the hovering stop used during a vertical helipad approach.



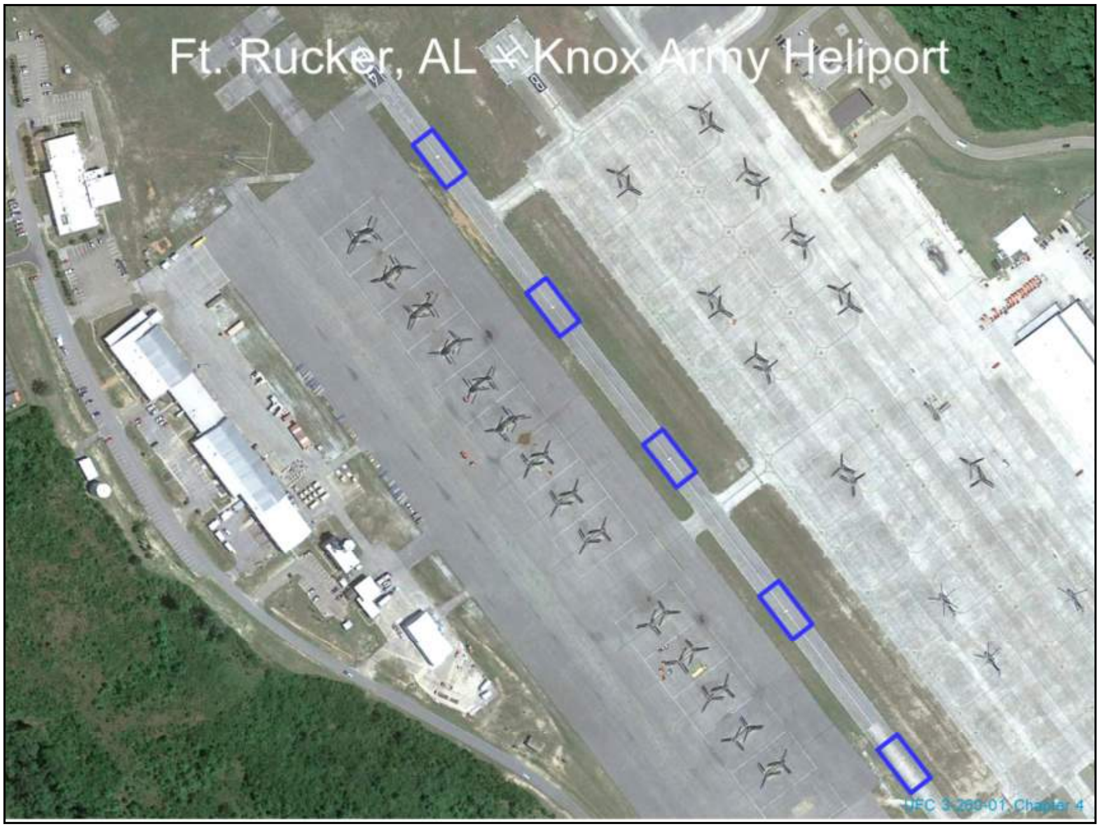
- **Naval Station Mayport**
- **Adm David McDonald Field (KNRB)**

- Fixed/Rotary Wing Runway - allows for a helicopter to quickly land and roll to a stop, compared to the hovering stop used during a vertical helipad approach.
- Service Specific Requirements
- Rotary Wing Runway can be its own facility, or it can be combined with a fixed wing facility, or helicopters can also land on fixed wing runways
- For example, this airfield has a fixed-wing runway, plus multiple helipads (magenta outlines around marked helipads)
- Hoverpoints (yellow outline)



• UFC 3-260-01, Chapter 4, Paragraph 4-8
• Figure 4-15

• Landing Lanes are sometimes used at Rotary-Wing Airfields.
• A Landing Lane is a series of points treated as individual helipads which permit efficient simultaneous use by a number of helicopters in a designated traffic pattern.

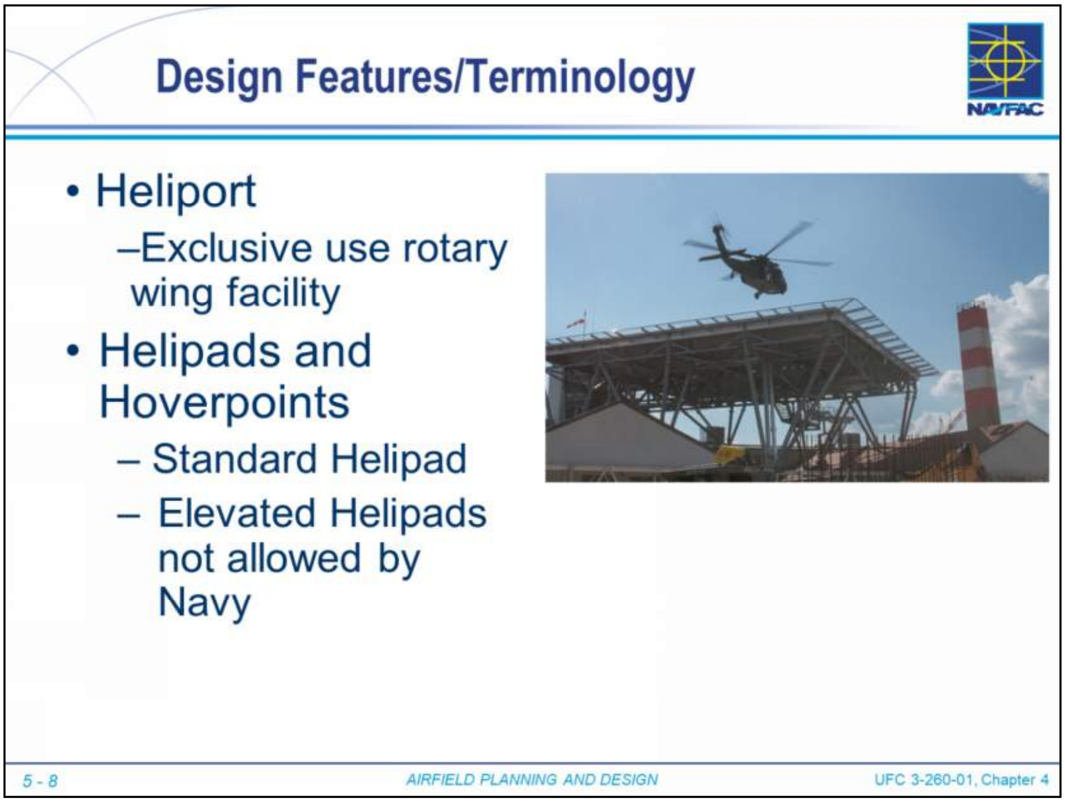


•**Ft. Rucker – Knox Army Heliport (AHP)**

• Highlight: Runway is divided into smaller chunks (white boxes along centerline, 400-ft at this heliport) to guide the pilots and allow for multiple take-offs.

•Example of a Landing Lane at Knox Army Heliport on Fort Rucker.

•Landing spots on the lane are the white markers on centerline, regularly spaced down the landing lane.



• Heliport - Facility designed for the exclusive operating, basing, servicing and maintaining of rotary-wing aircraft (helicopters).

• Helipads

  • Allow for helicopter hovering, landing, and takeoff

  • Used at facilities where a rotary-wing runway is not provided.

• Hoverpoints

  • Prepared and marked surface used as a reference or control point for air traffic control purposes by arriving or departing helicopters

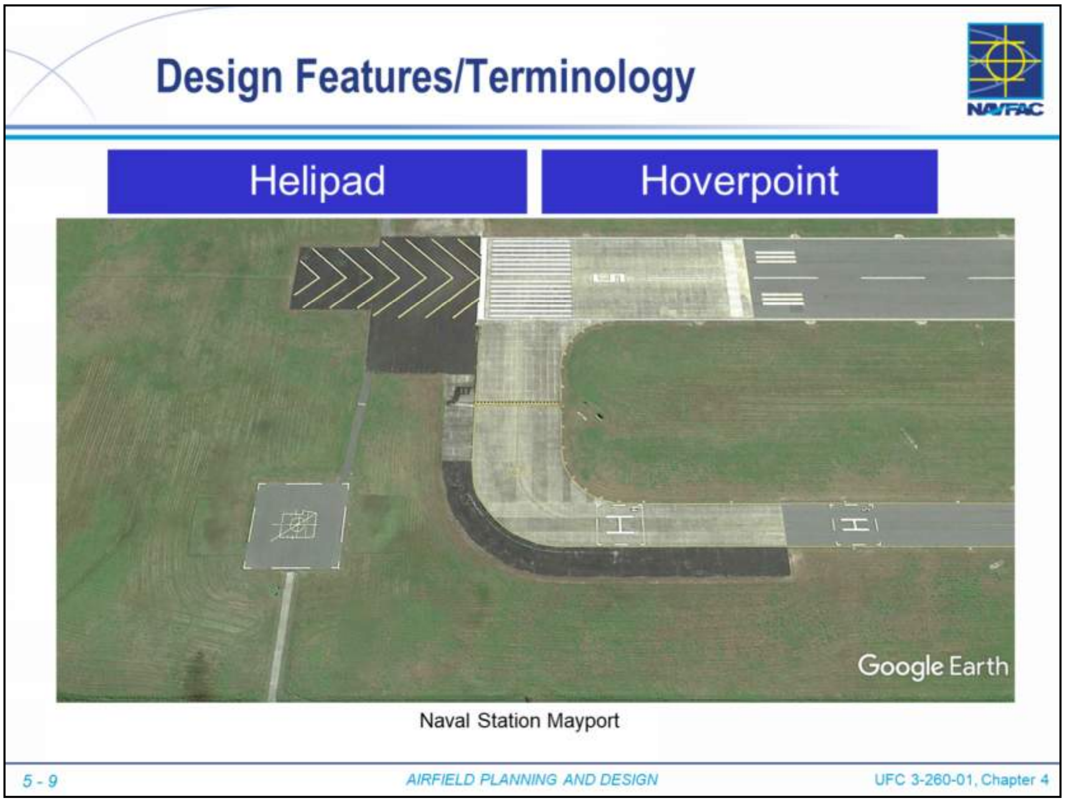
• Standard VFR Helipad - Paragraph 4-4 .1

• VFR design standards are used when no requirement exists or will exist in the future for an IFR helipad. Criteria for this type of helipad permit the accommodation of most helipad lighting systems.

• VFR Rotary-wing facility used only for observation, attack, medical evacuation and utility

  • Examples: Hospitals, headquarters facilities, missile sites

• IFR Helipad – Para 4-4.3. Instrument approach capability is essential to the mission and no other instrument landing facilities, either fixed-wing or rotary-wing, are located within an acceptable commuting distance to the site.



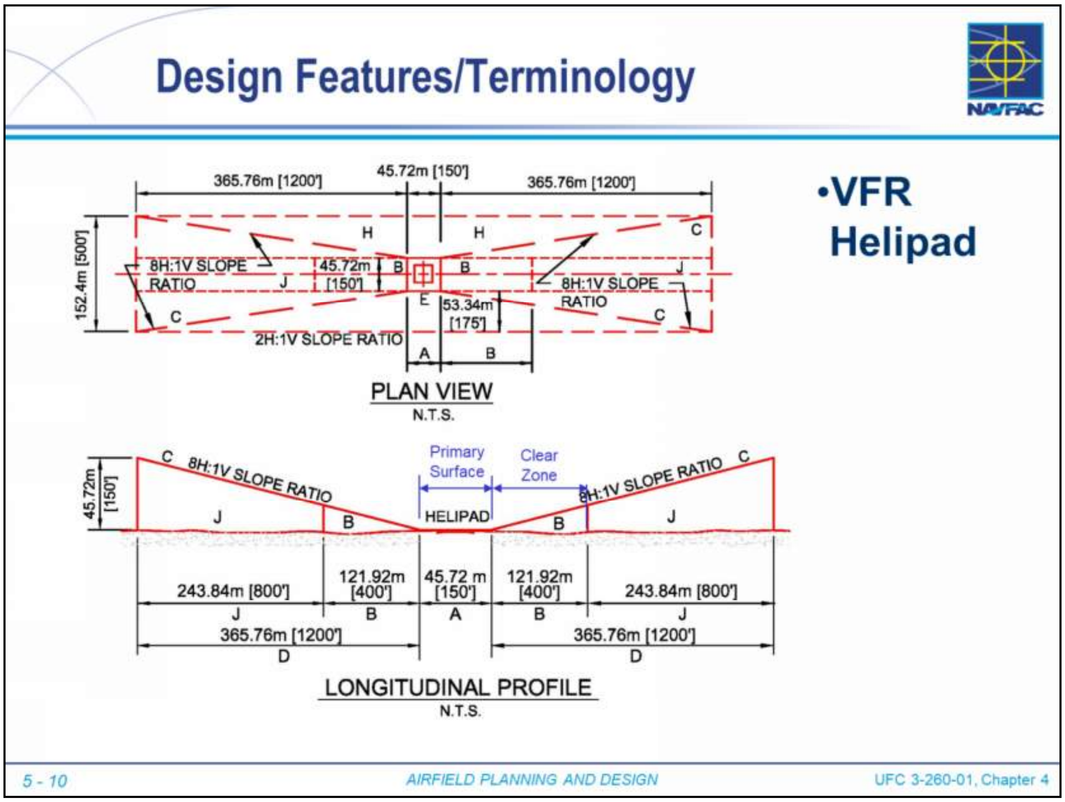
•Naval Station Mayport

- •Shows an example of a Helipad
- •Shows an example of a hoverpoint.

• Define differences between Helipads and hoverpoint

• Helipad – A prepared area designated and used for takeoff and landing of helicopters, **which includes both the touchdown and hoverpoint**.

• Hoverpoint – Prepared and marked surface at a heliport or airfield used as a reference or central point for arriving or departing helicopters.



•Figure 4-9.

•Paragraph 4-4 .1 – Standard VFR Helipad

• VFR design standards are used when no requirement exists or will exist in the future for an IFR helipad. Criteria for this type of helipad permit the accommodation of most helipad lighting systems. Imaginary surfaces are much smaller than IFR – extend only 1200' away from 300' x 300' primary surface

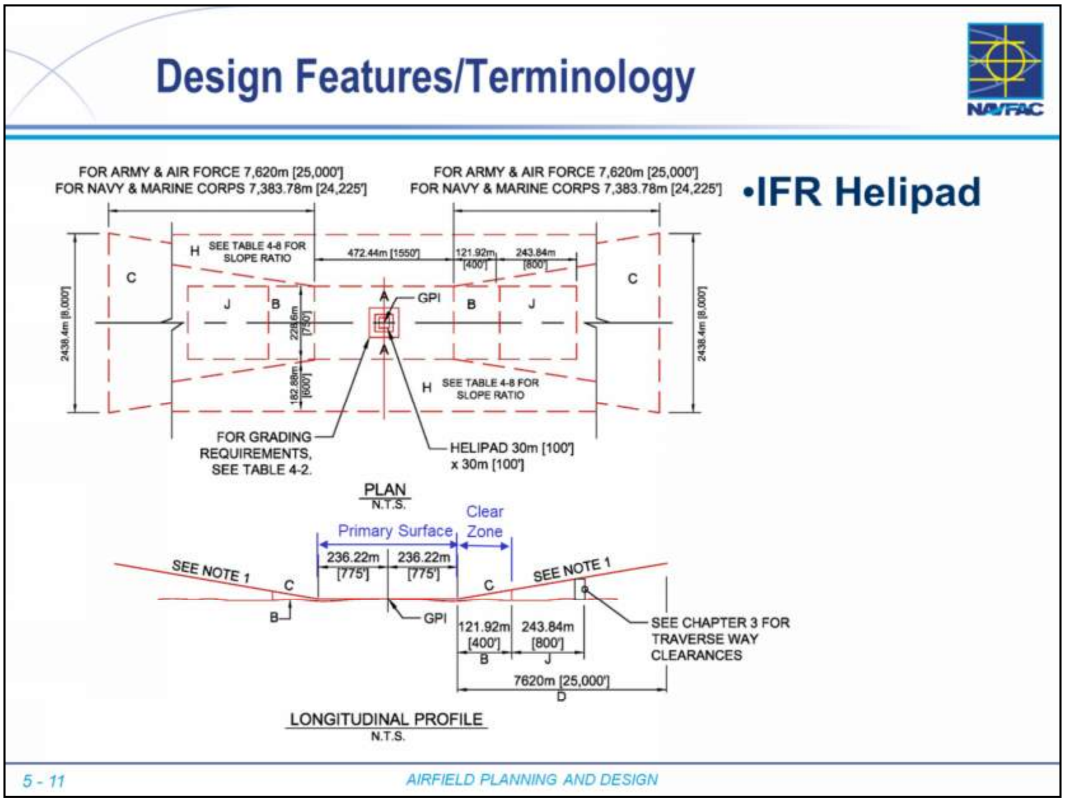
• **VFR**

- Full
- Limited Use
- Can be bi-directional or unidirectional (One Way in / One Way Out)

• IFR design standards are used when an "all-weather" facility is needed and will have approach lights and NAVAIDs can be installed. Imaginary surfaces are much larger than VFR – extending 25,000' away from only 1200' away from 750' x 1550' primary surface.

• **IFR**

- Full
- Can be bi-directional or unidirectional (One Way in / One Way Out)



•Paragraph 4-4 .1 – Standard VFR Helipad

• VFR design standards are used when no requirement exists or will exist in the future for an IFR helipad. Criteria for this type of helipad permit the accommodation of most helipad lighting systems. Imaginary surfaces are much smaller than IFR – extend only 1200' away from 300' x 300' primary surface

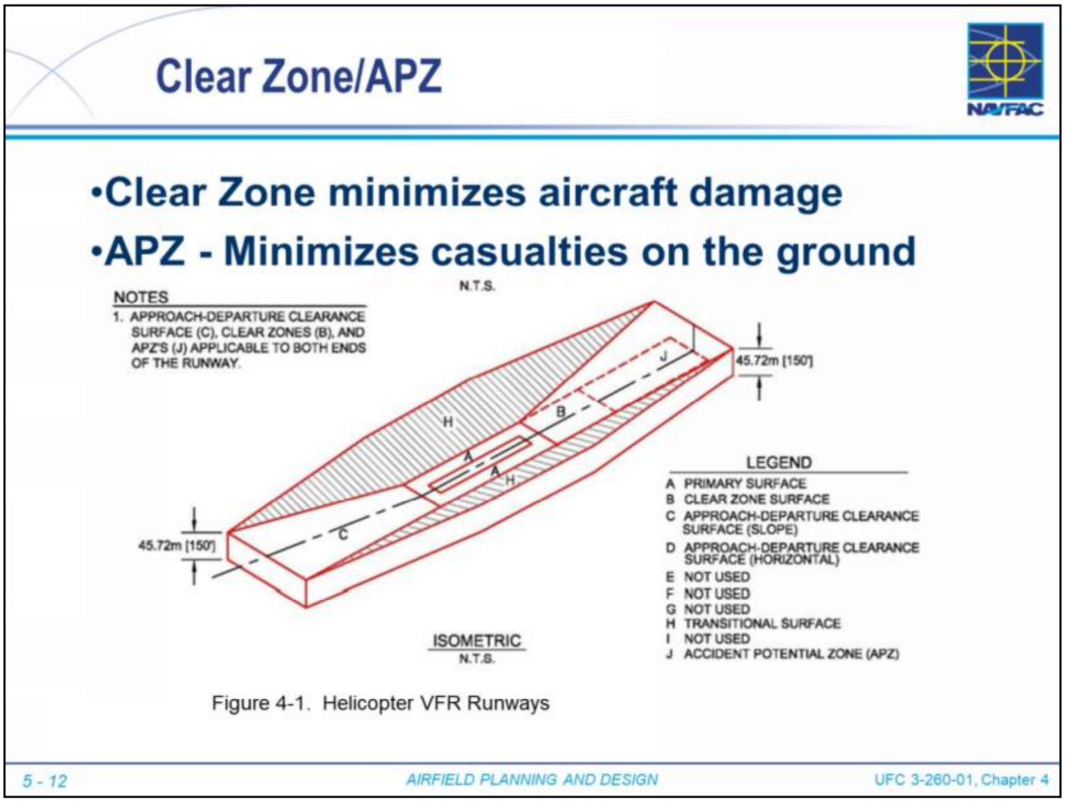
• **VFR**

  - Full
  - Limited Use
  - Can be bi-directional or unidirectional (One Way in / One Way Out)

• IFR design standards are used when an "all-weather" facility is needed and will have approach lights and NAVAIDs can be installed. Imaginary surfaces are much larger than VFR – extending 25,000' away from only 1200' away from 750' x 1550' primary surface.

• **IFR**

  - Full
  - Can be bi-directional or unidirectional (One Way in / One Way Out)



•Chap 4, Paragraph 4-12
•Clear Zone/APZ also defined by AICUZ/DoDI

Clear Zone

• Land use for Clear Zone corresponds to the clear zone land-use criteria for fixed-wing airfield. Criteria is Service-specific.

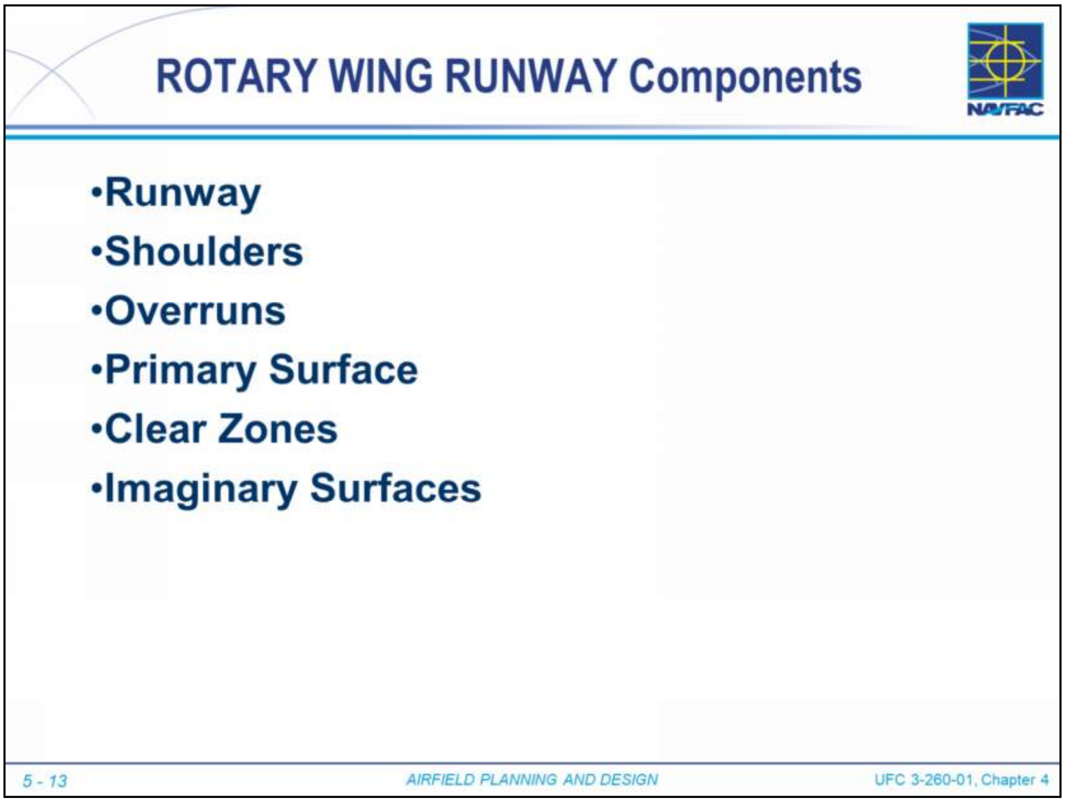
• Requirements:
    - Must be free of obstructions (natural and man-made), rough-graded to minimized damage to an aircraft that runs off or lands short of the end of the landing surface.
    - Allow for recovery of aircraft that are aborted during takeoff.
    - Doesn't have to be on Military property, but needs to be protected under a long-term lease.

- VFR landing pads/runways – Clear Zone required
- Admin and Hospital Helipads – Clear Zone not required
- IFR Landing Pads/Runways – Much Larger Primary Surface, but CZ still required

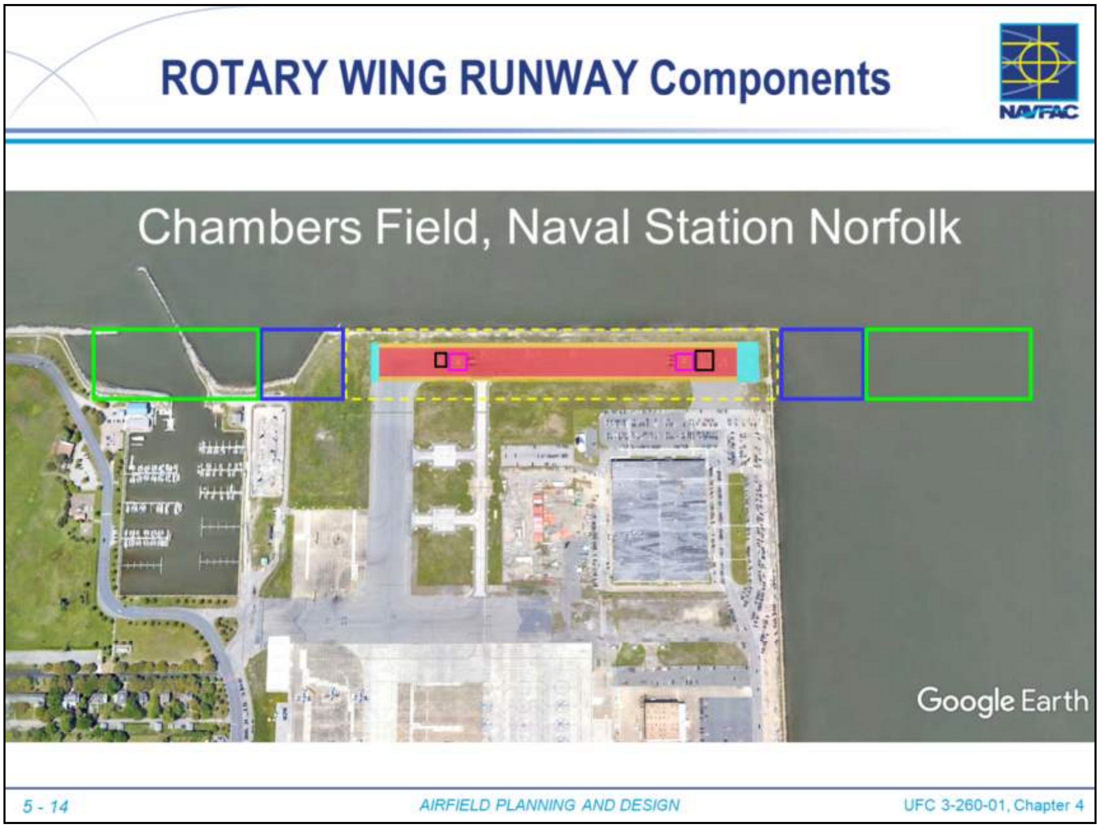
•**Accident Potential Zone (APZ**)

• Land use for APZ corresponds to the APZ criteria for fixed-wing airfield. Criteria is Service-specific.

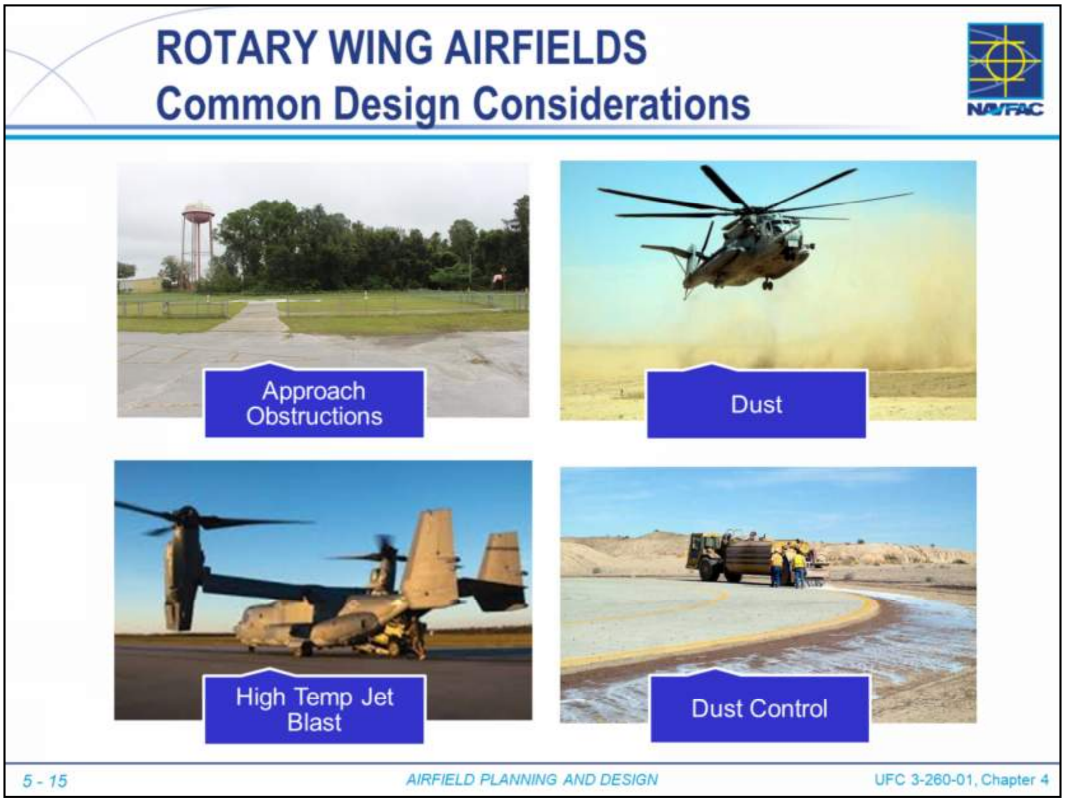
• Rotary Wing runways only have APZ I, not APZ II
• VFR landing pads/runways – APZ I required
• Admin and Hospital Helipads – APZ I not required
• **Imaginary Surfaces**
    •Primary Surface
    •Approach Departure Clearance Surface
    •Transitional Surface
    •Inner Horizontal Surface



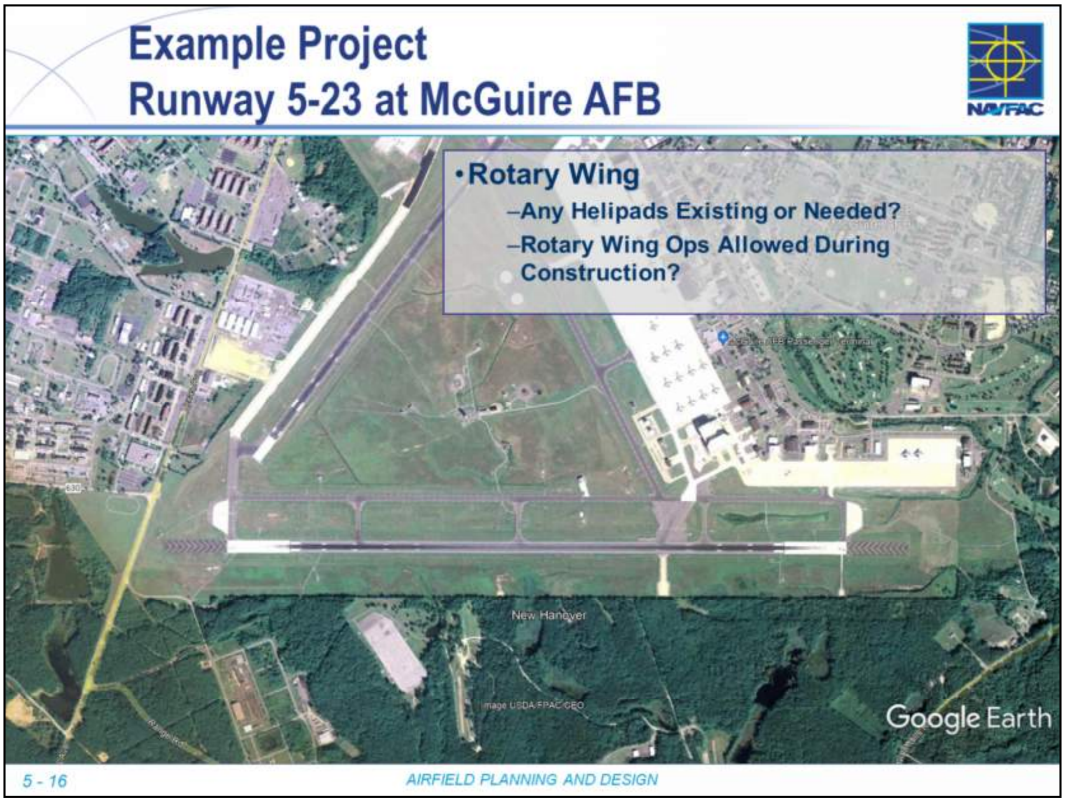
- Runway: allows for a helicopter to quickly land and roll to a stop, compared to the hovering stop used during a vertical helipad approach.
- Shoulders: Area adjacent to runways, susceptible to rotor-wash and erosion
- Overruns: Paved and Unpaved portions, required at the end of all rotary wing runways
- Primary Surface: 300-ft wide, centered, clear of obstacles
- Clear Zones: Off end of runway, or surrounding helipad. Dimensions in UFC
- Imaginary Surfaces
  - Primary Surface
  - Approach Departure Surface
  - Transitional Surface
  - Inner Horizontal Surface



- **Chambers Field, NS Norfolk - Heliport**
- Discuss Parts of Navy Heliport – each appears on click
    - •Helipad (Magenta Outline)
    - •Hoverpoint (Black Outline)
    - •Runway (Red shade)
    - •Shoulders (Gold Shade)
    - •Overruns (Blue Shade) – 75' VFR, 200' IFR
    - •Primary Surface (Yellow Dash) – 300' VFR, 750' IFR
    - •Clear Zones (Blue Outline) – 400' Long VFR & IFR
    - •Accident Potential Zone I (Green Outline) – 800' Long VFR & IFR



- Service Specific Requirements
  - Planning is Key
  - Consider Future Use
  - Consider Joint Use – Who is controlling?
- Direction of ingress/egress – Chapter 4-5
  - Part of the Planning Process
  - Allows a helicopter pad to be located in a confined area
  - Consider: Obstructions, neighboring Airfields/Heliports, Type of Use
  - Figures in UFC depict requirements of “Same Direction ingress/egress” also
- Obstructions
  - Same as Fixed-Wing Airfield
  - Must remove obstructions or have a waiver
- Dust Control
  - Location Specific. Turf/Pavement could be your friend.
  - Paved Shoulders required to control dust from rotor wash.
- Special Materials
  - HTC for V-22 to resist high temperature exhaust
  - Neoprene Joint Sealants



- Are there any Rotary Wing facilities within the project or adjacent to the project area?
- Will rotary operations be allowed adjacent to construction? Any special procedures required to allow this to happen? Dust control?

•Key Points of Section

- •UFC 3-260-01 is primary reference for Rotary Wing Runways
- •Navy has one size for helipads – not dependent on helicopter size like other services
- •IFR vs VFR causes a significant change in size for primary surface
- •Single Direction Ingress/Egress demands a significantly larger primary surface (300' vs 150' square, Figure 4-11)) because helicopter has to rotate in place
- •Heat Resistant materials are critical for V-22 operations

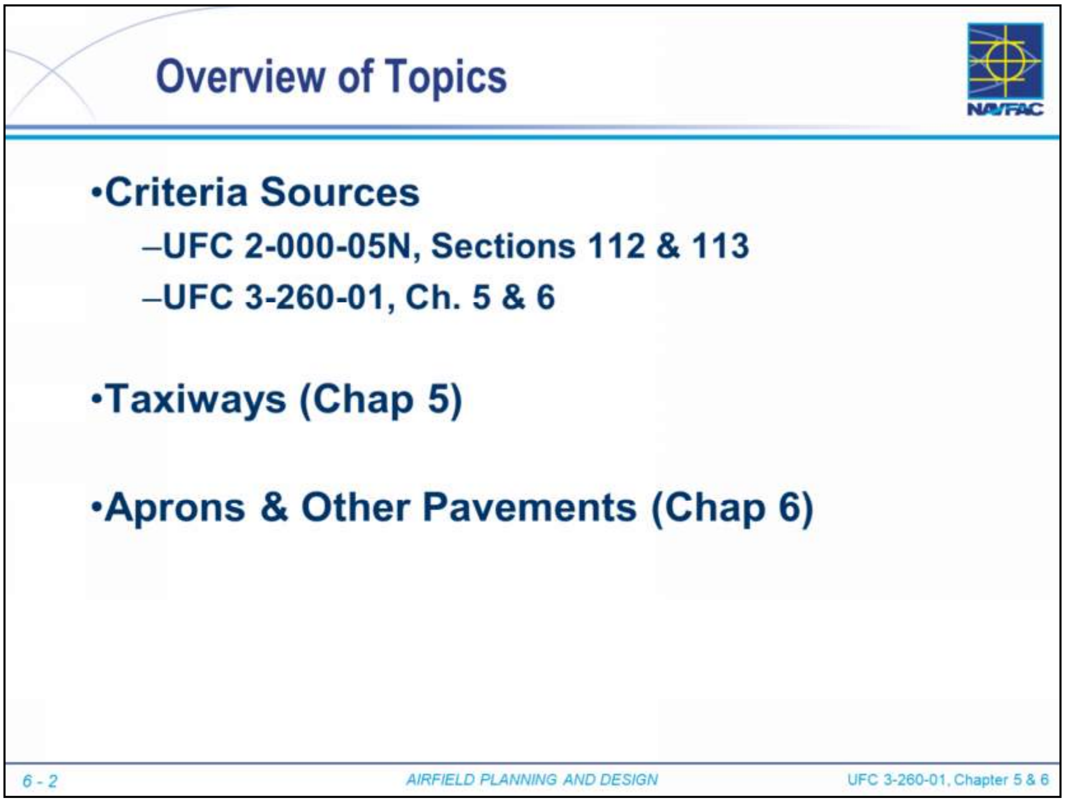
Name the Airfield

- AM-2 Matting

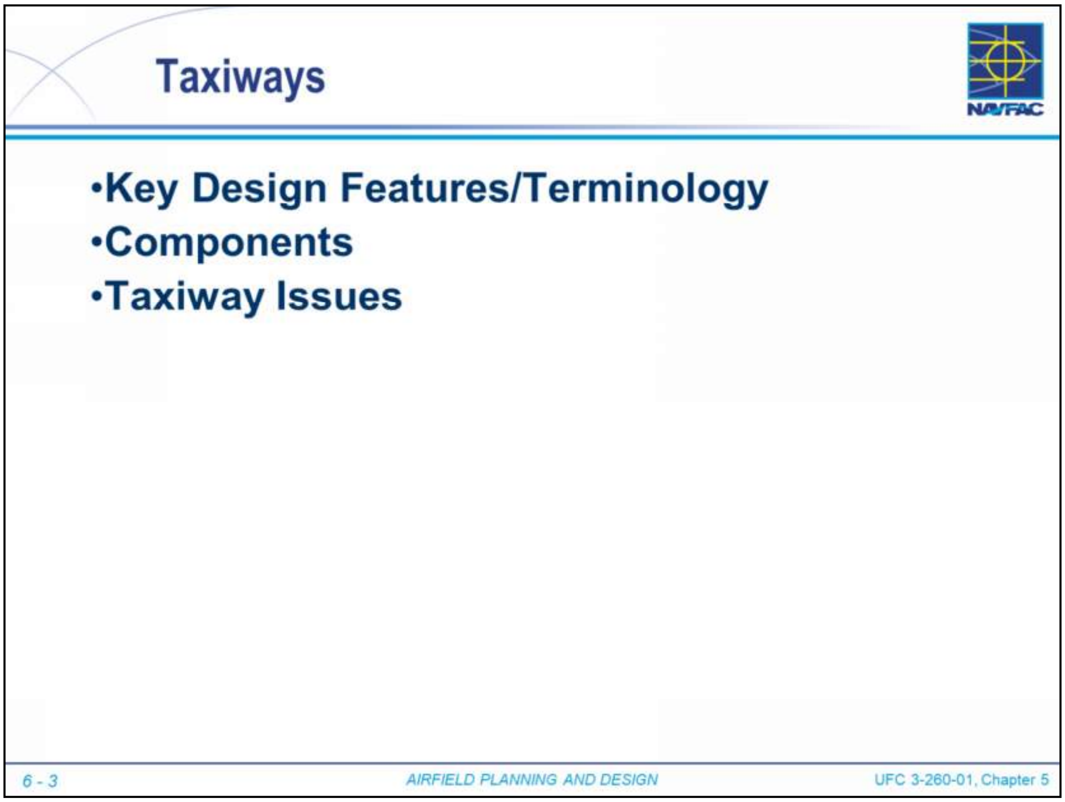
Section 6
Taxiways, Aprons and Other Facilities

AIRFIELD PLANNING AND DESIGN
CRITERIA TRAINING

5/7/2023



- This section will review UFC 3-260-01
  - Chapter 5 – Taxiways
  - Chapter 6 - Aprons



•Taxiways have the following functions

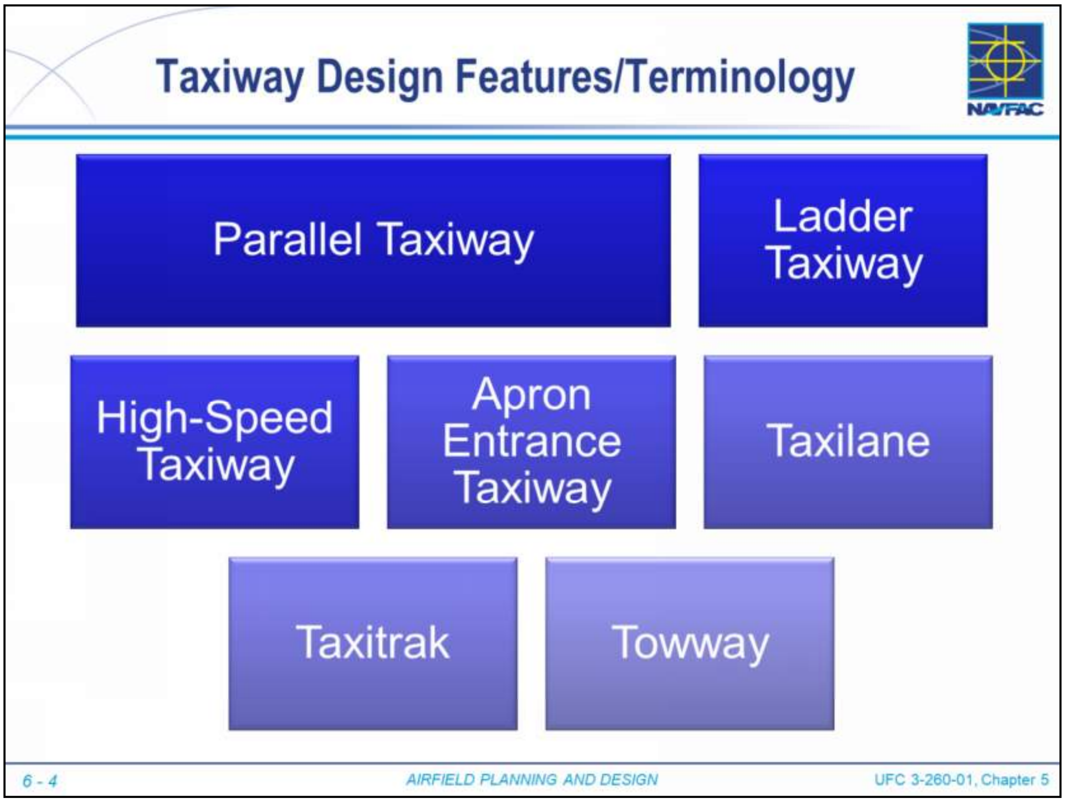
- Ground Movement of Fixed- and Rotary-Wing Aircraft
- Connect the Runways, Helipads and other landing/take-off surfaces with the parking and maintenance areas
- Provide access to hangars and various parking aprons and pads

•Next slides will review

•Key Design Features and Terminology

•Components

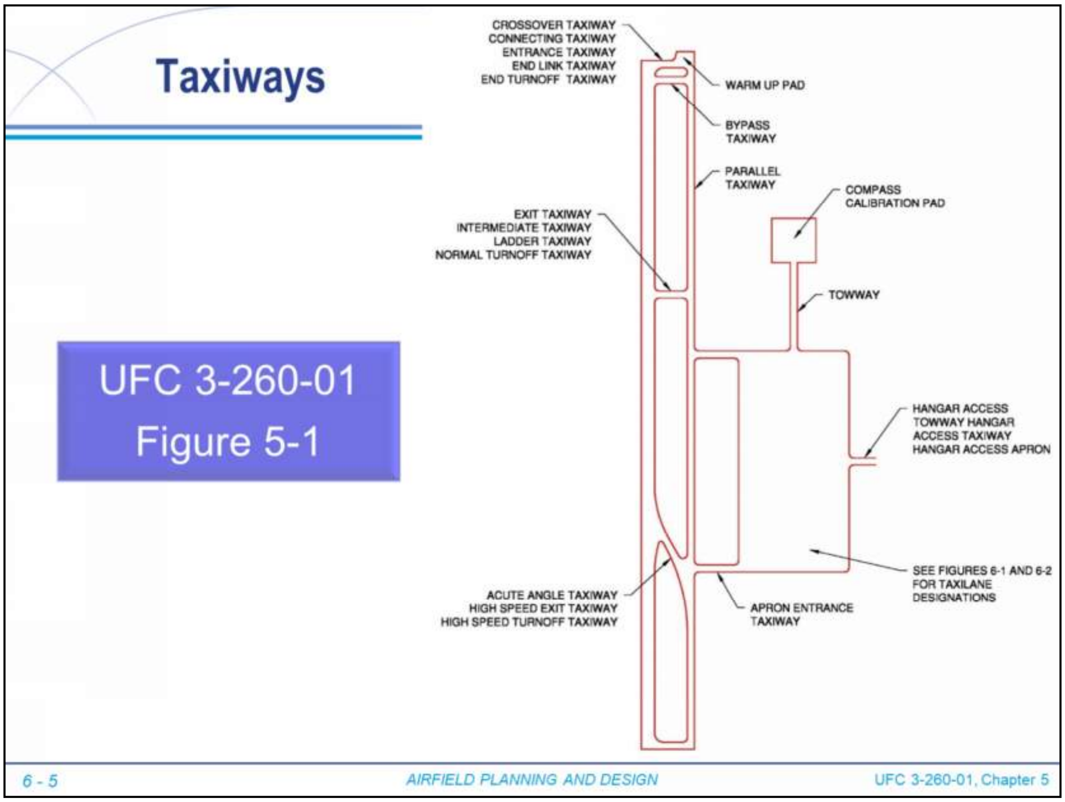
•Issues



•Taxiway Design Features & Terminology

• Many different types of taxiways
- •Parallel – runs parallel to runway
- •Ladder – short connector between parallel taxiway and runway
- •High-Speed Runway Exit – angled connector between parallel taxiway and runway
- •Apron Entrance – connects parallel or other taxiway to parking apron
- •Taxilanes on Aprons – designated travel lane within an apron pavement.
- •Taxitraks – a specially designated path, on an airfield other than mass parking areas, on which aircraft move under their own power to and from taxiways to dispersed platforms
- •Towways – paved surface designated only for towed aircraft

• Figure 5-1 of the UFC provides the common taxiway designations; however let's look at a few airfield examples to define these different design features.



•UFC 3-260-01, Figure 5-1

•Point out different types of taxiways

•Basic Airfield Layout

- Consists of a taxiway connecting the center of the runways, helipads and other landing/takeoff surfaces with the parking apron.

Taxiway Layout Goals

- Simplify Taxiing Routes
- Prevent Delays
- Provide Direct Access (Slightly Different than FAA)
- Efficiency

• **<u>Highlight Taxiway Components</u>**: Joint Base Andrews

<u>Parallel Taxiways</u> (Red)

- A Taxiway parallel to the runway for the entire length of the runway.
- Most efficient taxiway system.

<u>Ladder Taxiways (Blue)</u>

- Taxiways between the Parallel Taxiway and Runway.
- Can be straight from Apron to Runway (different from current FAA requirements)

<u>Apron Entrance Taxiways (Yellow)</u>

- East side – connects parallel to apron

<u>Highlight Taxiway Component</u>: Peterson AFB, CO

<u>High-Speed Taxiways (Magenta)</u>

- Angled turn-off taxiways located at intermediate locations along the runway.
- Approval is Service Specific:
    - For the AF – these need to be approved by the MAJCOM pavement engineer
    - For Army – approval has to be run through the Transportation Systems Center

• **Highlight Taxiway Component**: Joint Base McGuire-Dix-Lakehurst

Taxilanes

- Within a parking apron, immediately adjacent to or running between aircraft parking positions
- Other terminology:
    - Peripheral Taxilane (Navy)
    - Through Taxilane
    - Interior Taxilane (Green)
    - Parallel Taxilane (Red)

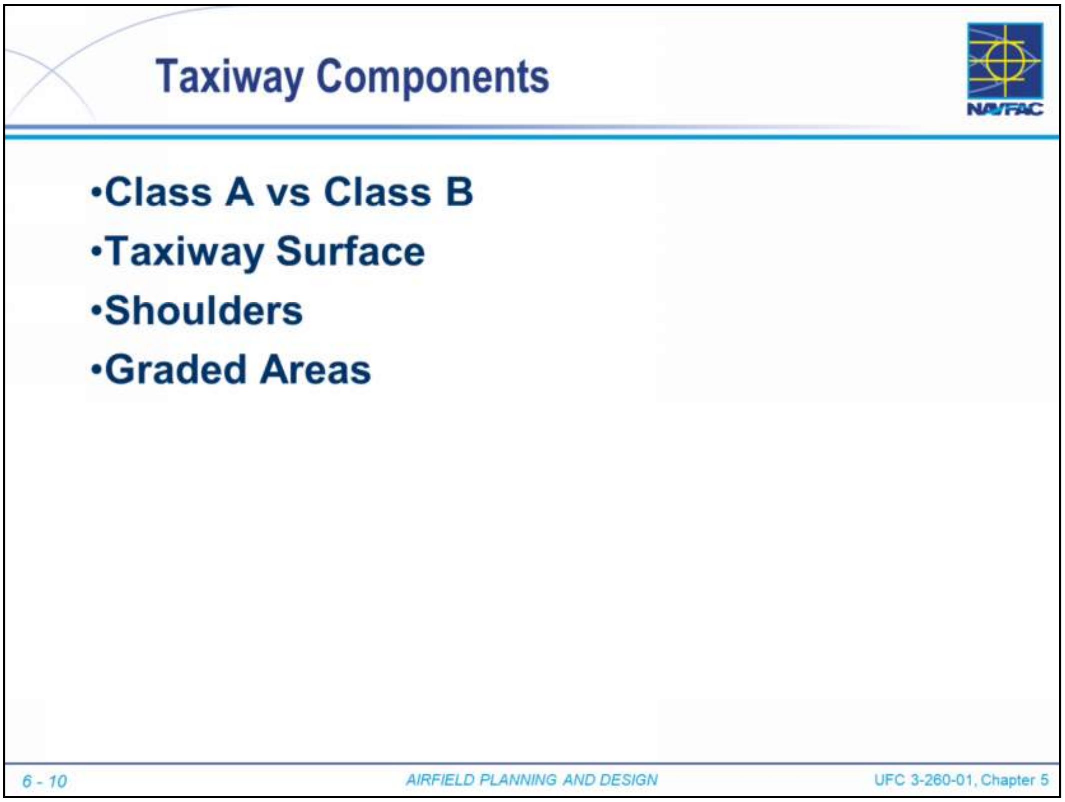
Towways

- Paved surface over which an aircraft is towed.
- More common at Army/Air Force Bases; Navy/Marines typically just call them taxiways.
- Example: Pavement to tow an aircraft to a Compass Calibration Pad (CCP).
- Considerations for towways are in Section 6-9.3 & 9-7.6

• **<u>Highlight Taxiway Component</u>**: Taxitrak

<u>Taxitrak</u> (Green)

- A specially prepared or designated path, on an airfield other than the mass parking area, on which aircraft move under their own power to and from taxiways to dispersed parking positions or shelters.
- Built specifically for fighter aircraft only.
- Use by tactical transport aircraft (AC-130) is permitted provided minimum clearances are meet (MAJCOM Guidance)
- Taxitraks are more common overseas and in deployed locations to disperse assets for protection and safety.
- Table 5-7 present the criteria for Taxitraks
- Graphic shows the taxitrack to the dispersed hangar facilities at Spangdahlem AF, Germany



- UFC 3-260-01 defines
  - Class A and Class B taxiways
  - Taxiway Surface
  - Shoulder Surface
  - Graded Areas

- Following slides will address these items

FIXED WING TAXIWAYS
Class A vs Class B

NAVFAC

Table 5-1. Fixed-Wing Taxiways

Table 5-1. Fixed-Wing Taxiways				
Item		**Class A Runway**	**Class B Runway**	
No.	**Description**	**Requirement**		**Remarks**
1	Width	15 m (50 ft)	23 m (75 ft)	Army and Air Force airfields
		12 m (40 ft)	23 m (75 ft)	Navy and Marine Corps airfields
		See Remarks		May be modified for particular mission requirements (special taxiways such as high-speed and end turn-off)
2	Total width of shoulders (paved and unpaved)	7.5 m (25 ft)	15 m (50 ft)	
3	Paved shoulder width	7.5 m (25 ft)	7.5 m (25 ft)	Army and Air Force airfields except as noted below
		N/A	3 m (10 ft)	Air Force taxiways devoted exclusively for fighter and trainer aircraft A paved shoulder up to 7.5 m (25 ft) is

6 - 11 AIRFIELD PLANNING AND DESIGN UFC 3-260-01, Chapter 5

Class A vs Class B

- The Runway Classification (Class A vs Class B) determines the criteria for Fixed-wing Taxiways (Table 5-1) and Towways (Table 5-6).
- For Rotary-wing Taxiways, the type of usage (Dual Use vs. Heliport) and type of Aircraft will determine the shoulder size. Table 5-3 provides the Rotary-wing requirements.
- Requirements are sometimes Service Specific.

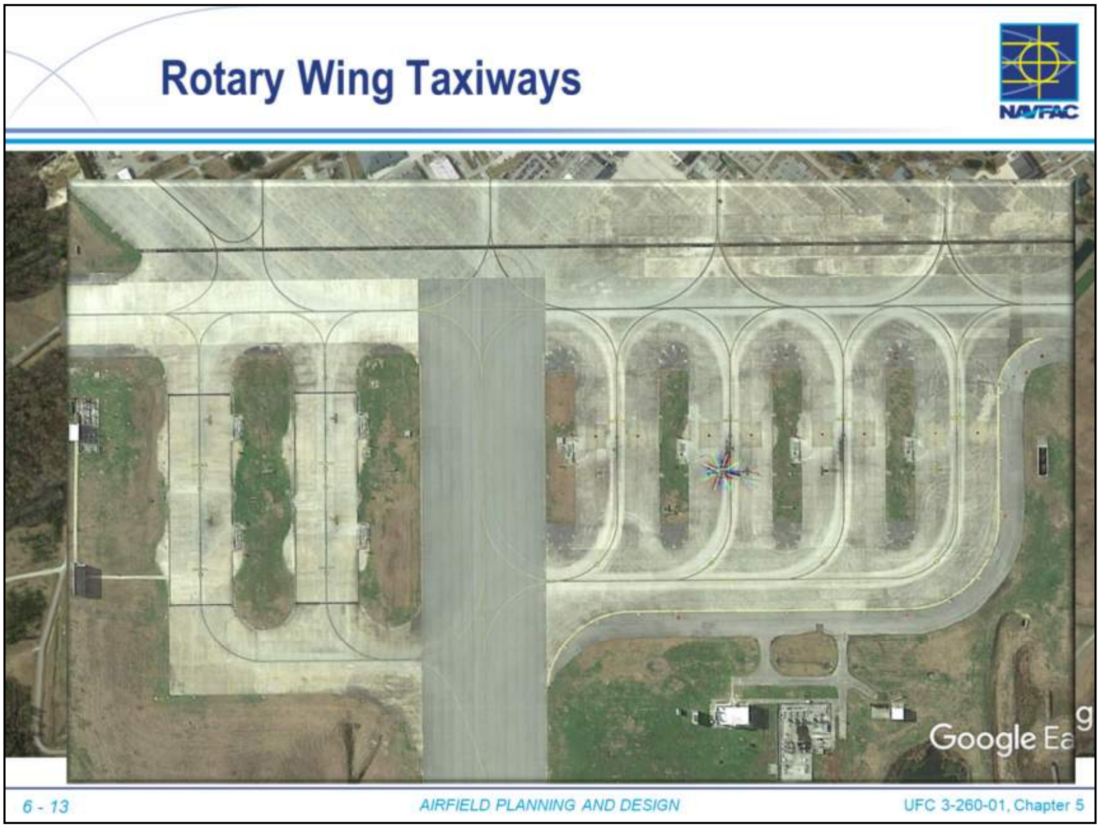
Taxiway Surface

- **Fixed-Wing Taxiways**
  - **Paved**
    - Class A – 40 ft Wide
    - Class B – 75 ft Wide
    - Shoulders – 25-ft Paved, with some exceptions
    - MV-22 – 100-ft paved width required
- **Rotary-wing Taxiways**
  - **Paved**
    - 40 ft Wide
    - Shoulders – 25 ft Paved
    - CH-53 and MV-22 – 100-ft paved width required

Highlight: Taxiway Surface

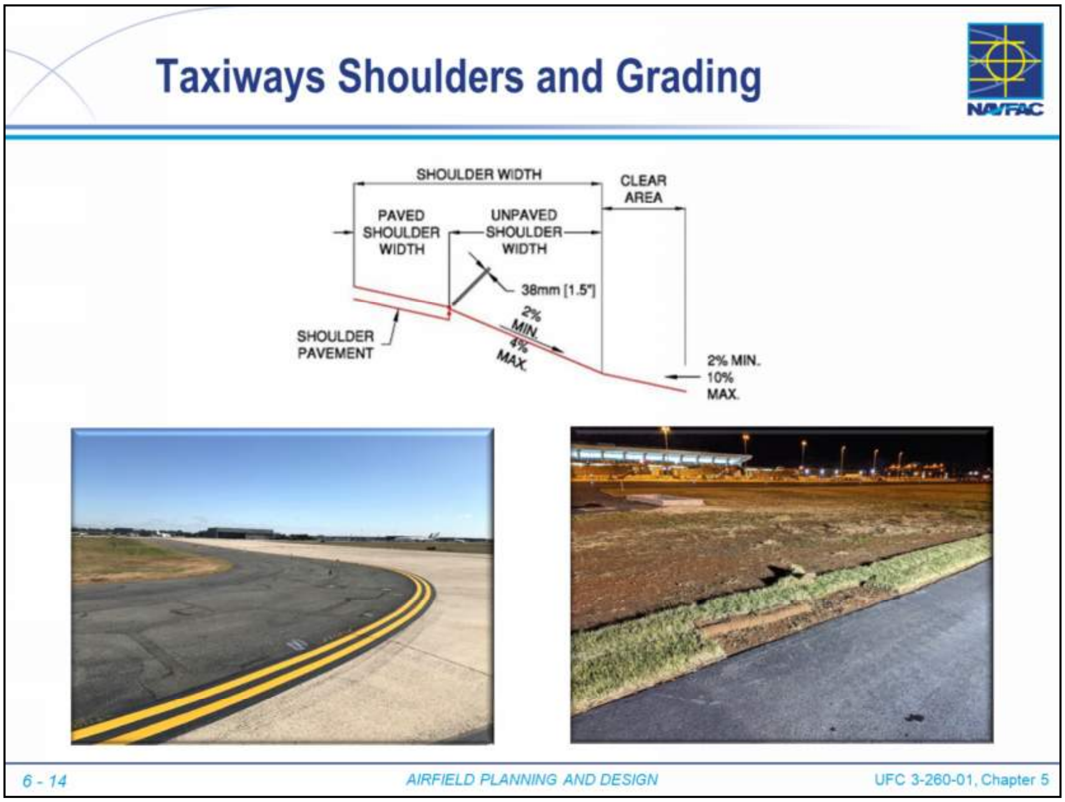
- Dictated by the type of Aircraft using the facility.

- Rotary-wing with wheeled aircraft require a paved surface
- At airfields supporting both fixed- and rotary-wing operations, the appropriate fixed-wing criteria will be applied, except as noted for shoulders or for STOVL aircraft requirements.



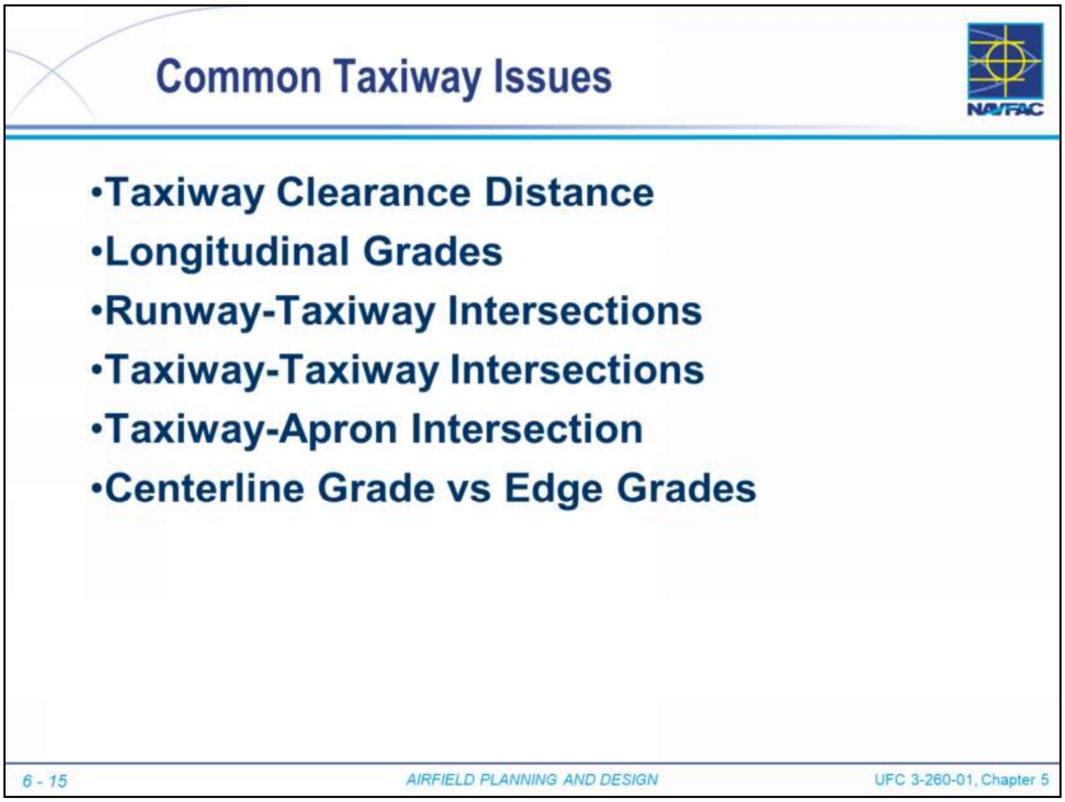
•**MCAS New River, NC**

- Primarily a rotary wing airfield, but has fixed wing components like runways
- Dedicated Rotary Wing Taxiways (click to zoom in)
    - 100-ft paved width
    - Helicopter Refueling Pits



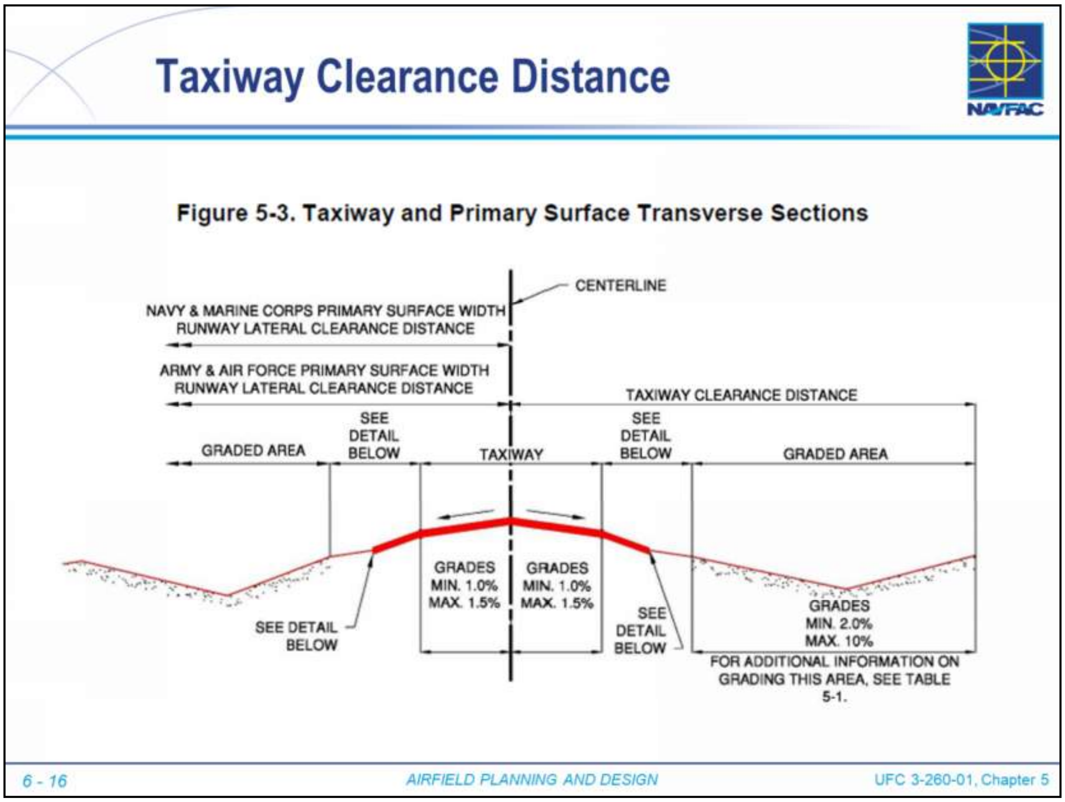
- Shoulders
  - UFC 3-260-01, Figure 5-3
  - Paved Portion
  - Unpaved Portion
  - 1.5” Dropoff at edge – important to promote drainage
  - Steeper Grade adjacent to Class B Runways – through unpaved width

- NOTE: New requirement in 2018 – Where CH-53 and V-22 operations occur, total paved width (taxiway plus shoulders) of 100 ft required for dust/FOD control.
  - Reference: UFC 3-260-01, Table 5-1, item 3 and Table 5-3, Item 2.



Common Issues

- Briefly cover several common issues related to taxiways



<u>Taxiway Lateral Clearance Distance</u>

- Lateral clearance offset distance are similar to those required on the runway.
- Figure 5-3 shows typical taxiway cross sections
  - Crowned on centerline
  - Shoulders and non-paved areas slope away from the taxiway
  - Clearance distance allows aircraft to safely and expediently perform operations.
- Clearances include:
  - Clearance from the Taxiway Centerline to a fixed or mobile obstacles
  - Distance between taxiway centerline and parallel taxiway/taxilane centerline
- For Fixed-wing Taxiways - clearances are service- and aircraft-specific.
- For Rotary-wing Taxiways – Minimum 100-ft
- Dual Use – Most stringent requirements

Taxiway Longitudinal Grades

Table 5-1. Fixed-Wing Taxiways

Item		Class A Runway	Class B Runway	Remarks
No.	Description	Requirement		
				assessment if not opting to install shoulders.
4	Longitudinal grade of taxiway and shoulders	Max 3.0%		Army, Navy, and Marine Corps airfields. For Navy and Marine Corps airfields, a maximum of 2.0% is recommended when jet aircraft are required to accelerate from a standing position.
		Max 1.5%		Air Force airfields. A gradient exception of 5.0% is permitted for a distance of not more than 120 m (400 ft) unless within 180 m (600 ft) of a runway entrance. There, a 3.0% maximum applies.
		See Remarks		Grades may be positive or negative but must not exceed the limits specified.
5	Rate of longitudinal taxiway grade change	Max 1.0% per 30 m (100 ft)		The minimum distance between two successive points of intersection (PI) is 150 m (500 ft). Changes are to be accomplished by means of vertical curves. For the Air Force and Army, up to a 0.4% change in grade is allowed without a vertical curve. A vertical curve is not necessary where a taxiway crosses a runway or taxiway crown.

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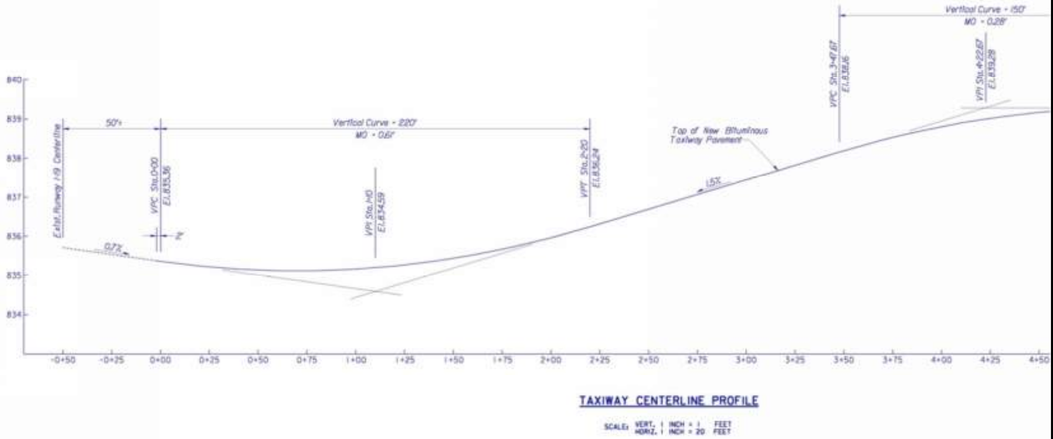
- UFC 3-260-01 Table 5-1
  - Max Longitudinal Grade
    - Army, Navy, MC: 3.0%
    - Air Force: 1.5%
      - Exceptions at runway entrance
  - Changing longitudinal grades
    - Must use vertical curves
      - Exception allowing 0.4% instantaneous
      - Exception across crowns
    - Max 1.0% per 100 ft

Taxiway Longitudinal Grades



- Typical taxiway centerline profile with 2 changes in grade and 2 vertical curves.

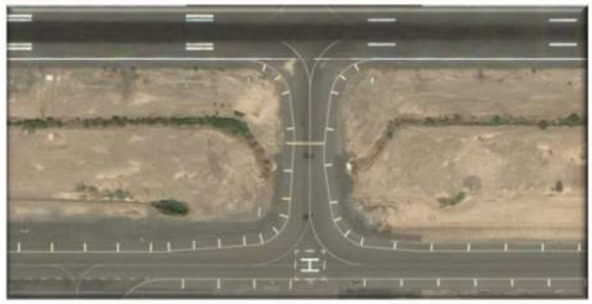
Intersection Geometry

Table 5-4. Runway/Taxiway Intersection Fillet Radii

Table 5-4. Runway/Taxiway Intersection Fillet Radii				
Runway Width	Taxiway Width	Fillet Radius	Fillet Radius	Fillet Radius
W	T	R1	R2	R3
More than 22.86 m (75 ft) but less than 45.72 m (150 ft)	22.86 m (75 ft)	45.72 m (150 ft)	38.1 m (125 ft)	76.2 m (250 ft)
45.72 m (150 ft) or more	22.86 m (75 ft)	38.1 m (125 ft)	38.1 m (125 ft)	76.2 m (250 ft)
More than 22.86 m (75 ft) but less than 45.72 m (150 ft)	15.24 m (50 ft)	18.29 m (60 ft)	18.29 m (60 ft)	18.29 m (60 ft)
45.72 m (150 ft) or more	15.24 m (50 ft)	15.24 m (50 ft)	15.24 m (50 ft)	15.24 m (50 ft)
More than 22.86 m (75 ft) but less than 45.72 m (150 ft)	12.19 m (40 ft)	15.24 m (50 ft)	15.24 m (50 ft)	15.24 m (50 ft)
45.72 m (150 ft) or more	12.19 m (40 ft)	15.24 m (50 ft)	15.24 m (50 ft)	15.24 m (50 ft)

Table 5-5. Taxiway/Taxiway Intersection and Taxiway Turns Fillet Radii

Table 5-5. Taxiway/Taxiway Intersection and Taxiway Turns Fillet Radii			
Taxiway Width	Fillet Radius	Fillet Radius	Fillet Radius
W	R4	R5	R6
22.86 m (75 ft)	45.72 m (150 ft)	38.1 m (125 ft)	76.2 m (250 ft)
15.24 m (50 ft)	18.29 m (60 ft)	12.19 m (40 ft)	27.43 m (90 ft)
12.19 m (40 ft)	18.29 m (60 ft)	12.19 m (40 ft)	27.43 m (90 ft)



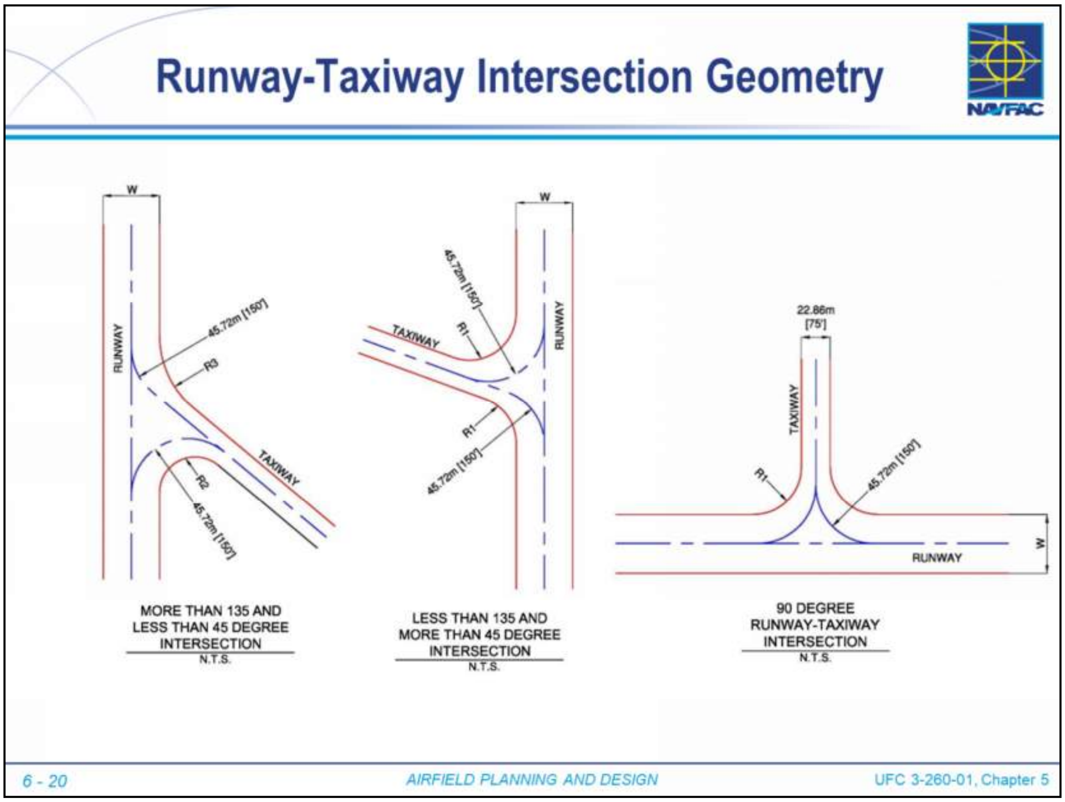
6 - 19 AIRFIELD PLANNING AND DESIGN UFC 3-260-01, Chapter 5

Taxiway Intersection Criteria

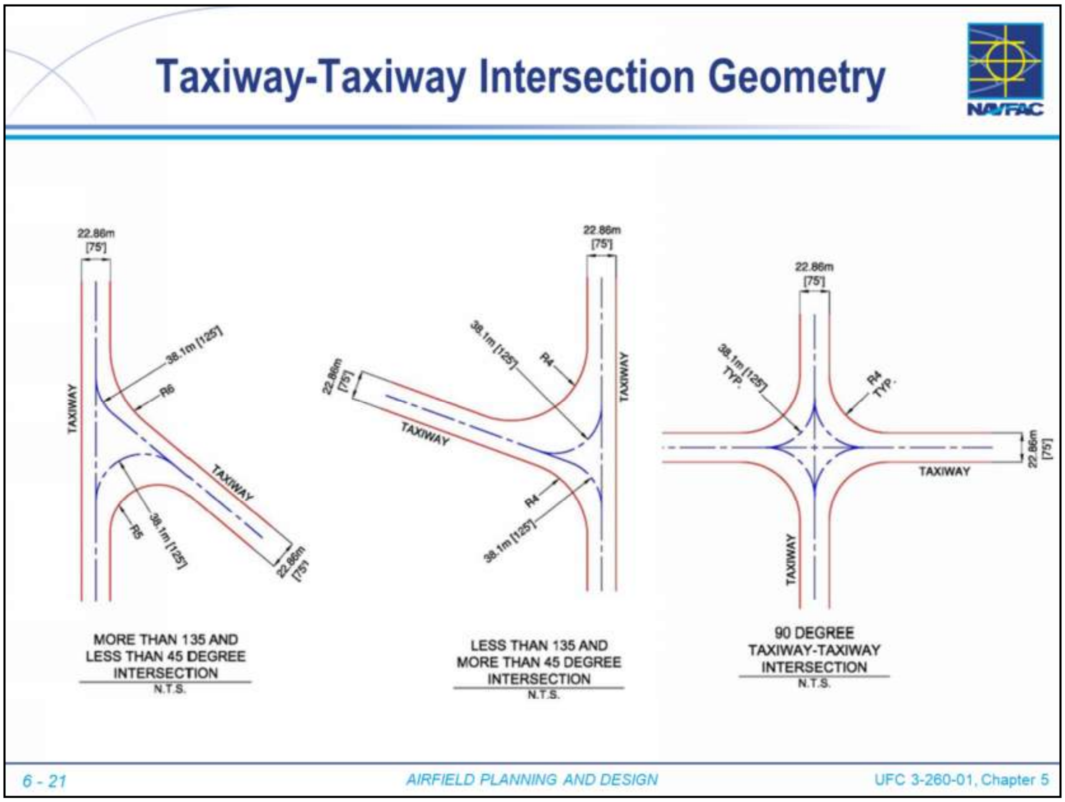
- Edge of pavement radii defined for different intersections in Table 5-4.
- Designed to prevent the main gear of an aircraft from coming too close to the outside edge of the taxiway during a turn
- Main gears, located to the rear of the nose gear, do not remain a constant distance from the centerline stripe during the turn (just like the rear wheels of a car)
- Main gears pivot on a shorter radius than does the nose gear during a turn.
- Design Intersections to maintain minimum 10-ft edge safety margin

- **NOTE**: This approach to Fillet Design is now unified for the Navy. Dropped the old taper and fillet approach that was similar to old FAA layouts.

- Old style – top image (Camp Lemonnier, Djibouti)
- New style – bottom image (Naval Station Norfolk)



- UFC 3-260-01
  - Figure 5-4 Runway-Taxiway Intersections

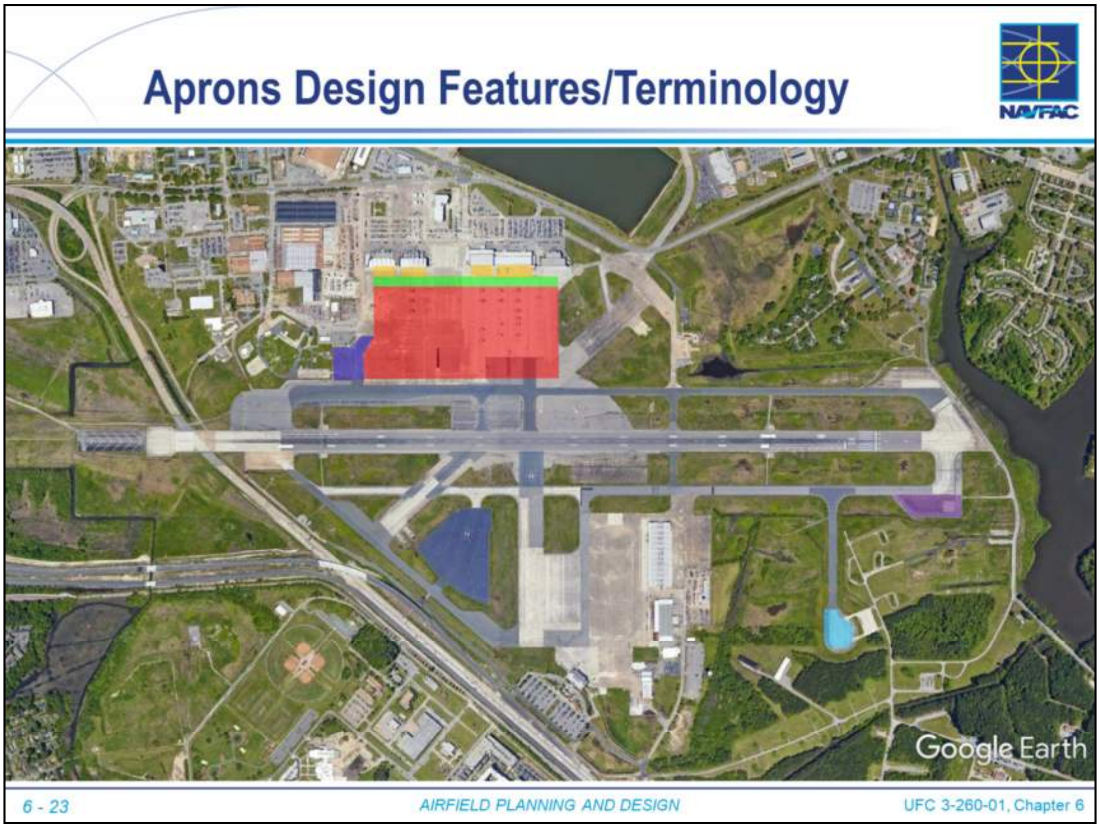


- UFC 3-260-01, Figure 5-5
  - Taxiway-Taxiway Intersection Fillets

•Aprons must provide sufficient space for parking fixed- and rotary-wing aircraft.

•Sized to allow safe movement of aircraft under their own power (unique to military vs civilian)

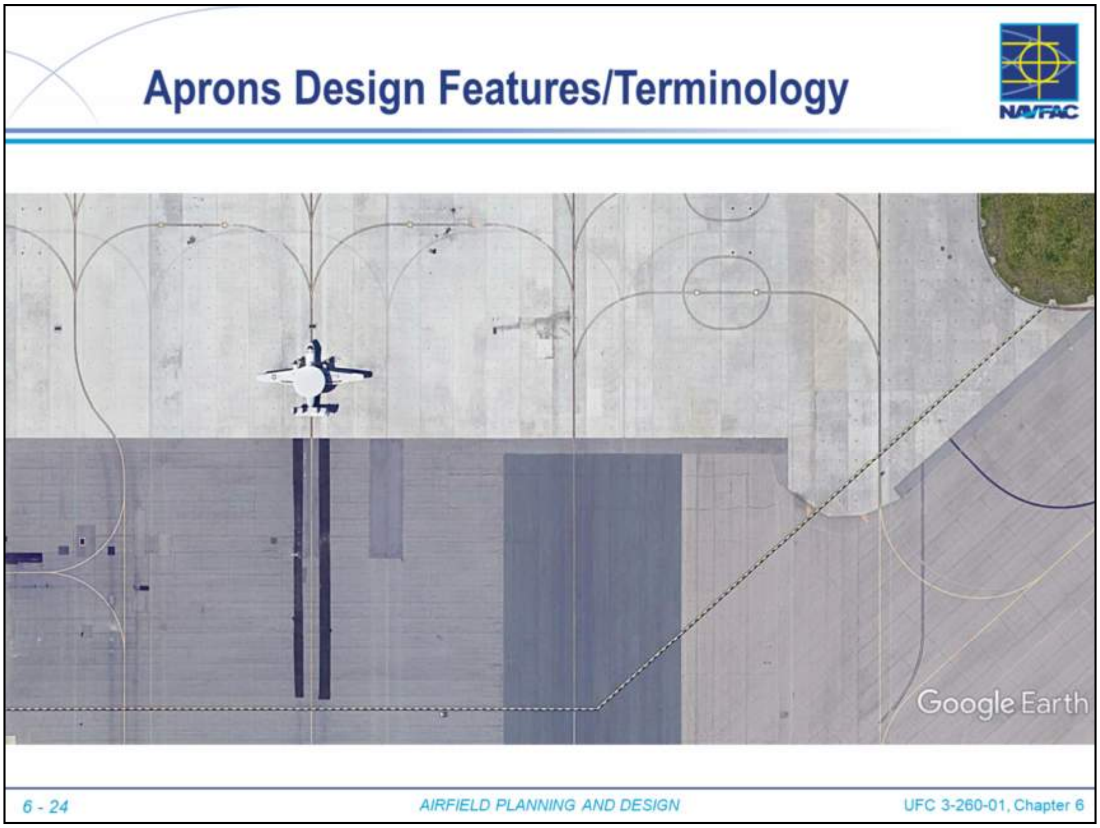
•During design, consider the effects of jet blast turbulence and temperature.



• Example: Chambers Field, Naval Station Norfolk

• Highlight the Key Components:

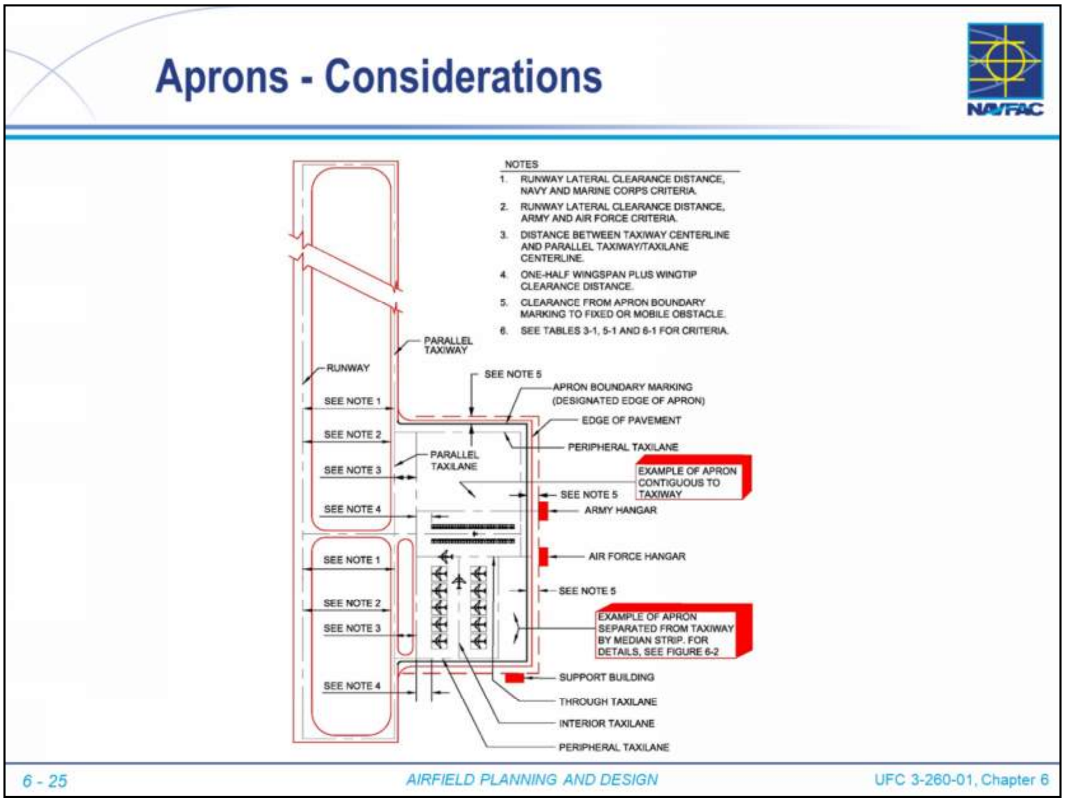
- Aircraft Parking/Maintenance Apron (Red)
- Transient Parking Apron (Dark Blue)
- Taxilane (Green)
- Hangar Access Apron (Gold)
- Arm/De-Arm Pad (Purple)
- Hazardous Cargo Pad (Light Blue)
- Mobilization Apron
- Unsuppressed Power Check Pads
- Compass Calibration Pad
- Alert Pad
- Aircraft Wash Racks
- Fueling Systems on Aprons



• Example: Chambers Field, Naval Station Norfolk

• Highlight the Key Components:

- Wingtip Clearance Line
- Nose Stop Positions
- Aircraft boxes



- UFC 3-260-01, Figure 6-1
- Highlight:
  - Layout
  - Taxilanes (Peripheral, Through, Interior)
  - Power in/out access
  - Wingtip Growth at Turns (Wide Turns….oversteer)
  - Clearance at Apron Edge to Fixed/Mobile Obstacles – 2-000-05N, Section 11320-7
    - Class A: 75 ft
    - Class B: 100 ft
  - Typical Hangar Access Apron Length – 2-000505N, Section 11340-1
    - 50 ft between apron edge and face of Hangar
    - Same Width as Hangar Door
  - Include Fire Hydrants at 300’ spacing along apron edge

•MCAS Miramar

- •Multiple Aircraft Types
- •Separate Aprons

•Aircraft dimensions control the layout and design of an apron.

• Aircraft dimensions can be found UFC 2-000-05N and UFC 3-260-01, Chapter 6

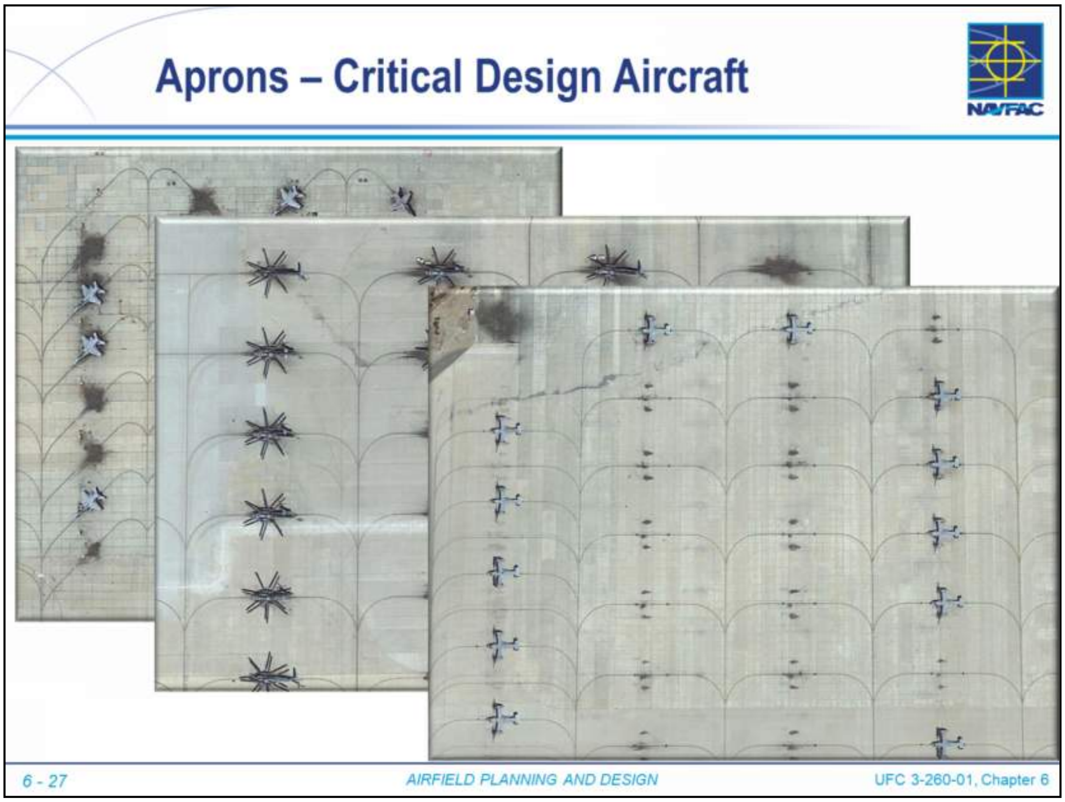
• Each aviation facility may consist of separate aprons for parking operational aircraft, transient aircraft, and transport aircraft, or an apron for consolidated parking.

• In general, no standard size (minimum or maximum) for aircraft aprons.

• Aprons are individually designed to support aircraft and missions at specific facilities.

• Design for the critical design aircraft, the wingspan and length of the aircraft need to be considered.

- •NOTE: In some cases, you may use one aircraft's wingspan and another aircraft's length
- •Aircraft Model also can change dimensions
- •Dimensions of the different aprons will be based on:
  - Number of authorized aircraft
  - Maneuvering space
  - Type of activity that the apron serves.



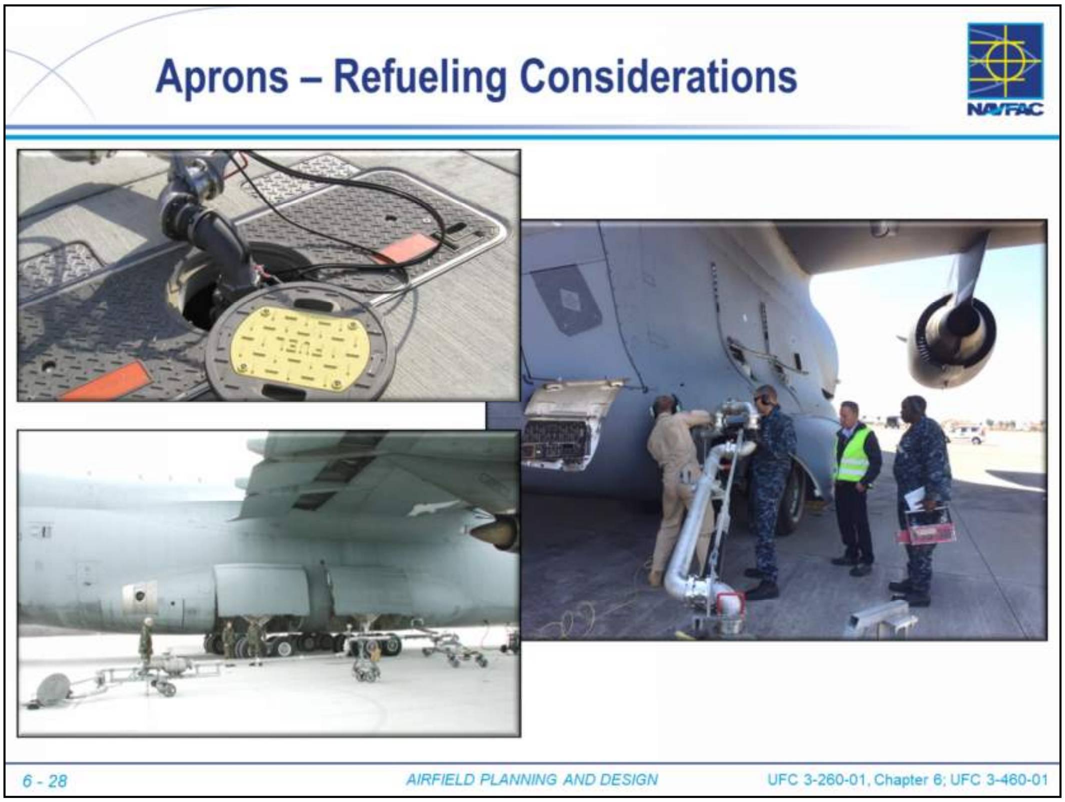
•Wingtip clearances must be provided for all parking scenarios

•Fixed-wing Apron (F-18)

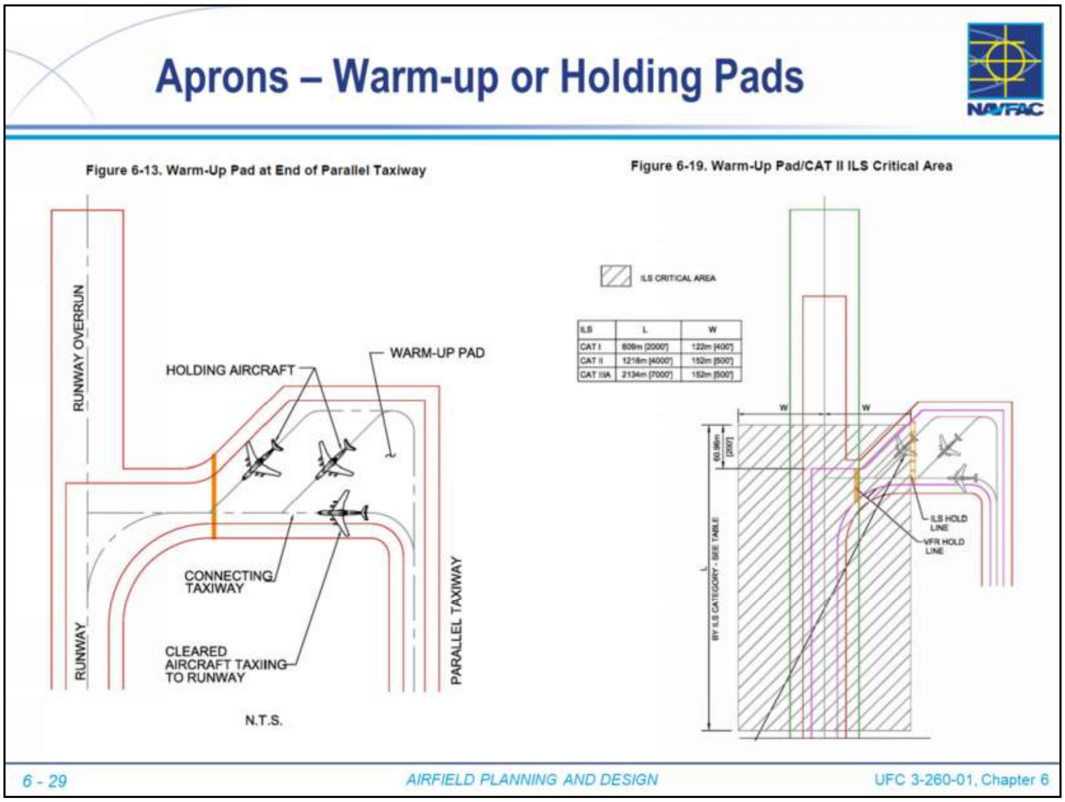
- •Angled parking provides more capacity due to jet blast considerations
- •UFC 2-000-05N, 11320-4.1 Jet Blast Protection. "Parked aircraft must be separated to maintain proper wing-tip clearances, interior taxilane widths and protection from jet blast. Jet blast protection is achieved by providing the space necessary to dissipate the temperature and velocity of the jet blast to levels that will not injure or damage aircraft personnel and equipment. Typically, this level is approximately **100 degrees Fahrenheit** (38 degrees Celsius) **and 30.4 knots (35 mph)**. This level can be easily achieved by parking carrier based aircraft at 45 degrees with their engine blast aimed into the interior taxilane, providing safe and adequate jet blast dispersion (see Table 11320-1 and Figure 11320-2)."

•Rotary Wing Apron (CH-53)

•Tilt-Rotor Apron (MV-22B)



- <u>Aircraft Direct-Refueling System</u>.
    - Hydrant Connections in the apron where aircraft can be fueled from closed circuit fuel system utilizing multi-arm pantographs or hydrant servicing vehicles (HSV).
    - Designed primarily for “hot” refueling of aircraft.
    - Commonly used for large refueler and cargo aircraft aprons.
- <u>Hot Refueling</u>.
    - Performed with engines running to provides minimum aircraft turnaround times
    - Reduces fueling personnel and equipment support requirements.
    - Presents hazards not normally encountered during normal fueling operations.
- <u>Mobile Aircraft Refuelers</u>.
    - Tanker trucks of various capacities and configurations
    - Primarily used for normal (cold) fueling operations
    - Most common method for small aircraft at Navy, Marine Corps and Army facilities
- <u>Refueling Considerations</u>:
    - Safety Zones, Parking Dimensions
    - Rotor Blade Clearances
- See UFC 3-460-01 *Design: Petroleum Fuel Facilities, Chapter 4* for detailed design information on Aircraft Fueling Facilities



- **WARM-UP PADS.**
  - Warm-up pad, also referred to as a holding apron, is paved area adjacent to a taxiway
  - At or near the end of a runway.
  - Intent of a warm-up pad is to provide a holding location, off the taxiway, for aircraft that must hold due to indeterminate delays.
  - Warm-up pad allows other departing aircraft unencumbered access to the runway.
  - Sized to provide a minimum of 7.62 m (25 ft) of jet blast-resistant pavement behind the tail of an aircraft

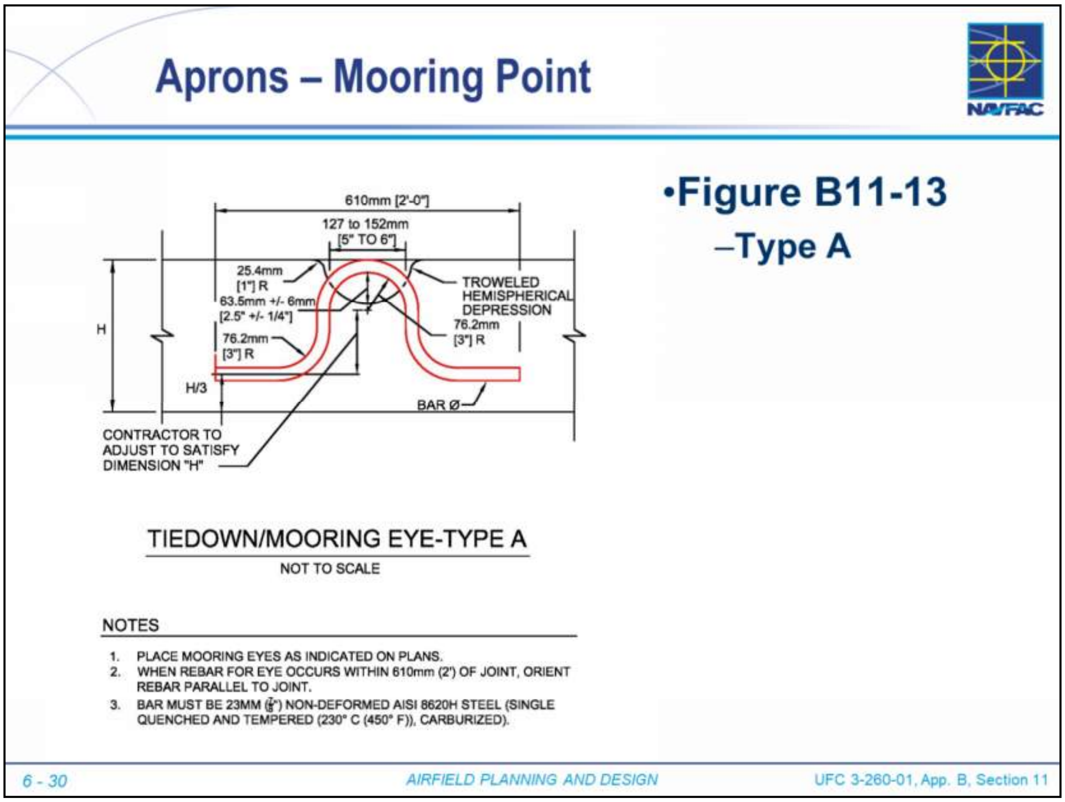
NOTE:

6-8.1 Navy and Marine Corps.

Warm-up pads are <u>not usually required at Navy facilities</u>. Typically, the end crossover taxiway is widened to 46 m (150 ft), which provides room to accommodate aircraft warming up or waiting for other reasons.

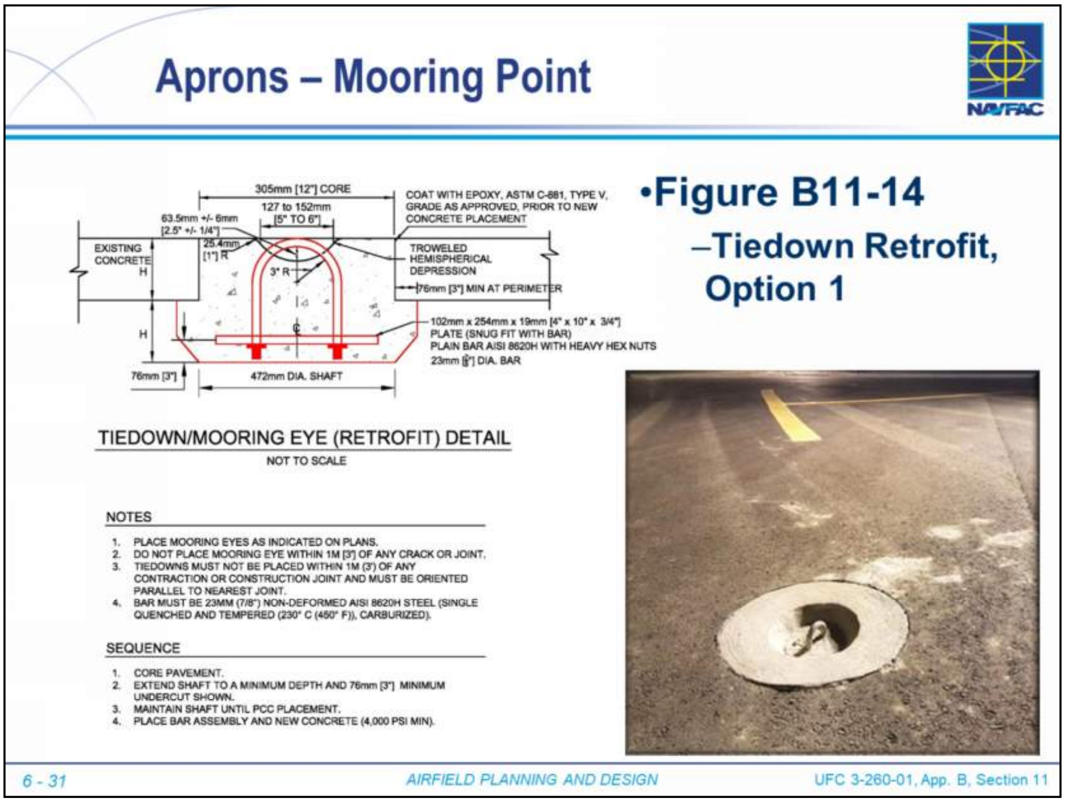
Warm-up Pad vs. ILS Critical Areas:

- Locate Warm-up pads so that they do not interfere with the operation of NAVAIDS, including instrument landing system (ILS) equipment and precision approach radar (PAR) facilities.
- To eliminate interference of the ILS signal by holding aircraft, holding aircraft on or off a warm-up pad must be outside the critical areas.

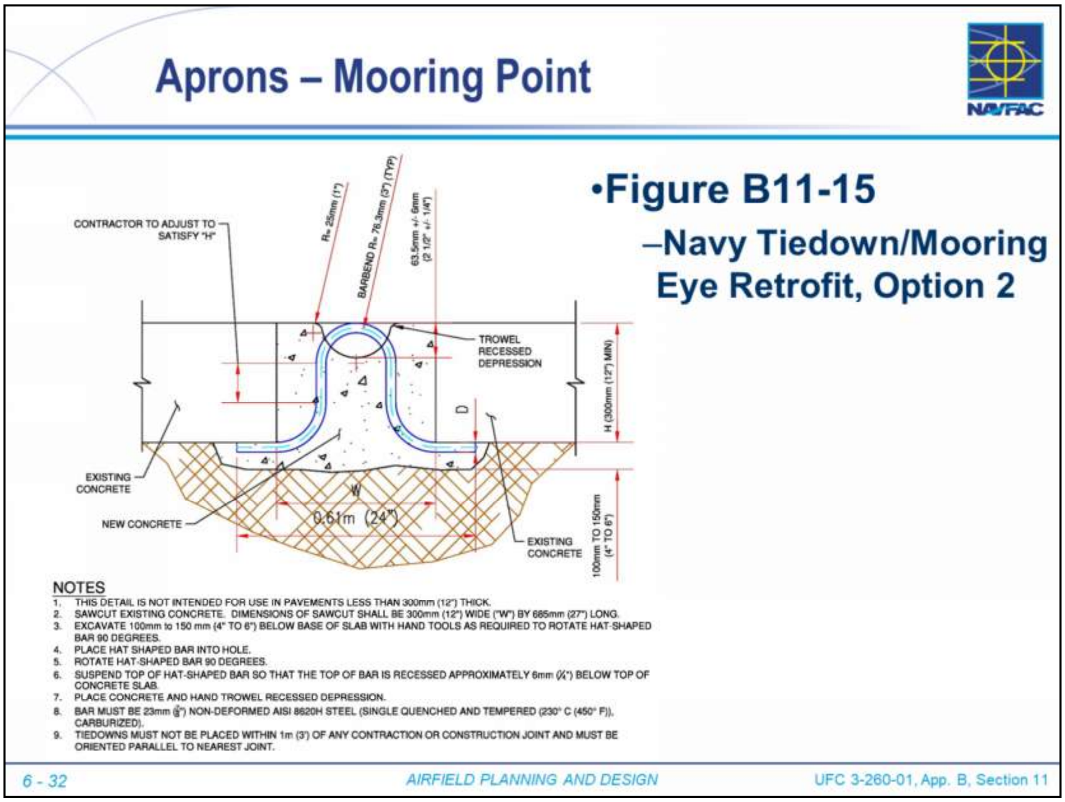


- Appendix B, Section 11, **Figure B11-13 Navy Type A** ***Mooring Point***
- For use in new construction
- Appendix B Section 11 provides details, examples and guidance about the tiedowns, mooring and grounding points.

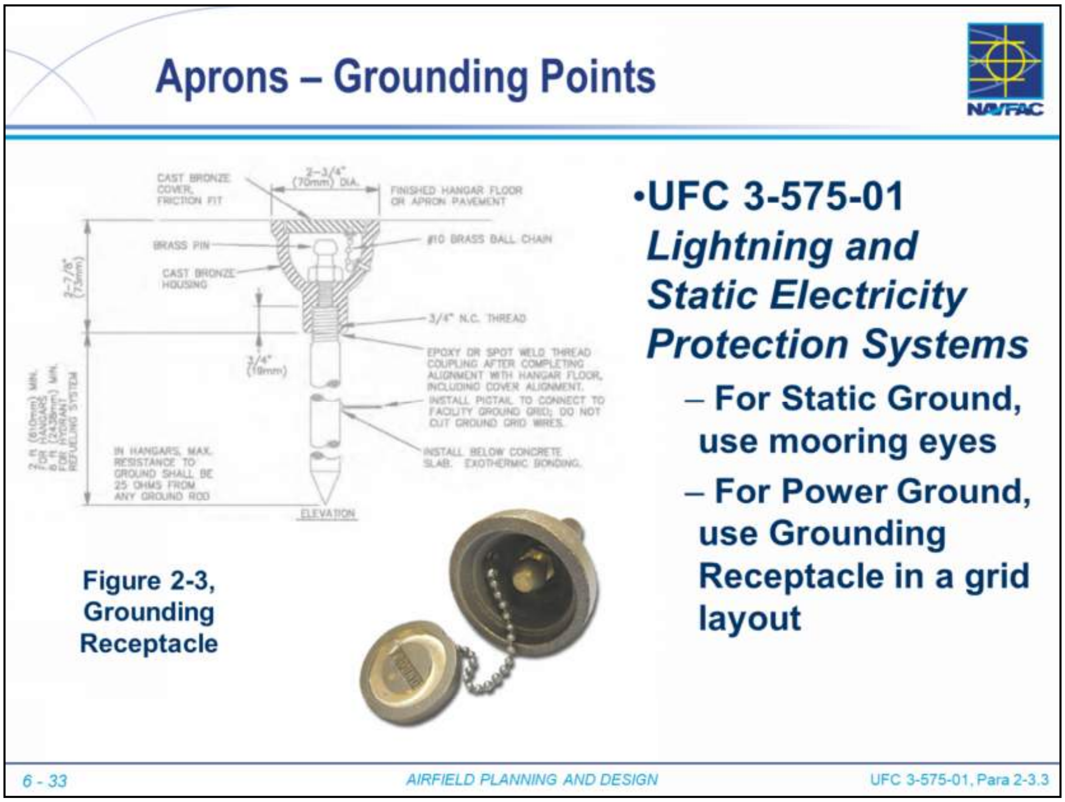
- **NOTE**: Bar Material updated in 2018 to be more corrosion resistant. Capacity of tie down is depended on slab thickness, not bar diameter. Slab will fail before bar breaks



- Appendix B, Section 11, **Figure B11-14 Navy Tiedown/Mooring Eye Retrofit, Option 1**
- Use Option 1 when PCC is < 12" thick
- Appendix B Section 11 provides details, examples and guidance about the tiedowns, mooring and grounding points.
- Design relies on tying mooring point to slab and for slab to fail before bar fails.



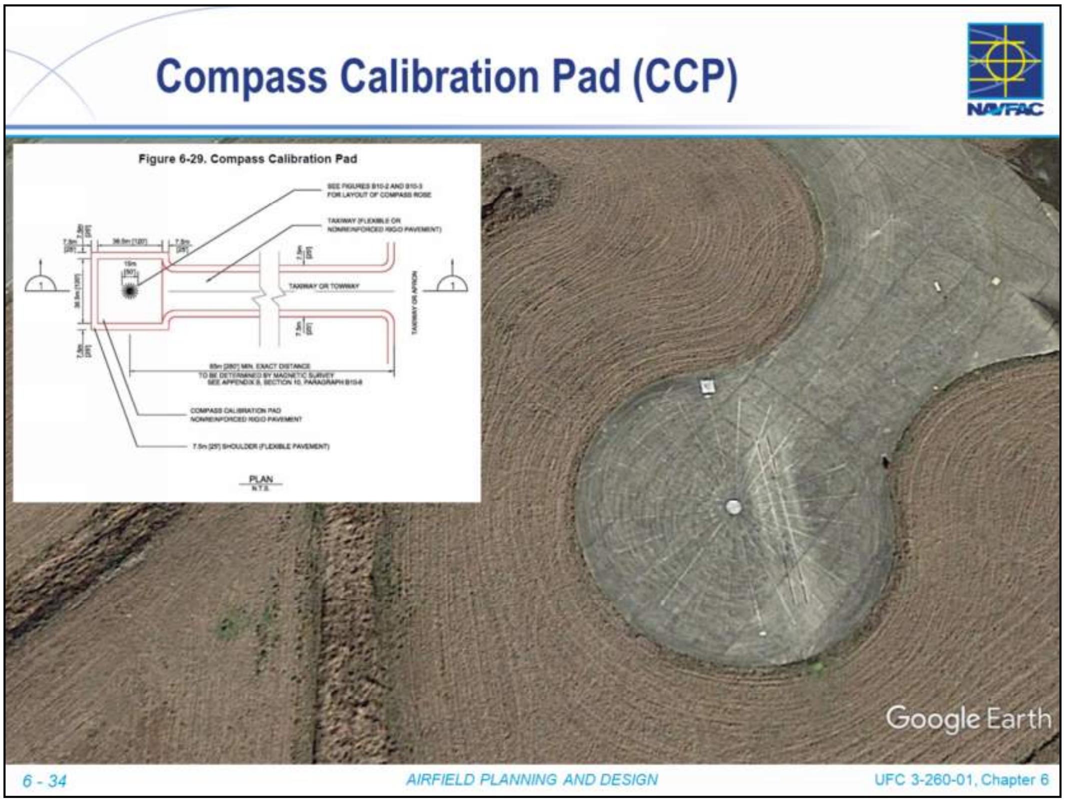
- Appendix B, Section 11, **Figure B11-15 Navy Tiedown/Mooring Eye Retrofit, Option 2**
- Use Option 2 when PCC is 12” or greater in thickness
- Appendix B Section 11 provides details, examples and guidance about the tiedowns, mooring and grounding points.
- Design relies on tying mooring point to slab and for slab to fail before bar fails.



- UFC 3-575-01, Para 2-3.3 "For the Army and Navy, mooring eyes / tiedowns, in accordance with UFC 3-260-01, Appendix B, Section 11, are permitted to be used as static grounding points. When the dimensions of the mooring eye rebar are larger than the normal static ground clamp used by the Activity for the aircraft, determine if the Activity will utilize adapters on their clamps, or if they require a separate ground system. If a ground system is required to obtain a power ground (25 ohms), use the **grounding receptacle, per Figure 2-3** with a grid arrangement as described in Section 2-3.3.2. Coordinate with Activity on whether or not the receptacle cover and ball chain are required to be removed for Foreign Objects and Debris (fod) prevention."
    - Remove lid and chain to prevent FOD

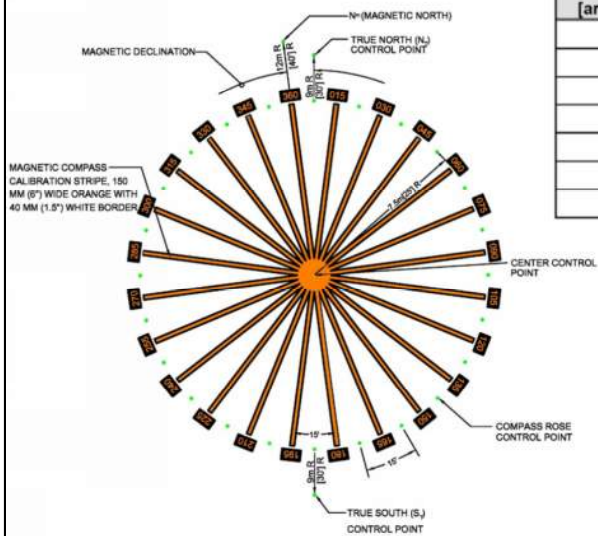
- Static Ground: Resistance to Ground <10,000 Ohms (easy to achieve)

- Power Ground: Resistance to Ground < 25 Ohms (can be hard to achieve, sometimes requires multiple ground rods or counterpoise; depends on soil type and moisture)



- <u>Compass Calibration Pad (CCP)</u>
  - Paved area in a magnetically quiet zone where an aircraft's compass is calibrated.
  - Typically located off the side of a taxiway with lateral clearance and airspace clearance
  - Any nearby metal can bust the siting - underground utilities, buildings, fences
  - Clearances from 2-000-05N, Section 11620
    - Min. 275 ft to centerline of nearest taxiway or towway
    - Min. 225 ft to underground metal and conduits
    - Min. 275 ft to edge of aircraft and vehicle parking areas
    - Min. 500 ft to underground powerline (except airfield lighting)
    - Min. 600 ft to overhead steam lines, AC power lines, railroad
    - Min. 1000 ft to DC power lines
- <u>Access:</u>
  - Provide an access taxiway from the primary taxiway to the CCP
  - Oriented to facilitate moving the aircraft onto the CCP on a magnetic north heading
  - At Army and Air Force aviation facilities, if the aircraft should be towed to the CCP, the access taxiway must be designed as a towway
  - At Navy and Marine Corps facilities, the taxiway should be designed as a taxiway.
- <u>Material</u>.
  - PCC pavement for the CCP and access taxiway must not contain any embedded ferrous metal items
    - No dowels bars, reinforcing steel, steel fibers
    - In addition, ferrous metal must not be placed in or around the CCP site

Compass Calibration Pad (CCP)



Magnetic Variation Rate of Change [arc-minutes per year]	Re-Survey Frequency
≤ 7	5 years
8	4 years
9-10	3.5 years (42 months)
11	3 years
12-14	2.5 years (30 months)
15-18	2 years
≥ 19	1.5 years (18 months)

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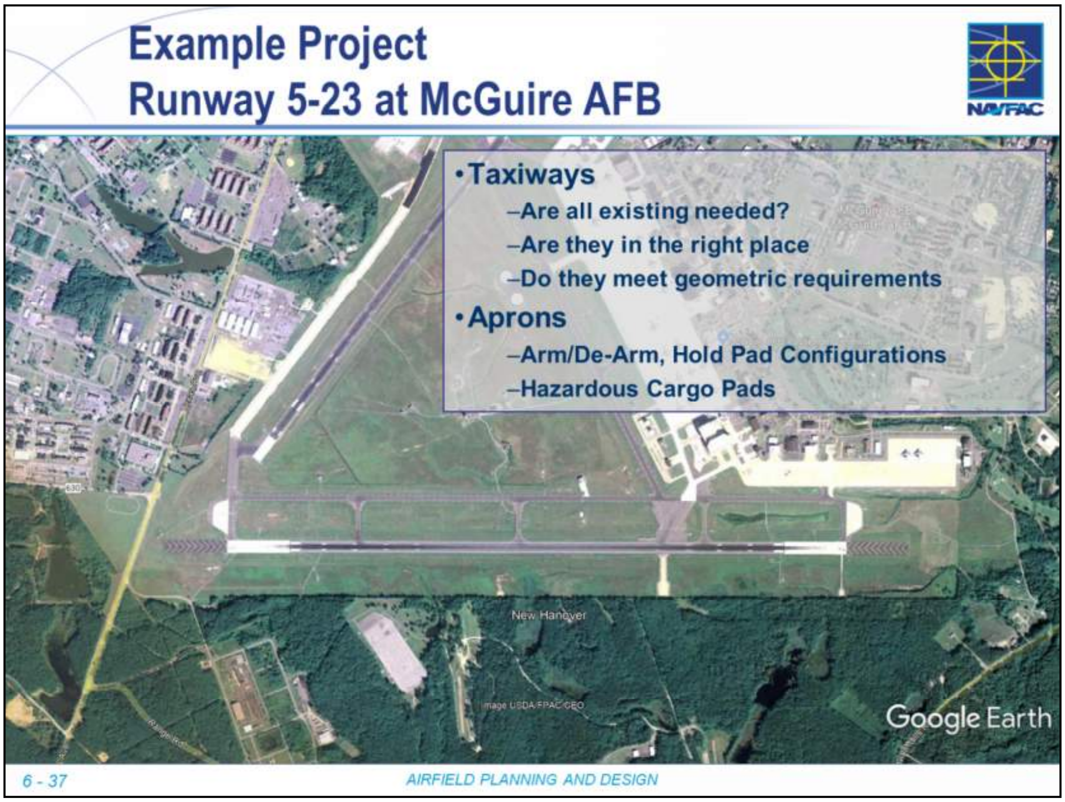
- 6-11.5.3 Magnetic Survey and Re-marking Requirements.
  - The CCP magnetic survey is an airfield engineering survey used to ensure that the CCP area is magnetically quiet, to determine the magnetic variation (MagVar) of the area, and to layout the markings for the pad. A magnetic survey shall be conducted after construction of a new CCP and at regular intervals thereafter to ensure the CCP remains suitable for aircraft magnetic compass calibrations. The procedure to conduct magnetic surveys is outlined in Appendix B, Section 10.
- 6-11.5.3.1 Magnetic Survey Frequency.
  - Because the Magnetic North Pole is constantly moving, the MagVar at any location on the Earth is constantly changing at varying rates. Every CCP must be re-surveyed periodically to update the MagVar, update the alignment with Magnetic North, and update the CCP markings.
  - The CCP markings shall be removed and replaced **when the new MagVar differs by more than 30 arc-minutes (0.5 degrees) from the existing CCP markings**.
  - Periodic re-survey required. Where the rate of change is low (7 arc-minutes or less per year), a re-survey must be conducted at an interval of 5 years or less. At locations where the MagVar rate of change is greater than 7 arc-minutes per year, more frequent re-surveys are required.
  - Table 6-3 lists the re-survey frequency needed based on MagVar rates of change. If at any time the difference exceeds the tolerance of the aircraft compass or calibration equipment, the Airfield Manager may schedule a survey more frequently.

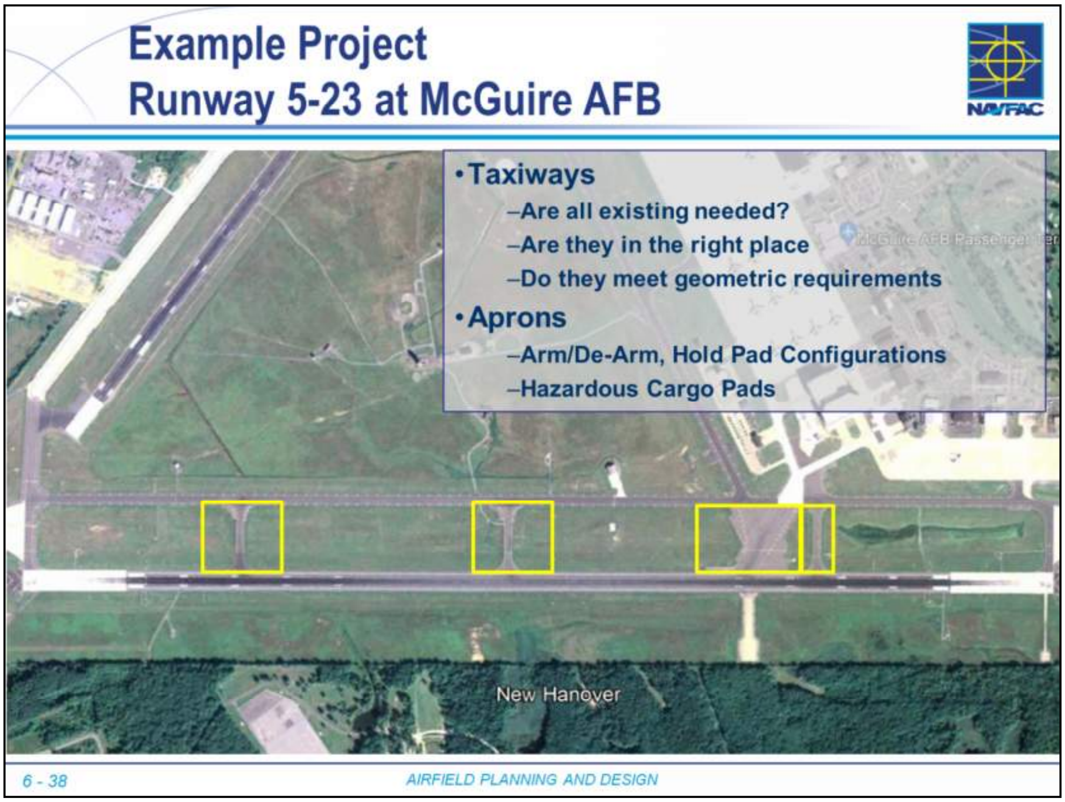
- Line Vehicle Parking. Vehicle parking areas are provided for parking mobile station-assigned and squadron-assigned vehicles and equipment (e.g., aerospace ground equipment).

- Line Vehicle: Vehicle used on the landing strip, such as a crash fire truck or tow tractor.

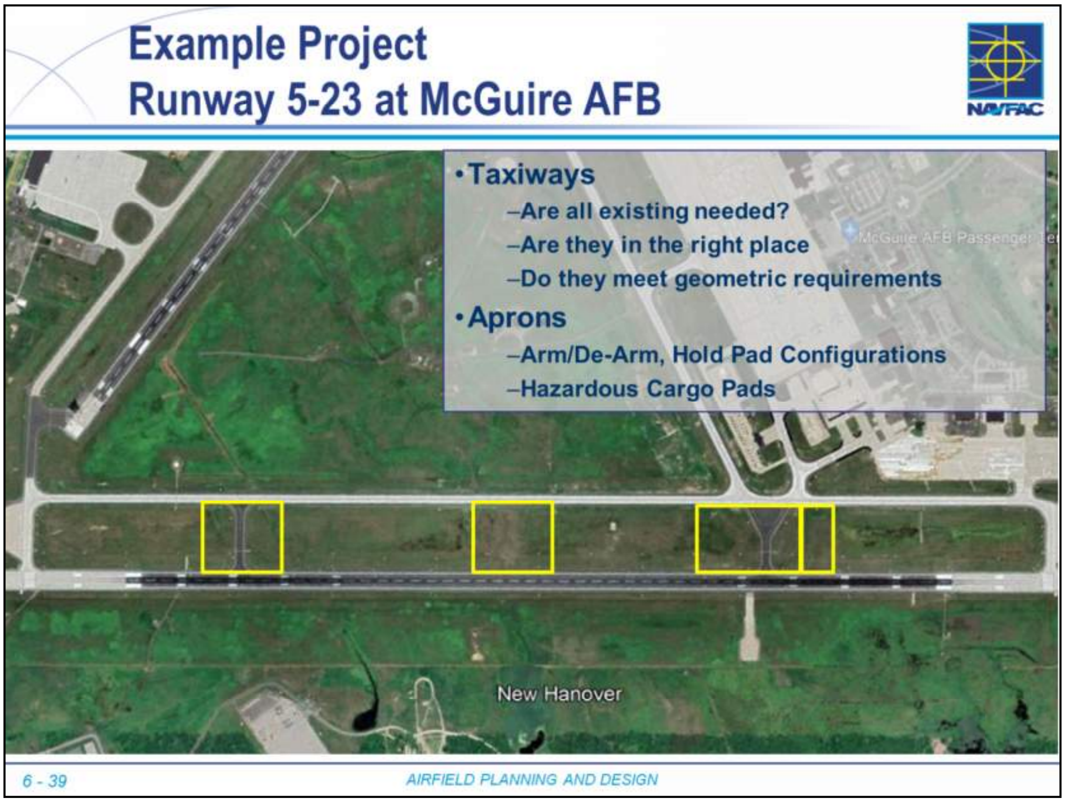
- When planning aprons, account for locations to park support vehicles and equipment



- Taxiways
    - Discuss what is needed and frequently used?
    - Is a relocation needed to improve aircraft traffic flow?
    - Do the existing taxiways meet geometric requirements to support aircraft traffic movements?
- Aprons
    - Arm/De-Arm and Hold Pads – are they still used/needed? Sometimes they are a relic of a past mission
    - Hazardous Cargo Pads – will they be active during construction? Do they have a Q-D arc that overlaps with the construction area? Will that place constraints on the Contractor's activities when the pad is active? Those constraints need to be captured in the contract documents.



- Taxiways
  - Discuss what is needed and frequently used?
  - Is a relocation needed to improve aircraft traffic flow?
  - Do the existing taxiways meet geometric requirements to support aircraft traffic movements?



- Taxiways
  - Demolished two taxiways
  - Reconfigured wide taxiway into much smaller configuration

Questions?

6 - 40 AIRFIELD PLANNING AND DESIGN

Key Points for this Section

- Taxiways
    - UFC 3-260-01 is primary reference, but UFC 2-000-05N has info too
    - Fixed Wing Class B Taxiway 75-ft wide plus 25-ft paved shoulders
    - Rotary Wing Taxiway 40-ft plus 25-ft paved shoulders
        - CH-53 and MV-22 require 100-ft paved corridor
- Aprons
    - UFC 3-260-01 has info, but UFC 2-000-05N has many key clearances specific to Navy/MC
    - Parking Layouts are specific to using aircraft
    - Std Hangar setback is 50-ft
    - Fire Hydrants required along aprons at 300-ft spacing
- Structures in Aprons or Shoulders (Manholes, Handholes, Inlets, etc.) (UFC 3-260-01, Chapter 2)
    - Design for 100,000 lbs wheel load with 250 psi tire pressure
    - For structures with spans > 2 ft, consider multiple wheels of critical aircraft

Name the Airfield

6 - 41 AIRFIELD PLANNING AND DESIGN

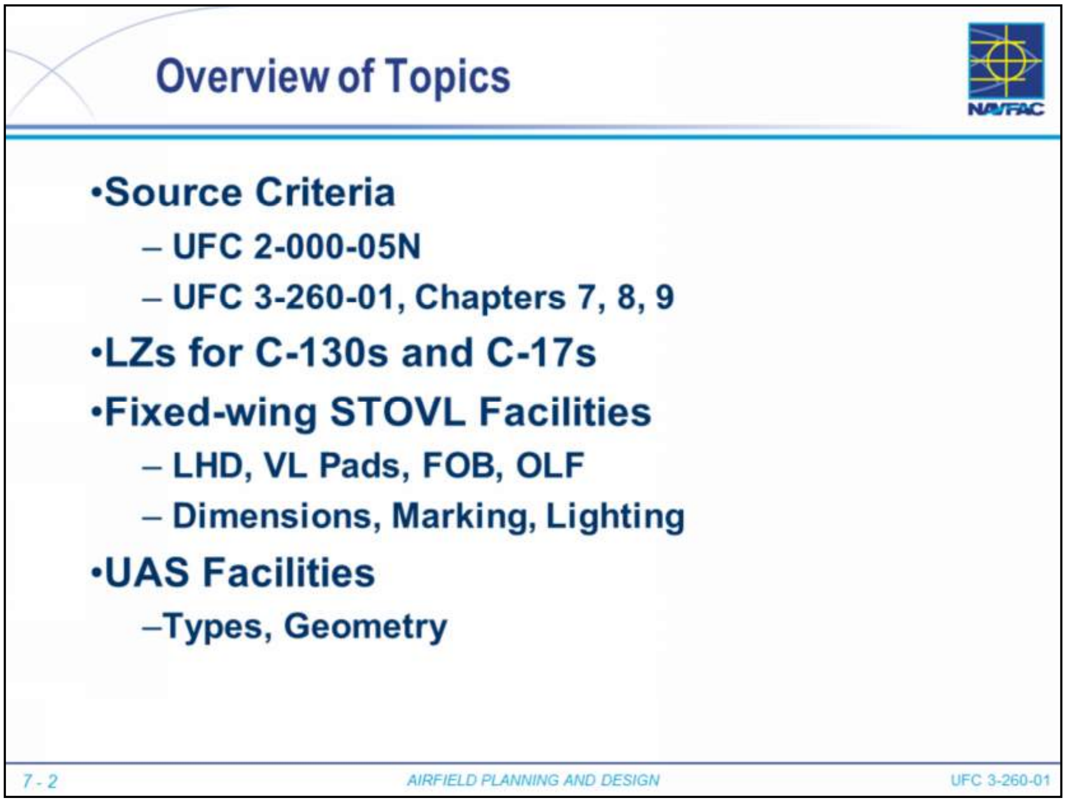
- Golf Course in Clear Zone at 29 end
- Rotary Wing Aprons
- Everything is paved

Naval Facilities Engineering Command

Section 7
LZs, STOVL and UAS Facilities

AIRFIELD PLANNING AND DESIGN
CRITERIA TRAINING

5/8/2023



- Source Criteria
  - UFC 2-000-05N (some parts, but may be outdated)
  - UFC 3-260-01, Chapters 7, 8, 9
    - Added to UFC in 2019

•LZ – Names also used:

- ALZ – Assault Landing Zones
- Shortfields

•Will discuss the items in the bullet list in following slides

Landing Zones (LZs)

- **Key Design Features/Terminology**
  - **Width**
  - **Length**
  - **Overruns**
  - **Shoulders**
  - **Maintained Areas**
  - **Taxiways**
  - **Aprons**

7 - 4 AIRFIELD PLANNING AND DESIGN UFC 3-260-01, Chapter 7

• Landing Zone (LZ) - A prepared or semi-prepared (unpaved) airfield used to conduct operations in an airfield environment similar to forward operating locations.

  • If training facility, need to be constructed for long-term operations
  • LZ runways are typically shorter and narrower than standard runways.

•The term LZ refers to: A runway, a runway and taxiway, or other aircraft operational surfaces (aprons, turnarounds, etc.)

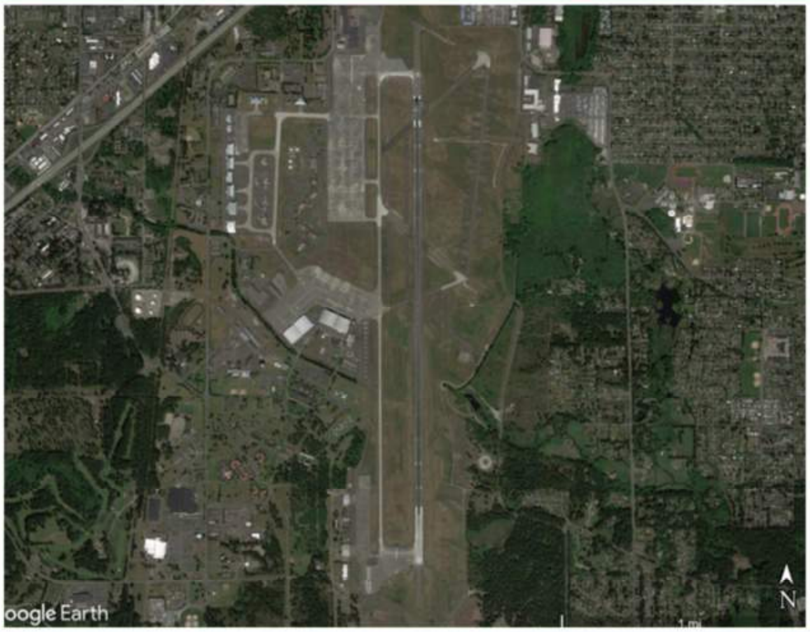
• Landing Zone can either be:

  • Superimposed on a Class A or B Runway
  • Separate, Stand-Alone Facility

- DoD Services (Air Force, Army, Navy and Marine Corps) have generally agreed to the same criteria.
- Exceptions are noted in the text, tables or figures of the LZ Chapter.

Video: C-17 landing on Semi-Prepared Landing Zone

Superimposed LZ
McChord Airfield, WA



7 - 7 AIRFIELD PLANNING AND DESIGN UFC 3-260-01, Chapter 7

• **McChord Airfield, WA** which is a component of **Joint Base Lewis-McChord**.

•LZ that is superimposed on a Class B Airfield

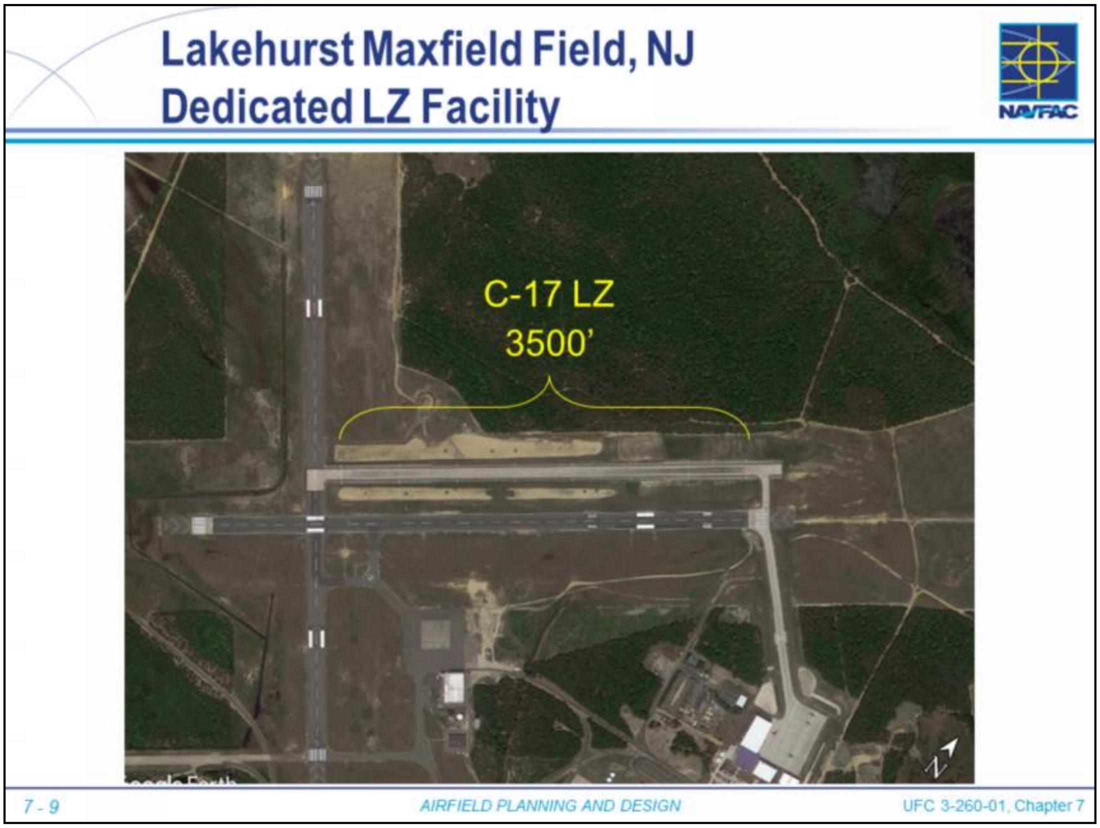
•The next slide shows a closer view of the marking.

Superimposed LZ
McChord Airfield, WA

7 - 8 AIRFIELD PLANNING AND DESIGN UFC 3-260-01, Chapter 7

•**McChord Airfield, WA**

• White non-reflective 90’x3500’ VFR daytime Landing Zone (ALZ).



• Lakehurst Maxfield Field, NJ (Previous Naval Air Engineering Station Lakehurst (NAES Lakehurst)), which is a component of Joint Base McGuire-Dix-Lakehurst (JB MDL).

• Graphic shows an example of a "prepared" Landing Zone at Lakehurst Maxfield Field, which is a dedicated LZ facility. This one is also 3500' in length, servicing C-17 Training.

• **Lakehurst Maxfield Field, NJ** (Previous Naval Air Engineering Station Lakehurst (NAES Lakehurst)), a component **of Joint Base McGuire-Dix-Lakehurst (JB MDL).**

• Tables 7-1 through 7-5 provide dimensional criteria for the layout and design of LZ runways, Taxiway, aprons and overruns.

• Criteria based on Aircraft (C-130 or C-17) and Surface type; Paved or Semi-Prepared (Unpaved).

• Similar to airfields and heliports, the UFC provides criteria for the different components of the LZ.

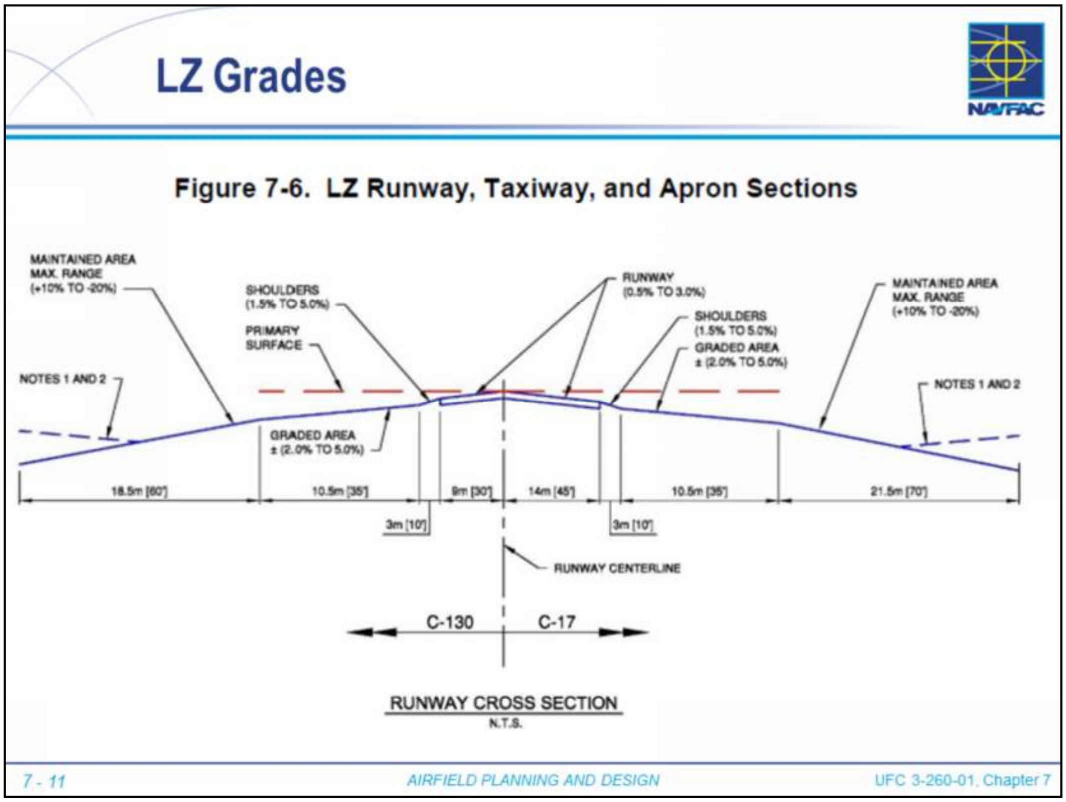
Highlights:

• Minimum Length (Typ): C-130 = 3000-ft; C-17 = 3500-ft

• Width (Typ): C-130 = 60-ft; C-17 = 90-ft

• Shoulders: 10’ – Paved if on a paved LZ, unpaved will have stabilized to prevent erosion by jet blast.

• Overruns: 300’ area beyond the runway end constructed to the same standards as the LZ runway.

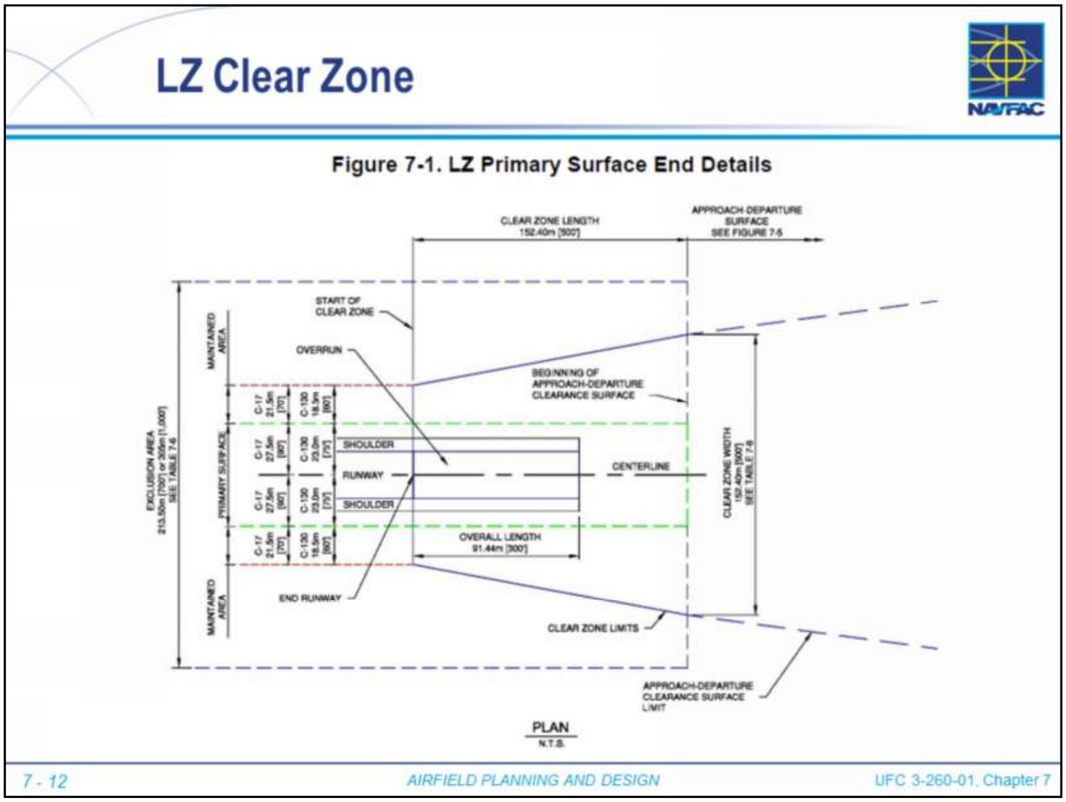


- Longitudinal Grades: Hold to minimum practicable and should be gradual.

- Transverse Grade: Sloped down from the runway centerline.
  - Slope is to facilitate drainage without adversely affective aircraft operations.
  - Figure 7-6 shows the Transverse slopes on the runway, runway shoulders and graded area.

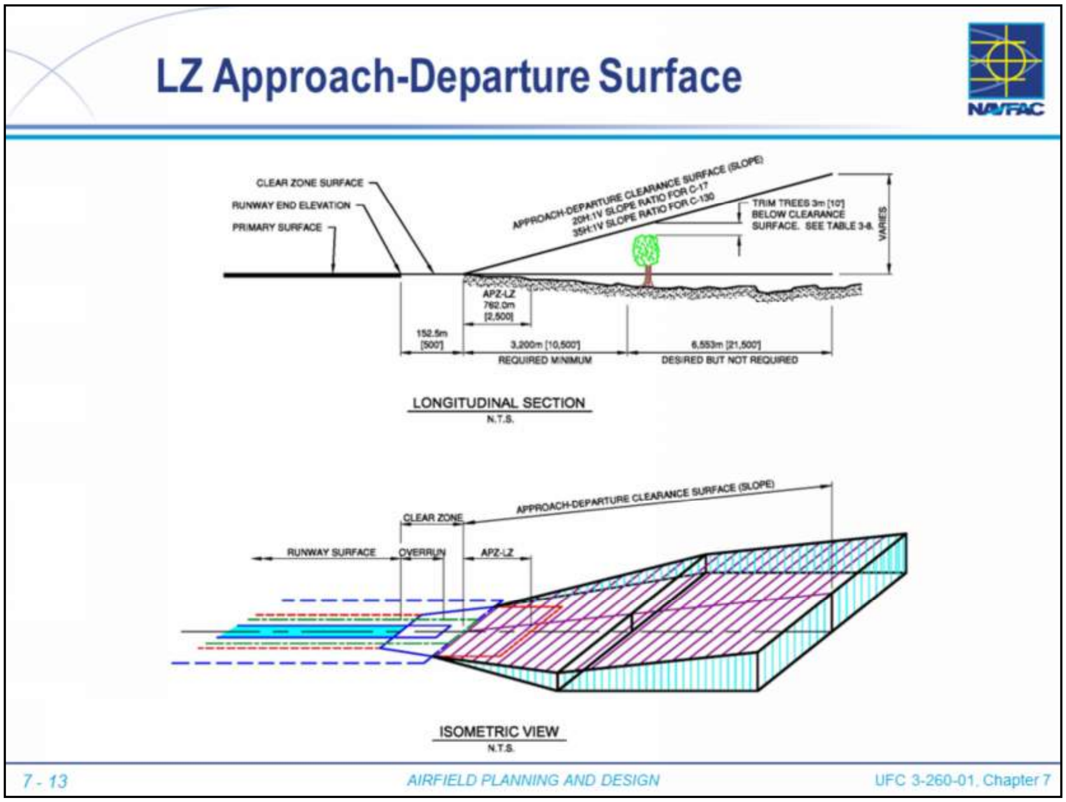
- Graded Area: Must be clear of vegetation, trees, etc. (anything >4” prohibited)

- Graded Area Erosion: Jet blast may cause erosion of this area.
  - For paved LZs where adequate vegetation cannot be established, the graded area may be covered with a thin asphalt layer or with an engineered surface such as articulated concrete blocks or a stone bed spread and compacted to present an even surface with no protrusions.
  - Open culverts, headwalls and elevated drainage structures are not allowed in this area.



- Clear Zones – These are laid out to provide a reasonable level of safety for LZ operations and prohibit certain actions and land uses. These include: Accident Potential Zones (APZ), Exclusion Areas, Clear Zones and Imaginary Surface.

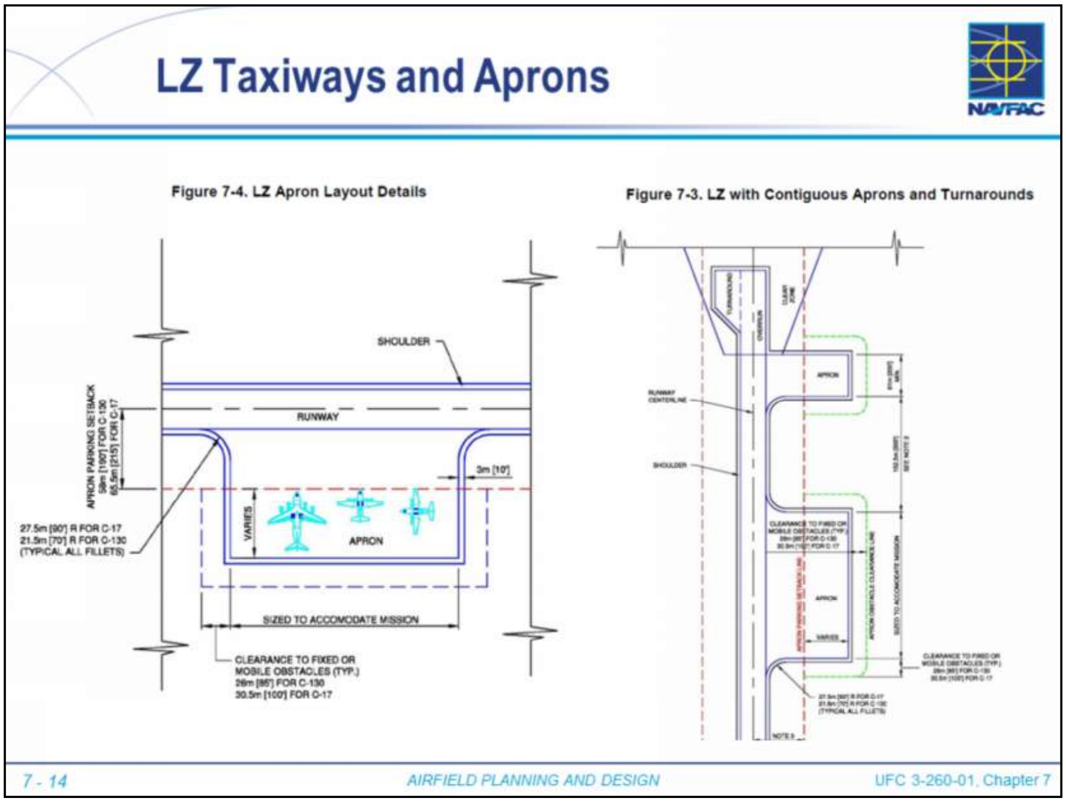
- These areas and surfaces are described in the different figures in Chapter 7.



- Approach-Departure Clearance Surface

- Determined by Design Aircraft
    - 20H:1V for C-17 (Steeper)
    - 35H:1V for C-130 (Flatter)

- If UAS use LZ, ADCS must be compatible.
    - Some UAS (MQ-1 Predator, MA-9 Reaper) require a flatter ADCS of 40H:1V



- Taxiways and Aprons for LZs are generally small and minor on an LZ facility.
- Sometimes aprons are connected directly to the runway, with no intervening parallel taxiway
- Turnarounds are often provided beyond the thresholds and attached to the overruns where a taxiway system is not constructed
- See the UFC for details on layout of these facilities

•Paved: Principal components of paved LZ included one of the following:

- A flexible or non-rigid pavement, or one that includes a bituminous concrete surface course designed as a structural member with weather- and abrasion-resistant properties
- A rigid pavement, or one that contains PCC as an element
- A combination of flexible and rigid pavement layers, such as an overlay, where a flexible pavement is placed over an existing rigid pavement layer to strengthen the rigid pavement layer

• Semi-Prepared: The amount of engineering effort required to develop a semi-prepared LZ depends on multiple factors:

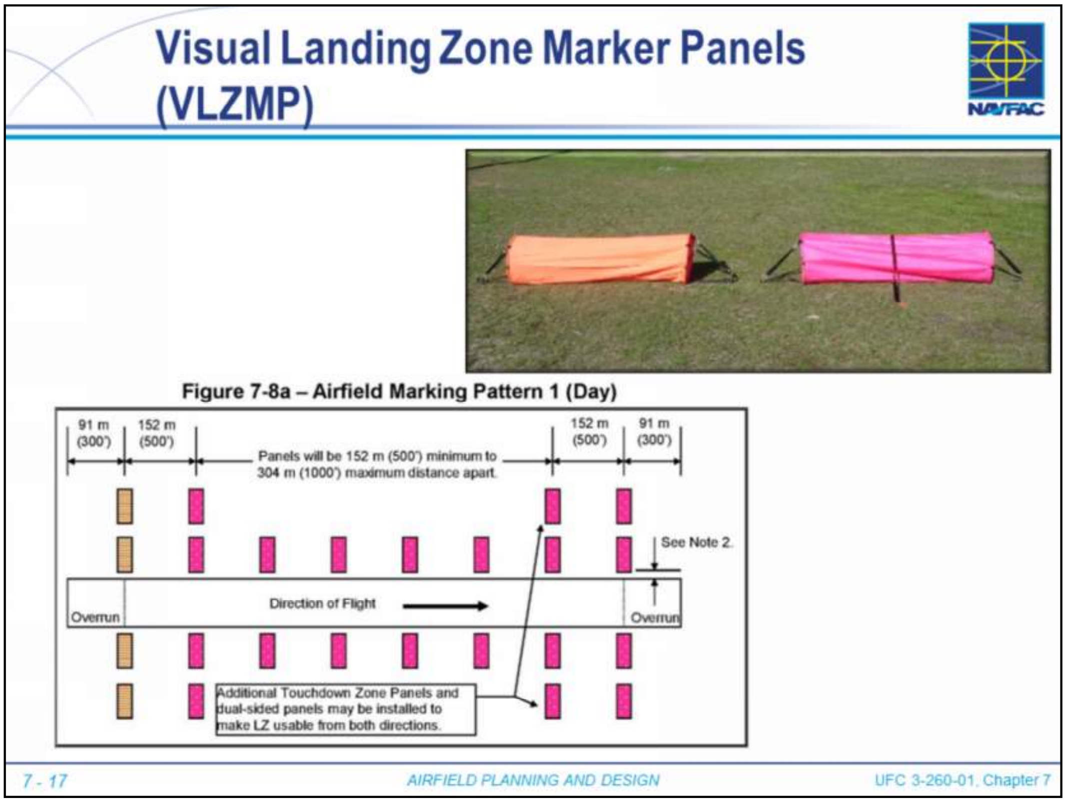
- Planned operations, Service Life, Existing Soil, Weather conditions.

- Semi-prepared construction/maintenance preparations may range from those sufficient for limited use to those required for continuous, routine operations.
- Surface options may include:
  - Stabilization, Aggregate, Compacted in-place soils, Matting

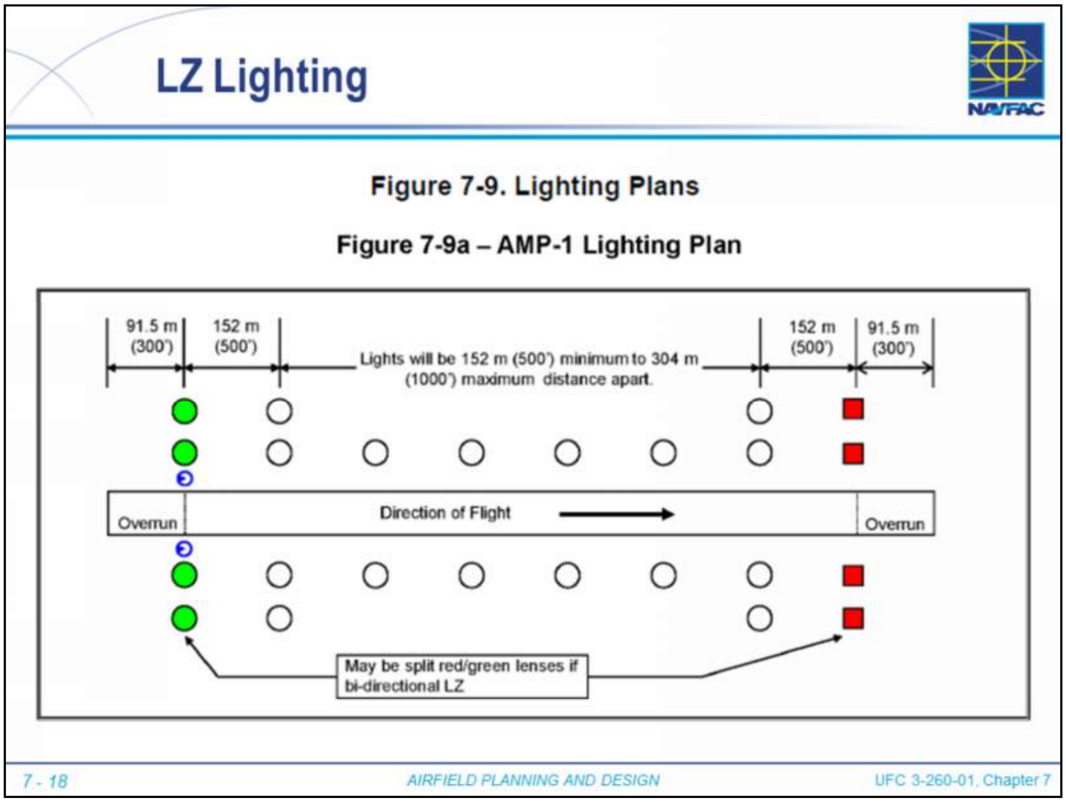
- **Schoonover Field, Fort Hunter-Liggett, CA**

- Semi-prepared LZ
  - Dirt Surface
  - Turnarounds
  - Taxiway Connectors and aprons

- Stabilized Soil vs Unstabilized Surface
  - Sometimes delamination in stabilized becomes a problem
  - Hard to repair stabilized surface
  - Easy to periodically re-grade and compact unstabilized surface

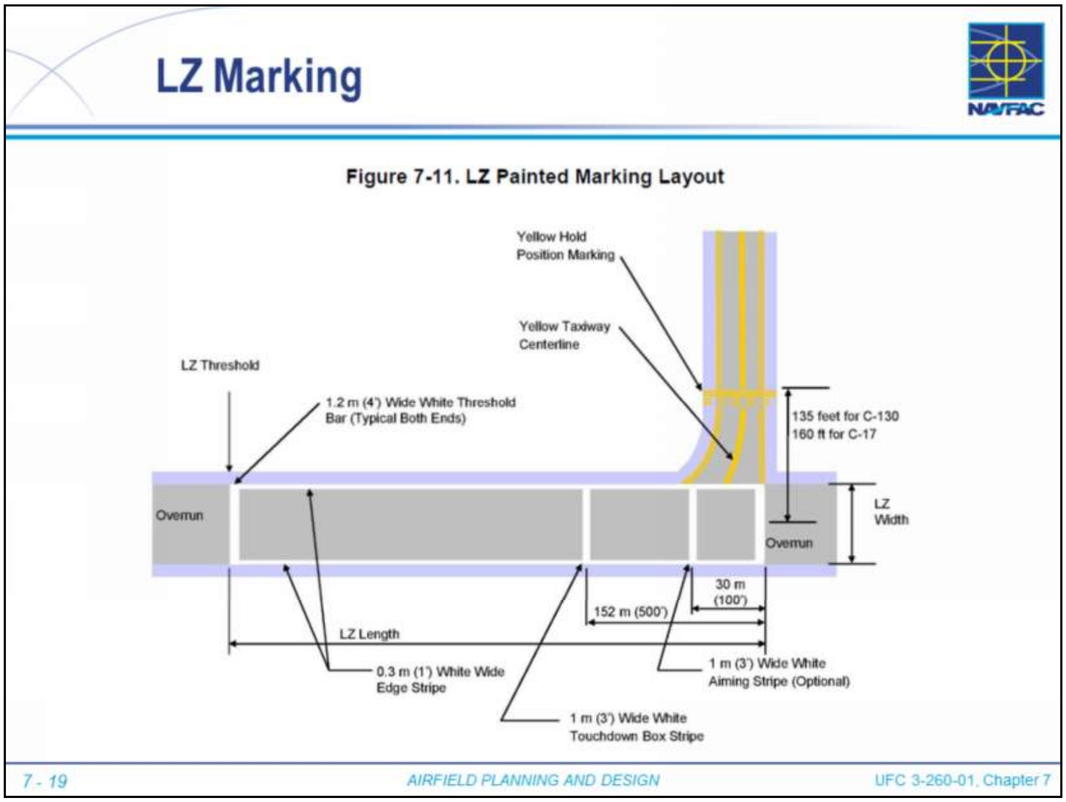


- Vertical, colored panels installed along runway edges to indicate the threshold location and distance remaining.
- Two types of Panels: Temporary and Permanent
- <u>Temporary Panels</u>: intended for short-term or temporary use.
    - Marked with one of the arrangements in AFI 13-217, *Drop Zone and Landing Zone Operations.*
- <u>Long-Term Applications</u>: Because training LZs are intended for long-term use, permanent panels should be installed.
    - Locations of these panels are derived from the same patterns shown AFI 13-217. See Figures 7-7, 7-8a, 7-8b, 7-12, 7-13, and 7-14.
- <u>Colors</u>: Orange and Cerise are typical
    - Orange: Marks Beginning of the LZ
    - Cerise: Placed at equal distances (500' min, 1000' max) along LZ.
    - Other colors can be used (example all orange); however must be approved and users briefed prior to operations.
- Panels can be omitted when a conflict exists on one or both sides.
- <u>Bi-Directional Operations</u>: Panels of the appropriate color will be attached to each side of the panels.

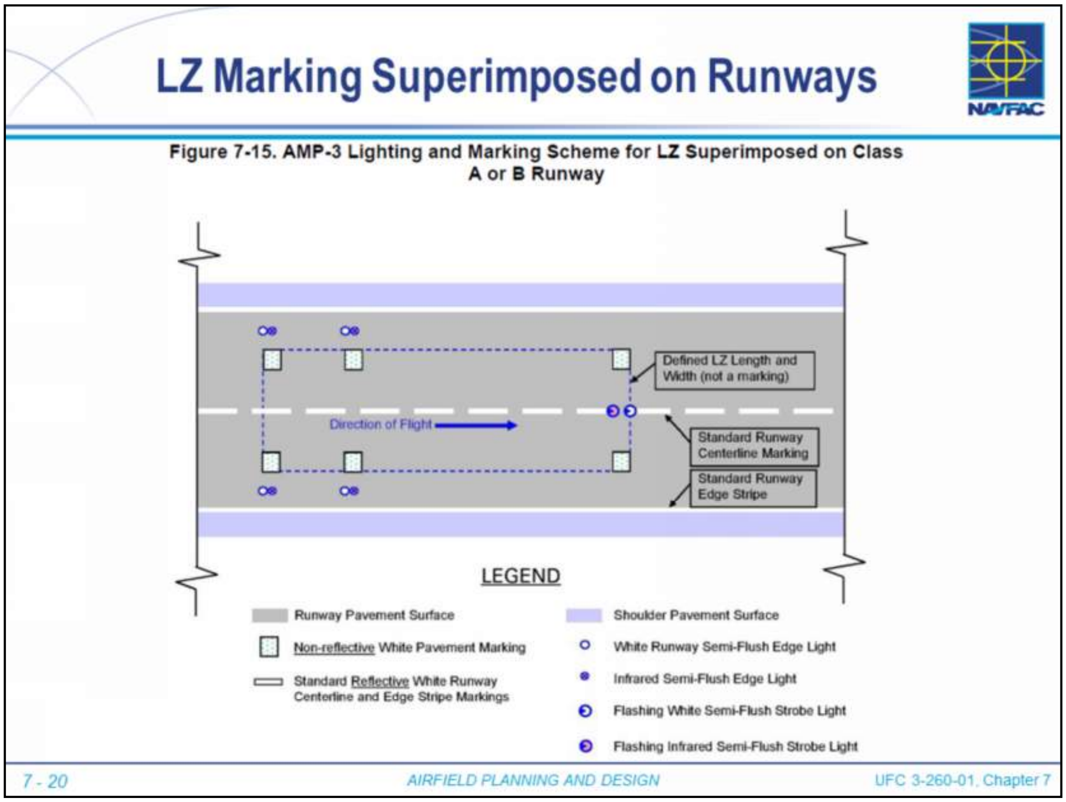


- Various Systems used during night operations to provide visual cues to pilots about the location and dimension of the LZ runways.
- Similar to the Marker Panels, lights are determined by the mission requirement and anticipated during of LZ use.

- Temporary Applications: Any lights are acceptable; however, the preference is for omni-directional steady-burn or flashing with minimum 15 candela.
- Permanent Applications:
    - Lights must meet FAA AC 150/5345-53 Standards.
    - Bi-directional lighting shall be used if LZ used in both direction.
    - If superimposed on an existing runway, semi-flush edge lights shall be used.
- Patterns: There are 3 Types of LZ Lighting Patterns: AMP-1, AMP-2, and AMP-3.
    - AMP-1 uses the most lights and is shown in the graphic.
    - The other two use less lights but include a Flashing White Strobe light at the end of the LZ.
    - See the UFC for the different patterns.



- Pavement Markings: Not strictly required; However may be helpful in delineating the edge of operational surfaces.
- Semi-Prepared Facilities: It is generally not practical to use paint at semi-prepared facilities.
    - If surface is stabilized; Paint may be feasible (but may require frequent repainting).
    - “Stake Chasers”, plastic bristles placed along the edges.
- Long-Term Use Facilities: desirable at permanent facilities. Normally LZ markings should not be reflective to improve realism for training
    - Glass beads can be used if additional reflectivity is required.
    - Common markings seen are: Threshold Bar, Edge Stripe and Touchdown Box Stripe.



- Markings for a LZ superimposed on Class A or B Runways are also detailed in the UFC.

- IMAGE: AMP-3 Lighting and marking scheme on a Runway.
- Location: When possible, site so the LZ touchdown area is within the first 1000-ft of the runway pavements and overrun falls on the runway surface (not overrun).
- Conflicts: Site so the markings do not conflict with threshold markings, runway designation markings, TDZ markings, or fixed distance markings.

- Ideal location for the LZ threshold is 300-ft from the runway threshold. The standard runway markings will take precedence if there are any conflicts.

Video: C-130 Landing on LZ.

- Combat Controllers on site
- Fabric Marker Panels

- There are four types of STOVL Facilities:
    - LHD (amphibious Assault Ship) Training Facility
    - Vertical Landing (VL) Pad
    - Forward Operating Base (FOB) Facility
    - Tilt-Rotor Outlying Landing Field (OLF)

STOVL Basis of Design

Facility Type	Basis of Design Aircraft
LHD	F-35B and V-22 (LHD 5 ship deck)
FOB	F-35B
VL Pad	F-35B
Tilt-Rotor OLF	V-22

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•Four types of STOVL Facilities are developed from the Basis of Design Aircraft listed in the chart.

- Not intended to prohibit operations of other aircraft on these facilities.
- Each using aircraft, including the basis of design aircraft, must evaluate the facility for operational suitability.

•Standard Drawings for LHD and VL Pad available through WBDG, UFC 3-260-01. Submit a CCR to request copies via the link on the UFC page.

- •Std Drawings require
  - Site adaptation
  - Update to current standards (if needed)

Video: F-35B Landing on Deck of USS Wasp

- LHD (Amphibious Assault Ship) Training Facility –
    - Full-size simulated land-base LHD ship flight deck used for field carrier landing practice (FCLP)
    - Supports Short Takeoff and Vertical Landing.
- Includes painted outline of LHD deck, with lighting matching an LHD deck
- Includes a LHD Tower, with lighting controls, radio equipment, etc. Provides training opportunity for the ship-based personnel too.
- Much of the paved area is purely for FOD cover in the approach and departure areas (cross-hatched)

- The paved area at this LHD at MCAS Beaufort is actually much smaller than current criteria – it was built years before the criteria was determined for Chapter 8.

See NAVFAC Simluated LHD Shipdeck Standard Drawings 14064429 through 14064452 for details

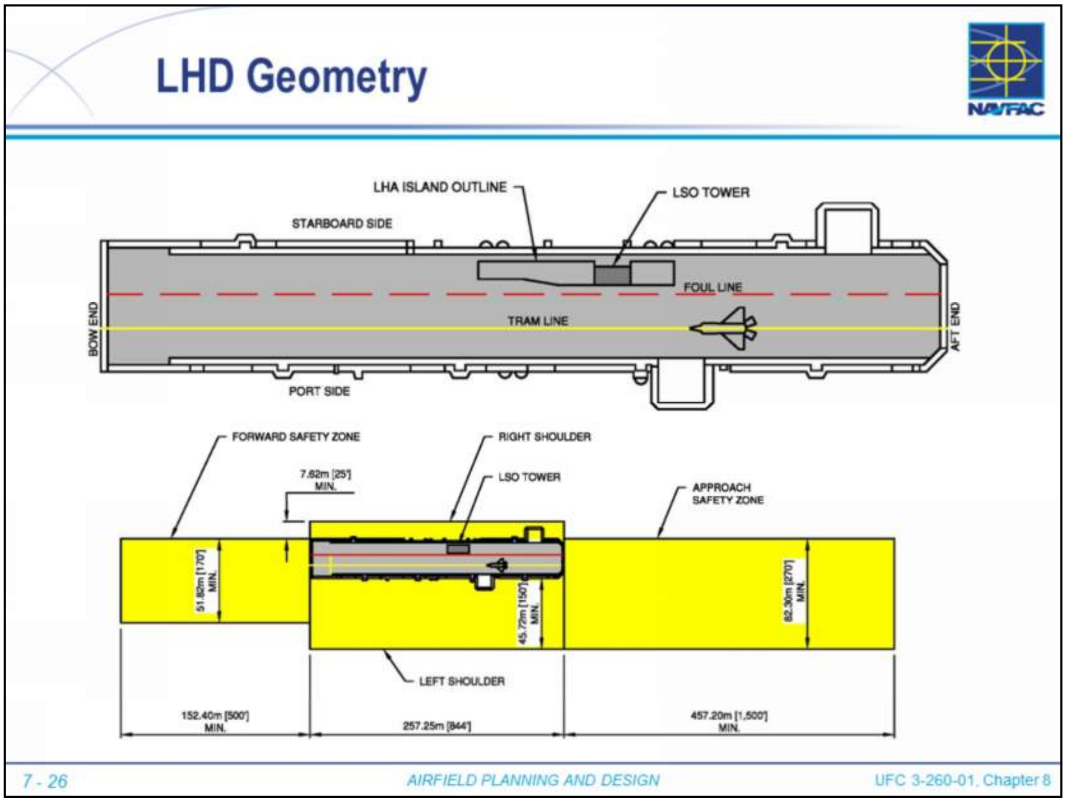


Figure 8-1 LHD STOVL Facility Outline

Figure 8-2 LHD STOVL Facility Safety Zones

- UFC defines overall site dimensions
- Shipdeck surface is fairly small, but paved area (yellow) surrounding the shipdeck surface as FOD cover is very large.

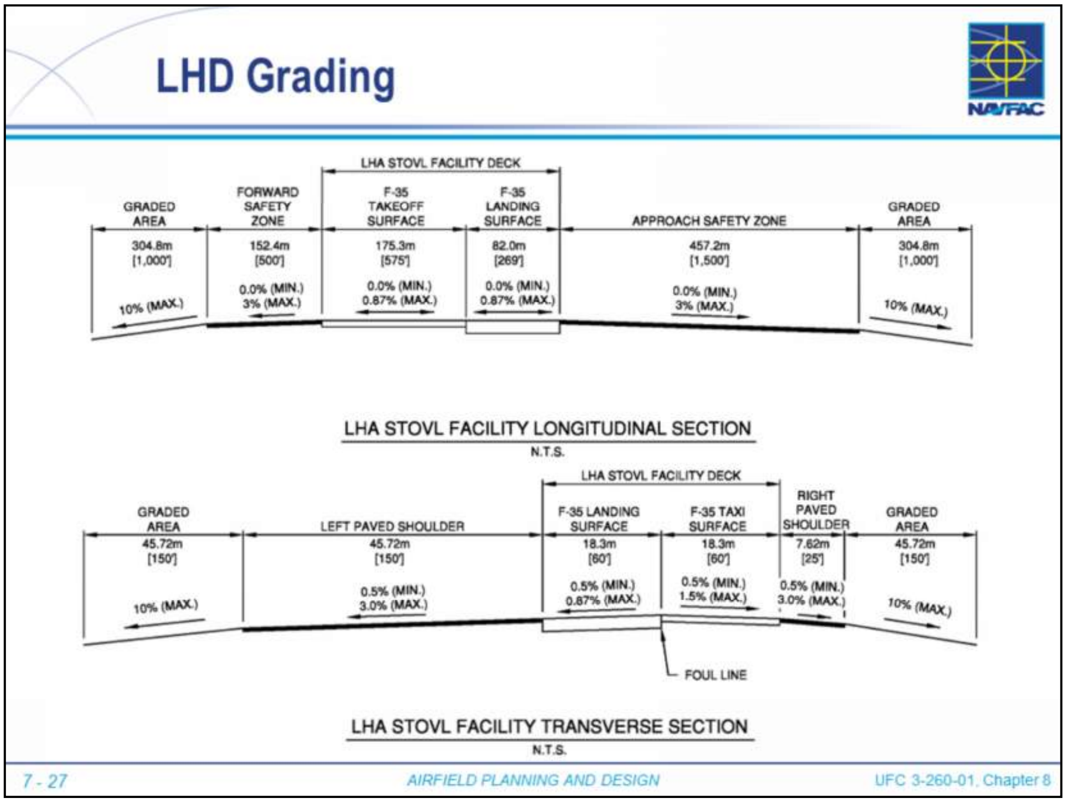


Figure 8-3 LHD STOVL Facility Longitudinal Gradient

Figure 8-4 LHD STOVL Facility Transverse Section

- UFC includes detailed grading requirements for paved areas and unpaved safety areas surrounding the pavement

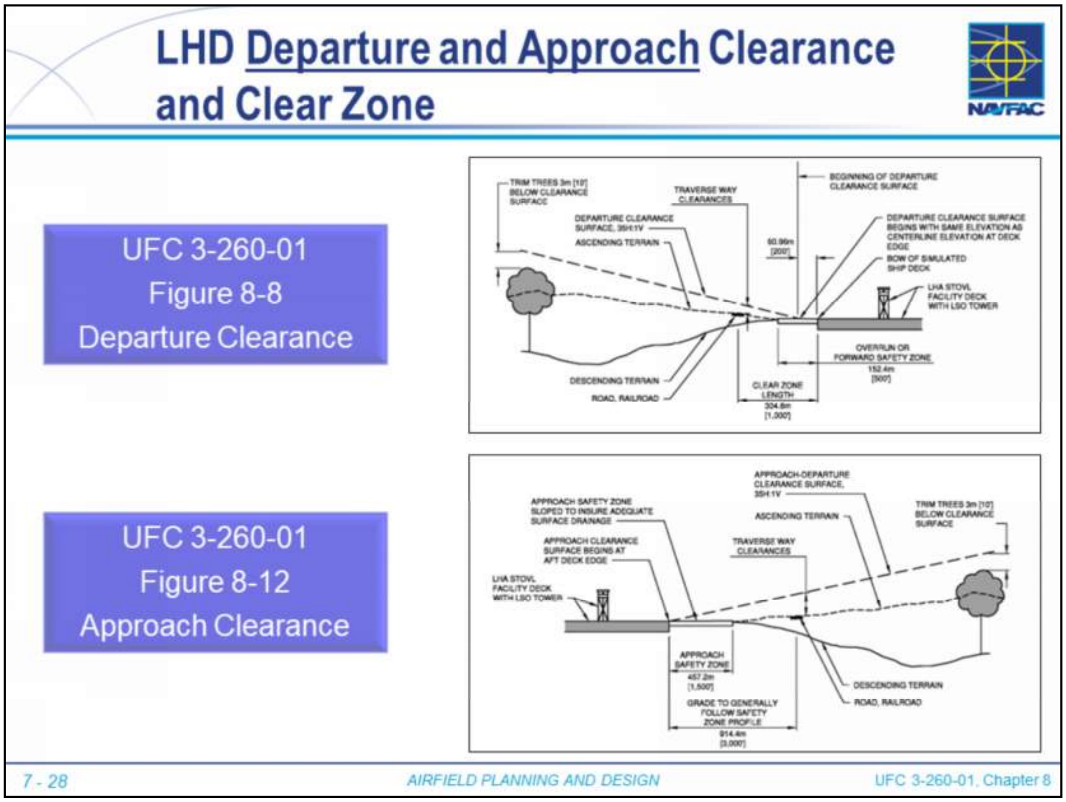


Figure 8-5: LHD STOVL Facility Departure Clearance Surface and Clear Zone

Figure 8-12. LHD STOVL Facility Approach Path Clear Zone

- LHD is a Uni-directional Facility
    - Clearance surfaces on each end are very different from each other

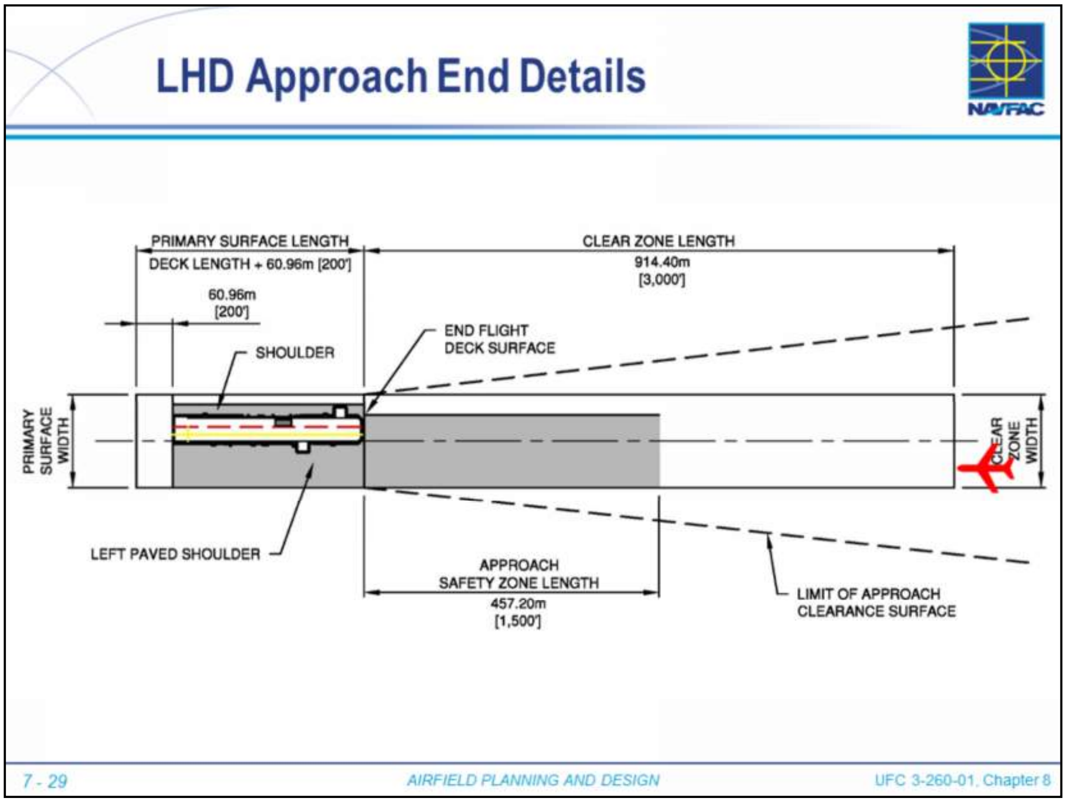


Figure 8-13. LHD STOVL Facility Approach End Details

- Describe LHD Landing Operations typical procedures
- Aircraft aligns left of ship deck while on approach
- Stops adjacent Spot 7, 35’ off pavement/deck, which is 100’ off water
- Shifts lateral to align over spot
- Final descent to deck

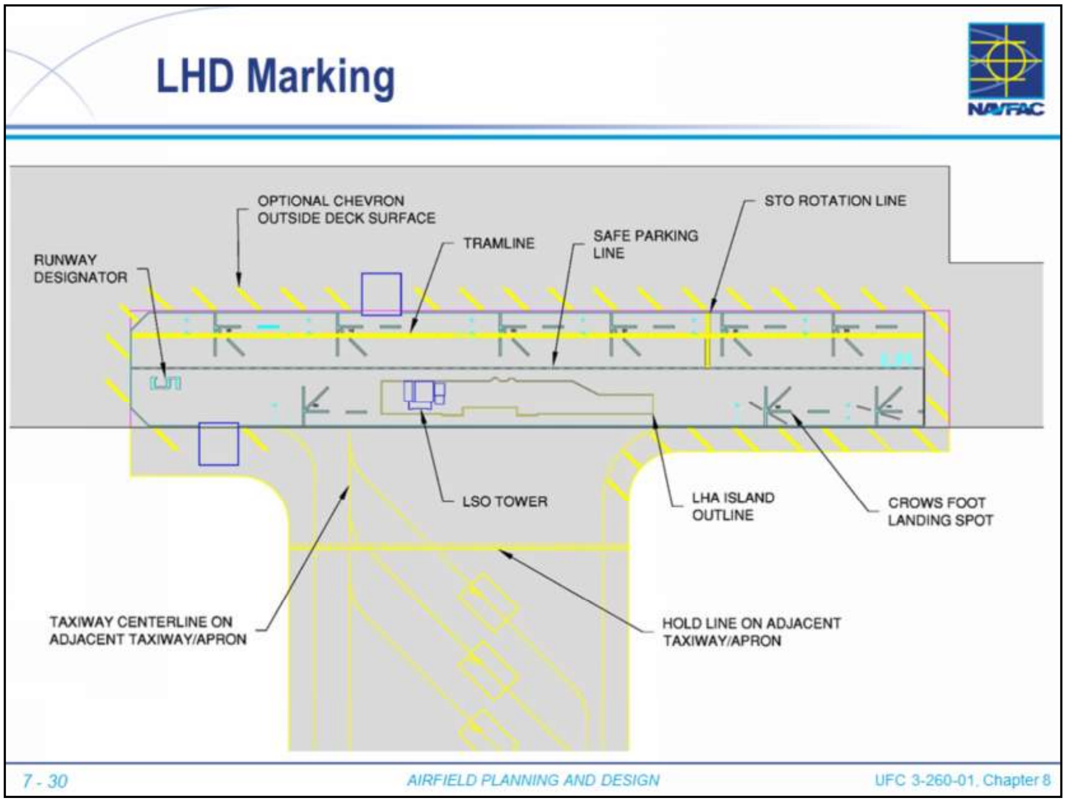


Figure 8-14 LHD Overall Marking

- Many markings that are only used on LHD because they are made to match the shipdeck surface.
- Many Details for markings in Chapter 8, but need to see NAVFAC Simulated LHD Shipdeck Standard Drawings 14064429 through 14064452 for detailed dimensions. Will require site adapting to current LHD needs.

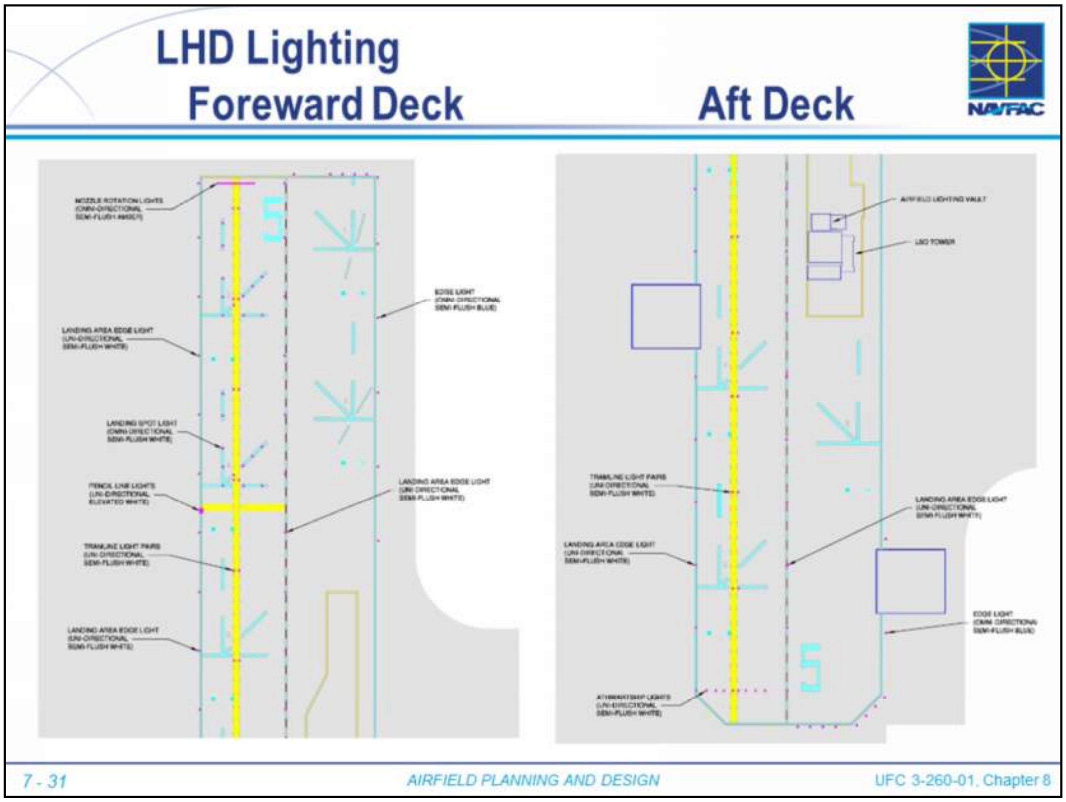


Figure 8-17. LHD Aft Deck Lighting

Figure 8-18. LHD Forward Deck Lighting

- LHD facility has unique lighting layout that simulates an LHD ship deck.
- Each landing position has specific lighting. Details in figures of UFC, but need to see NAVFAC Simulated LHD Shipdeck Standard Drawings 14064429 through 14064452 for details. Will require site adapting to current LHD needs.

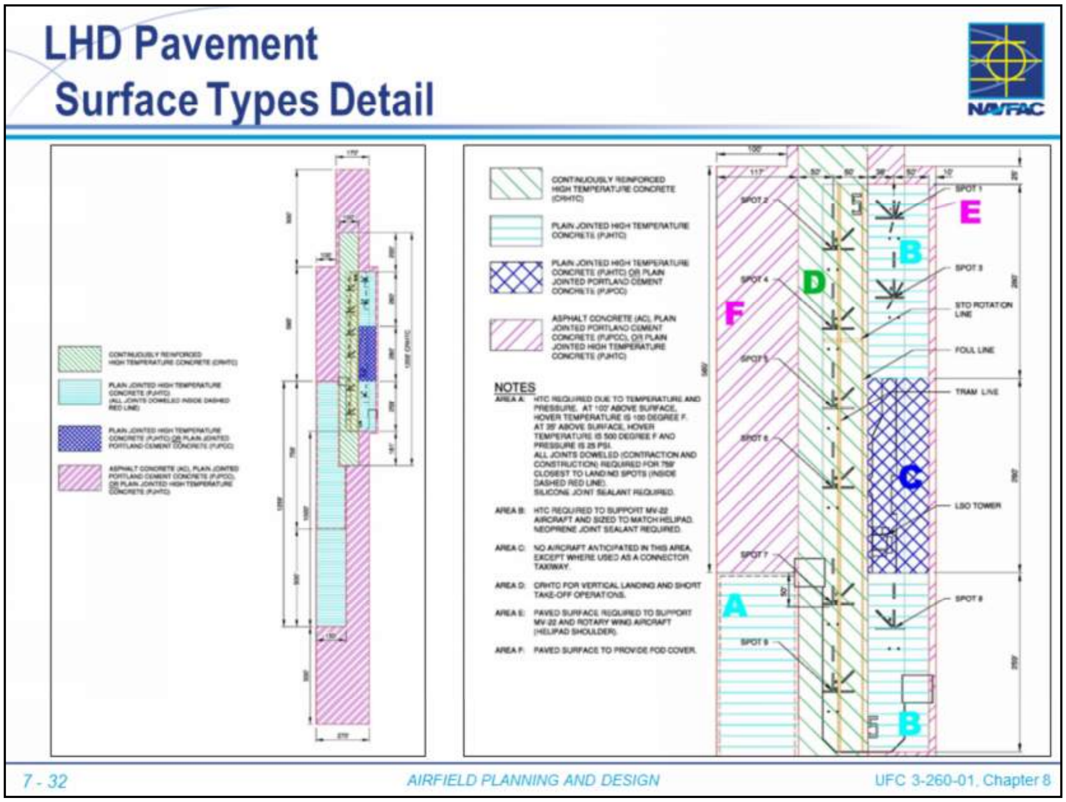


Figure 8-21. LHD Pavement Types

Figure 8-22. LHD Pavement Surface Types Detail

- UFC and Standard drawings describe the different pavement types used on an LHD
- High temperature and high blast pressures experienced at the primary landing spot (spot 7) and in the short takeoff lane (Area D)
    - Other landing spots in Area B may be used for Tilt-Rotor landings, therefore Plain Jointed High Temp Concrete required
    - FOD cover pavements surrounding LHD can be asphalt or concrete

- Continuously Reinforced High Temperature Concrete (CRHTC)
- Plain Jointed High Temperature Concrete (PJHTC)
- PJHTC or Plain Jointed PCC
- Asphalt Concrete, Plain Jointed PCC, or Plain Jointed HTC

- See NAVFAC Simluated LHD Shipdeck Standard Drawings 14064429 through 14064452 for details. Will require site adapting to current LHD needs.

Figure 8-20. LHD LSO Tower.

- Cab (49-ft above deck)
- Lighting Controls for deck lighting and Optical Landing System lights
- Lighting Vault on ground adjacent to LSO Tower.
- HVAC systems required for LSO Tower.

- **See NAVFAC Simulated LHD Shipdeck Standard Drawings 14064429 through 14064452 for details. Will require site adapting to current LHD needs.**

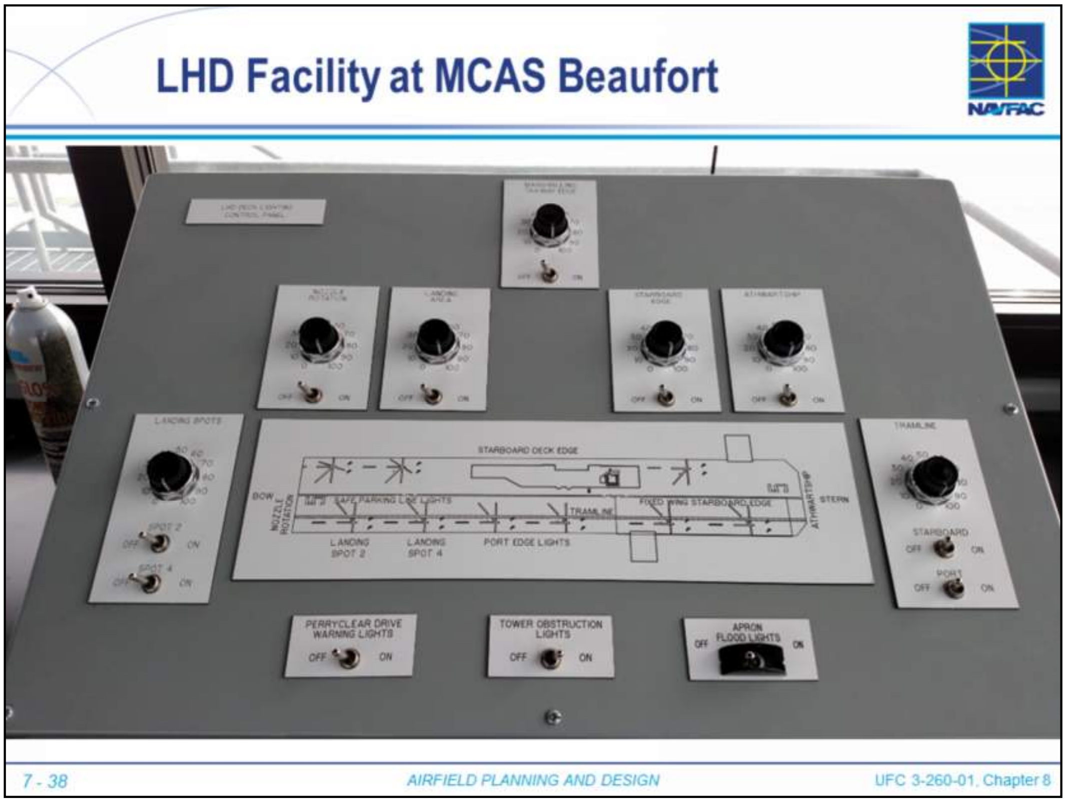
- View from LSO Tower towards Aft Deck

LHD Facility at MCAS Beaufort

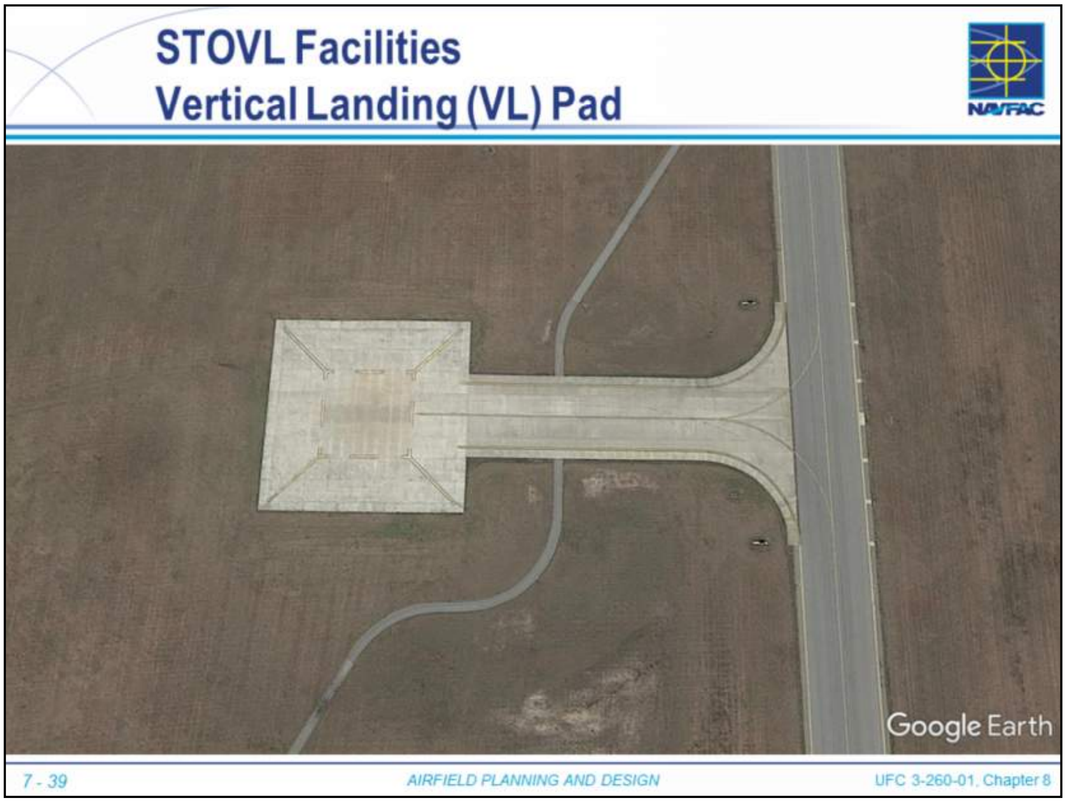
- View from LSO Tower toward Forward Deck

- Port Edge of LHD Deck
- Elevator Outline on left
- Tram Line on right

- Landing Spot 4 Marking and Lights with Tram Line through spot



- Typical Lighting Control Panel. Matches control panel found on an LHD Ship
- In a typical LSO tower, other control panels included such as Wave Off Cut Panel, HPI Panel and STO Rotate Panel

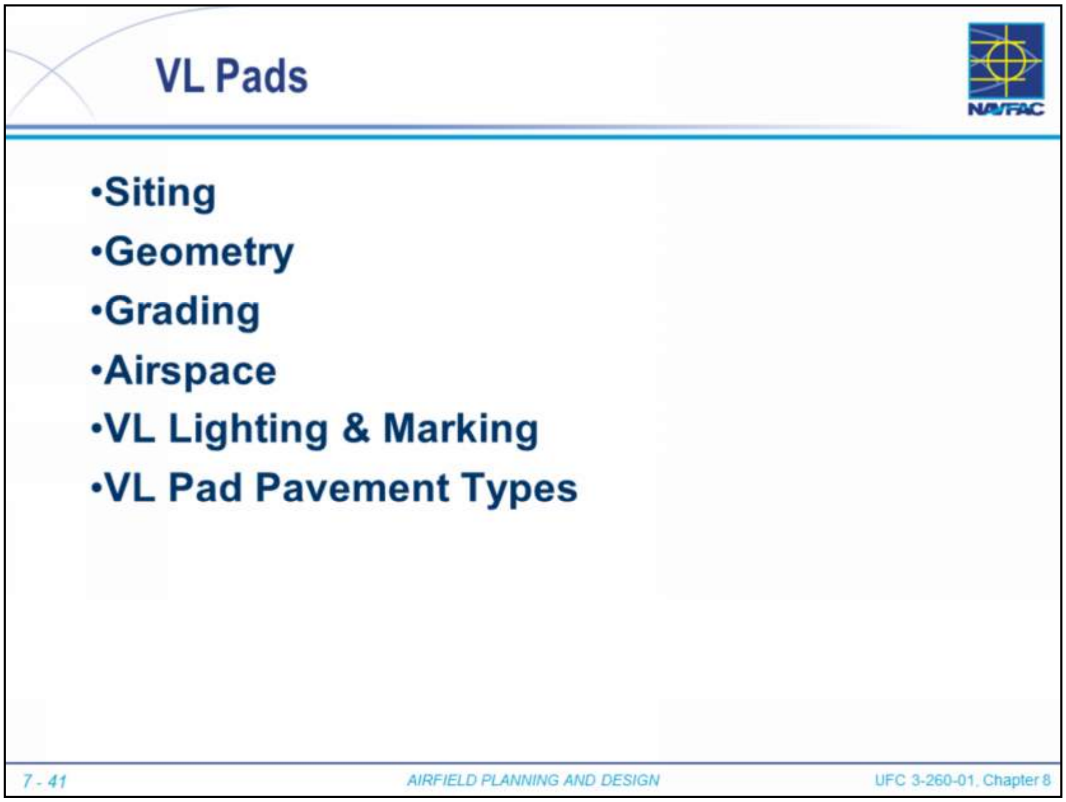


- Vertical Landing (VL) Pad
  - Paved surface of fixed dimension that affords a landing location for fixed-wing STOVL aircraft.

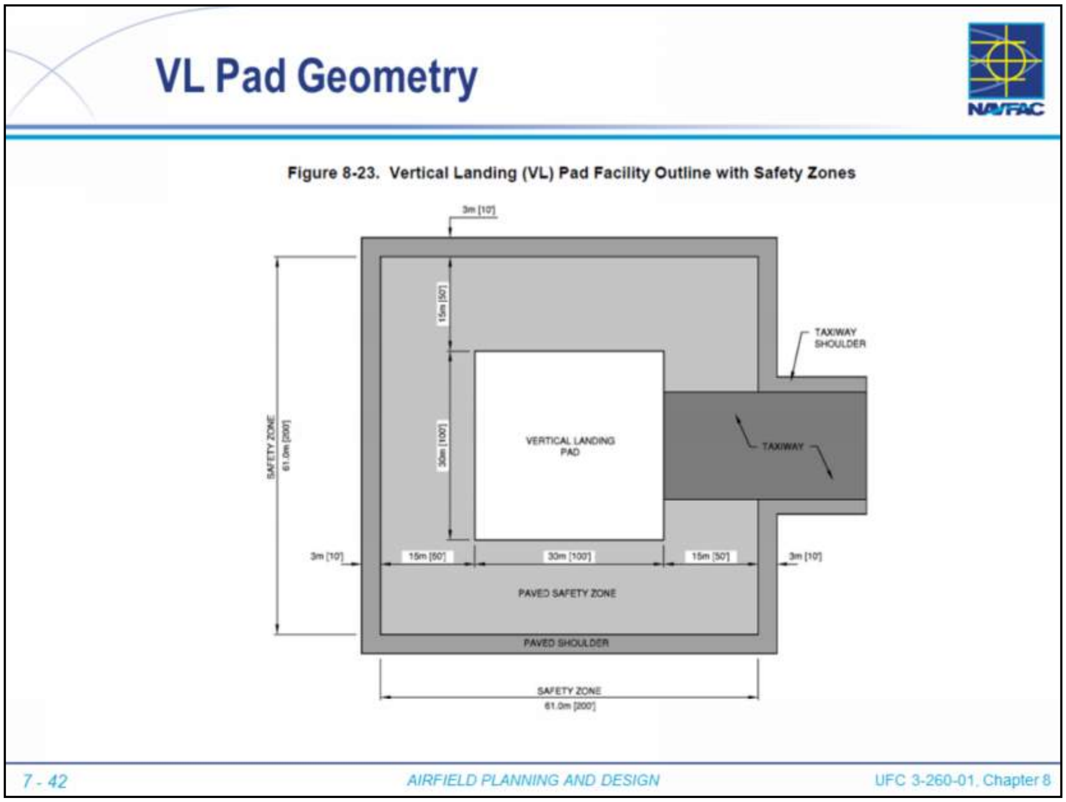
- VL Pad at MCAS Beaufort
  - Note: Edge stripe marking missing – not per standard

- **See NAVFAC Vertical Landing Pad Standard Drawings 14064454 through 14064465 for details**

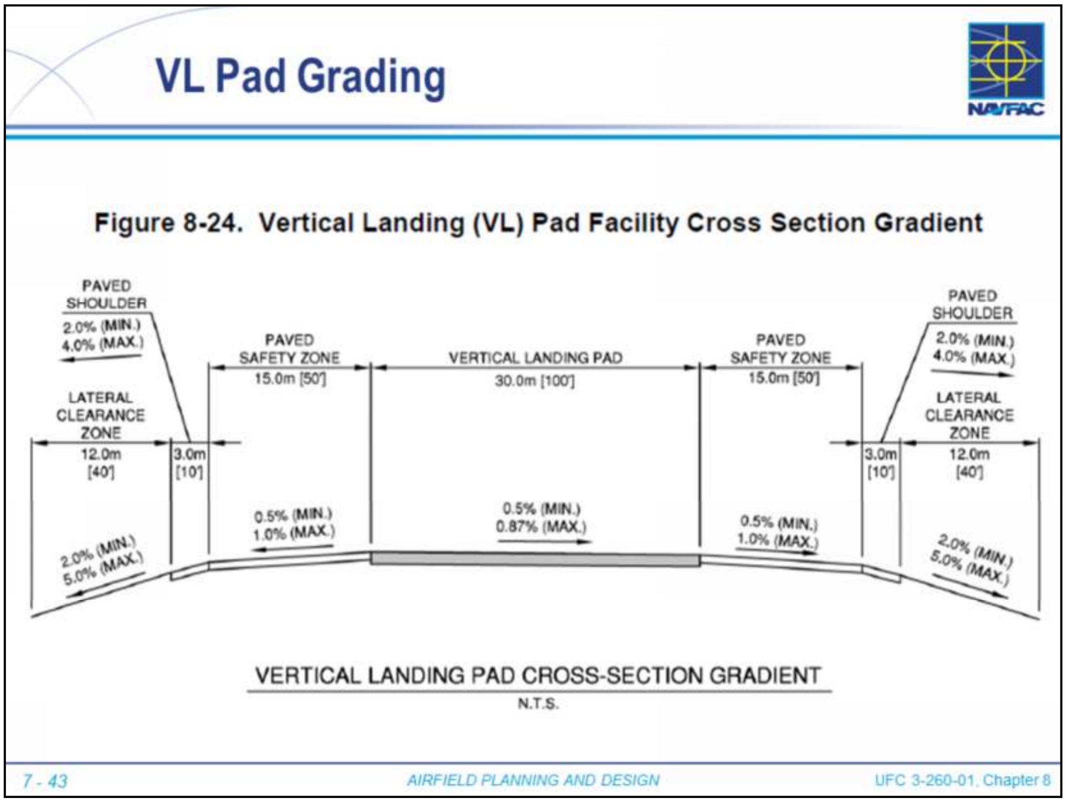
Video: F-35B Short Takeoff and Landing on VL Pad



- VL Pad Siting:
  - Located at main air base facilities or forward operating bases.
  - Positioned at these facilities to provide proficiency training and flexibility for degraded aircraft system recovery.
  - Though not prohibited, the STOVL design of the F-35B aircraft was not intended for routine vertical takeoffs from VL pads.
  - Instead the follow-on takeoff from a VL pad equipped facility will be a conventional or short takeoff based on the facilities available.
  - When the VL pad is collocated with an existing DoD airfield or FOB STOVL training facility and their respective imaginary surfaces overlap, the most restrictive or lower surface will be utilized to ensure obstacle clearance.



- <u>VL Pad Geometry</u>:
- Figures 8-23 through 8-27 and Table 8-4 provide dimensional criteria for layout and design of the VL pad and safety zones.
- VL pad and safety zones are provided to prevent erosion of graded surfaces by jet blast from aircraft transition to/from the pad and surface water runoff.
- Each zone or surface contains a brief description of their use and reference to where their specific dimension or graphic is located within the document.



- **VL Pad Grading**
  - A uniform surface, sloped in one direction, is required to eliminate irregularities between landing gear at touchdown.
  - After construction and prior to aircraft operations, each VL Pad will be surveyed on a 10’ x 10’ grid to determine elevations to the nearest 0.01’.
- **Raised Elevation.** Future grinding of the HTC surface may be required.
  - VL pad and safety zone must be constructed together such that up to 2 inches of material may be diamond-ground and still maintain the maximum and minimum grades to eliminate ponding.

• **Primary Surface Elevation.** The primary surface elevation is the highest point on a VL pad.

- Must not conflict with nearby runways

• **Grades Within Primary Surface.** Exclusive of pavement and shoulders, grades within the primary surface must be at least two percent to a maximum of five percent, prior to drainage channelization; however, the channel bottom may be flat. Remaining area shall be clear of obstructions and rough-graded to minimize damage to aircraft in the event of an emergency landing. For VLZs, the grade requirements apply to the entire primary surface.

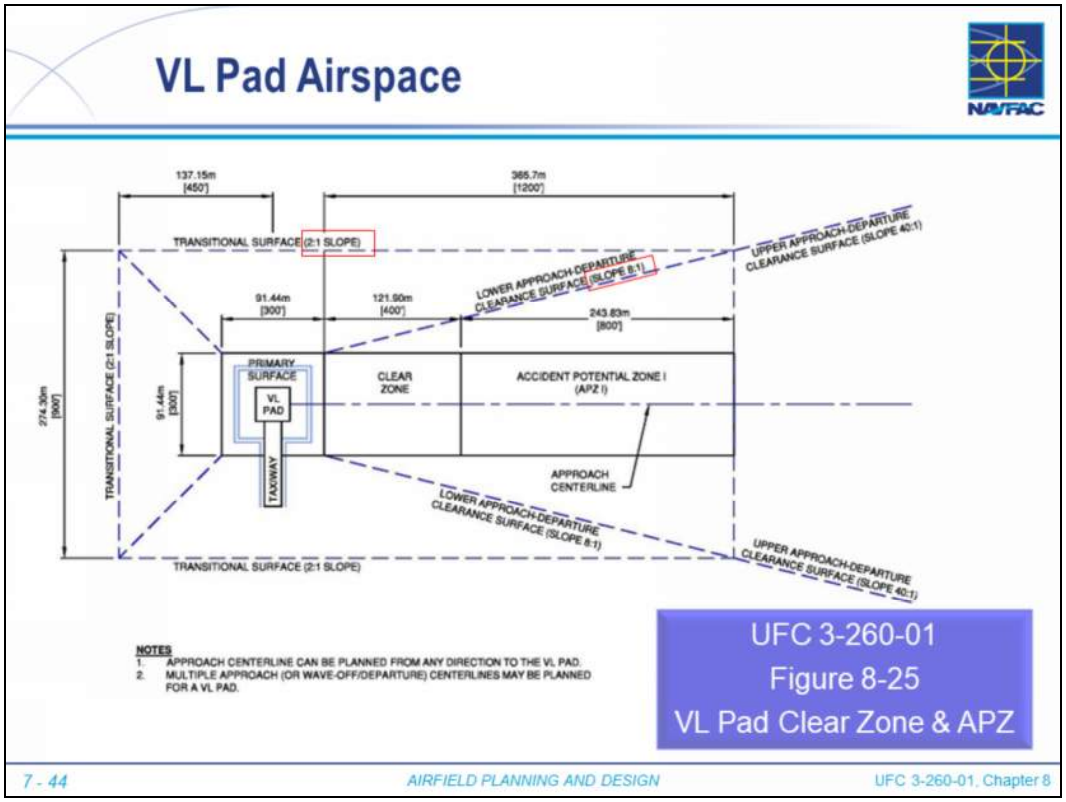
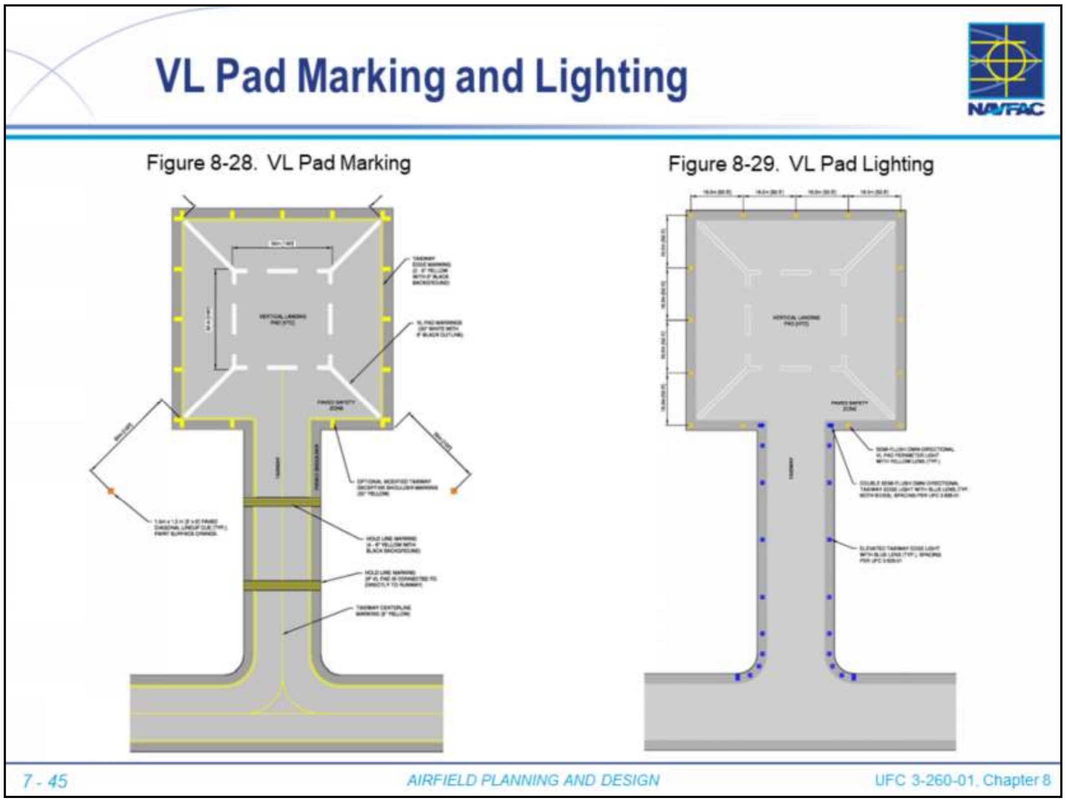


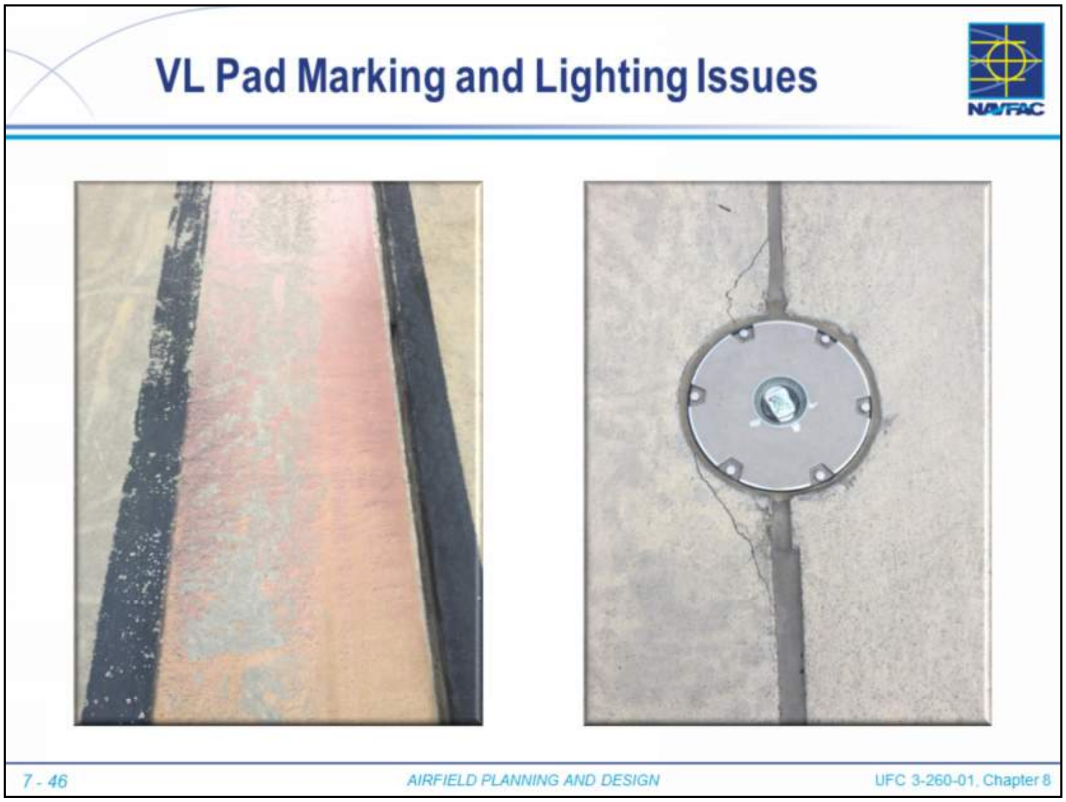
Figure 8-25. VL Pad Clear Zone and APZ

- Separation Distances are provided to provide applicable clearances and grade controls for reasonable level of safety.
- VL Pad Clear Zones and Imaginary Surfaces on the approach-departure path are compatible with rotary-wing (helipad) surfaces defined in Chapter 4.
- For only F-35B operations, the 2:1 Transitional Surface may be applied on all sides of the VL Pad and the ADCS will start at the edge of the Transitional Surface.

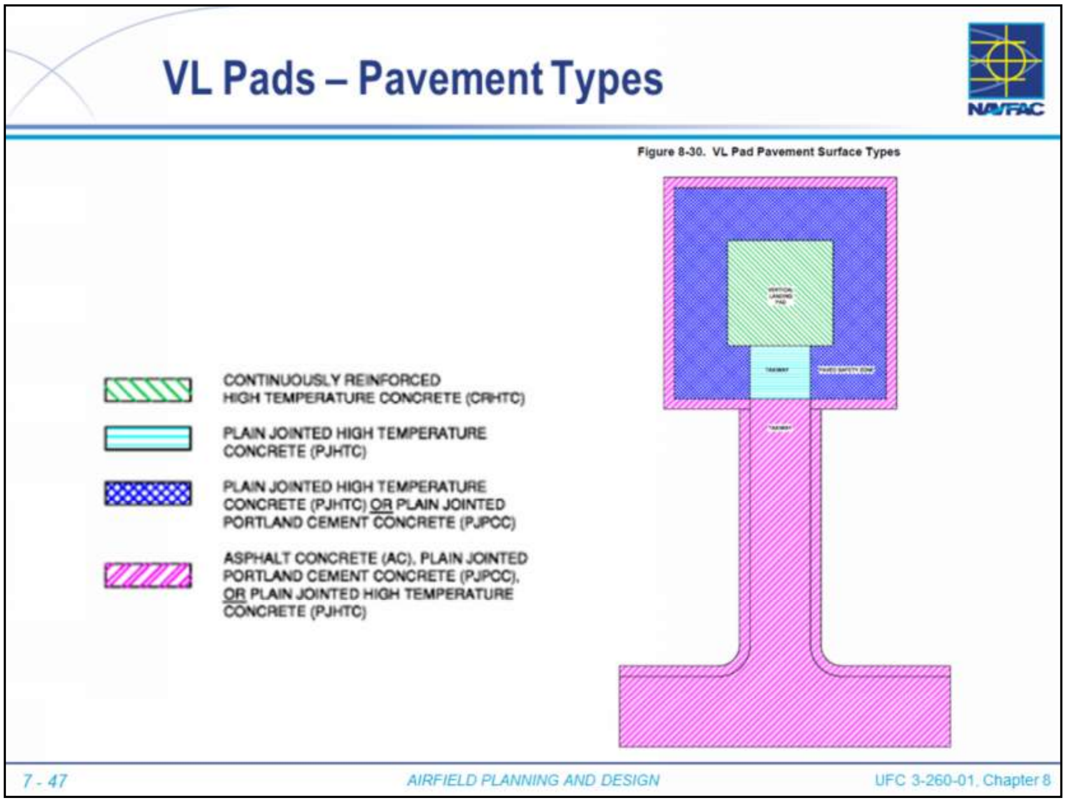
1. Airspace for Approaches Only and recovering from Missed Approaches. Figure legend (ADCS) is misleading – should not refer to departure surface
2. Approach Centerline May be from any direction to the VL Pad.
3. Multiple approach (or wave-off/departure) centerlines may be defined.



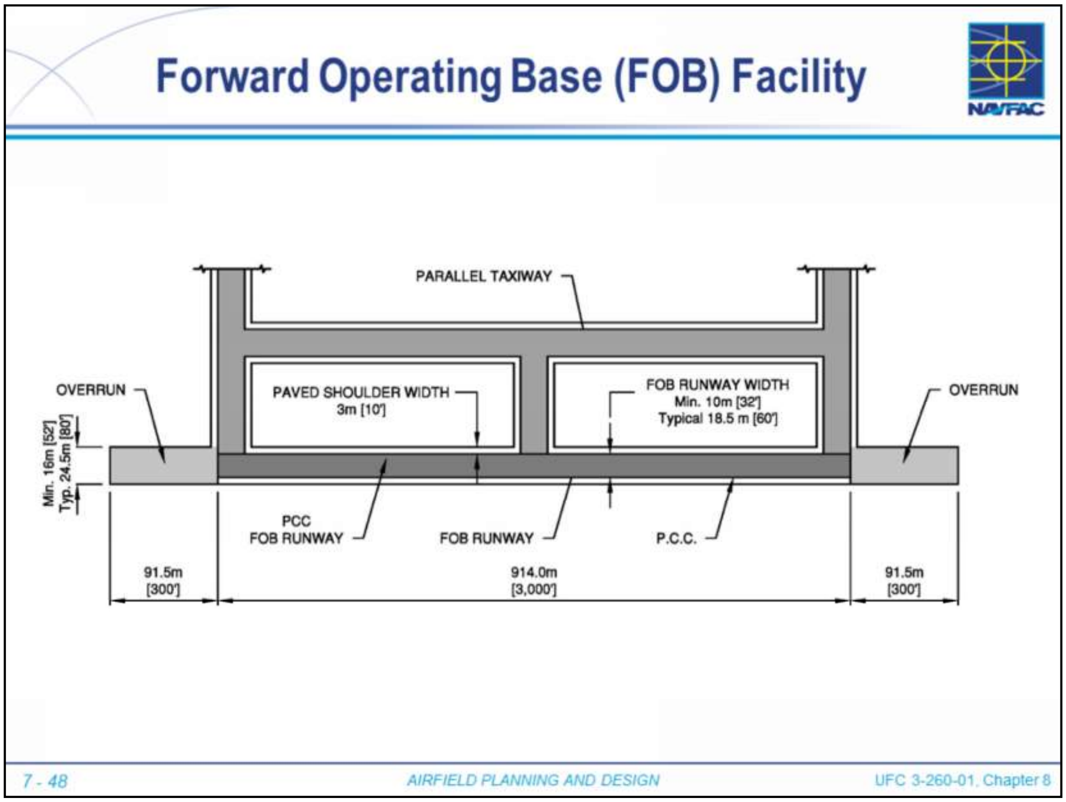
- <u>Marking</u>:
  - VL Pads will use reflective airfield marking paint as shown in Figure 8-28.
  - See NAVFAC Vertical Landing Pad (VLP) Standard Drawings for specific layout and detailed dimensions.
- <u>Diagonal Line-up Cue Markings</u>.
  - Paved pads 1.5m x 1.5m (5 ft x 5 ft) may be constructed on the diagonals at 100-ft from the corners of the VL Pad Safety Zone to provide additional visual cues for pilots to line up over the VL Pads prior to descending.
  - Pads will be at the same elevation as the surrounding turf and painted orange, as shown in Figure 8-28.
- <u>Lighting</u>:
  - Edge lights on the VL Pad and the connector taxiway will be installed at shown.
  - Semi-Flush lights around VL Pad
  - Specific details are in the NAVFAC Vertical Landing Pad (VLP) standard drawings.



- Markings
  - VL Pad Markings can get blasted away or discolored quickly by jet blast
- Lights
  - Layout for light cans must be deconflicted with PCC joints to avoid unwanted cracks



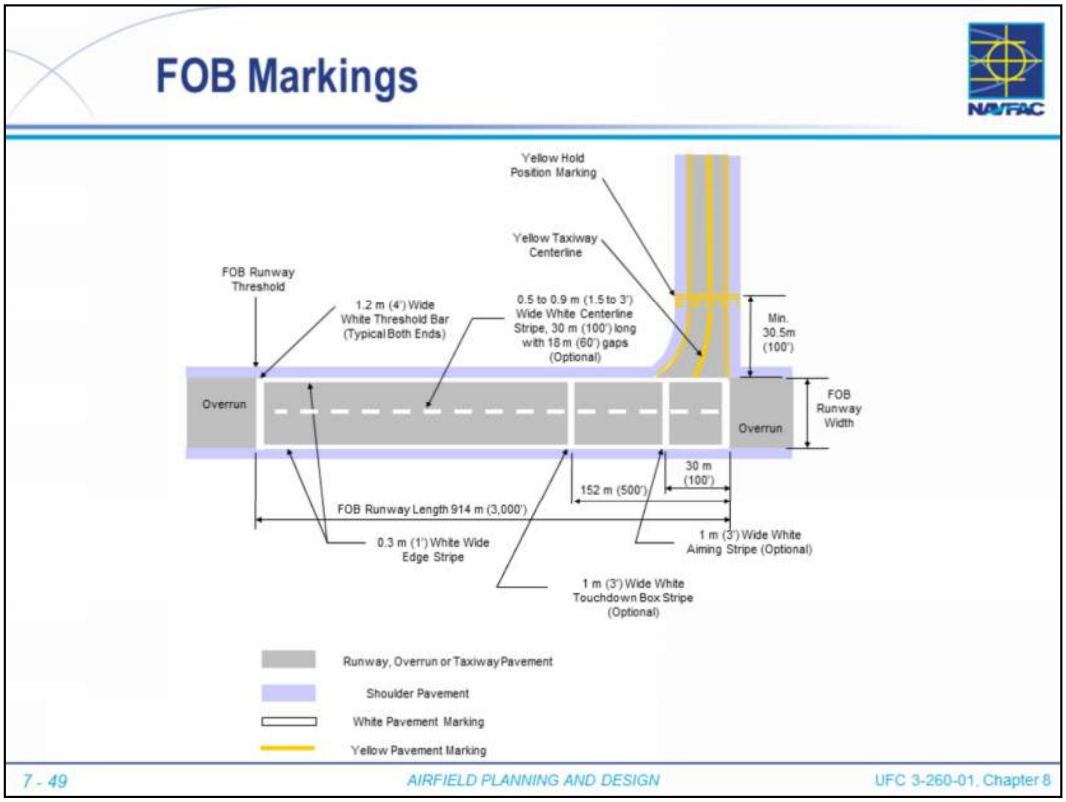
- Figure 8-30 shows the pavement types needed for VL Pads.
  - Constructed using CRHTC (Continuously Reinforced High Temperature Concrete).
  - Surrounding Paved Safety Zone constructed with PJHTC (Plain Jointed High Temperature Concrete).
  - Taxiway within 50-ft adjacent to the VL Pad will be constructed with PJHTC.
  - Taxiway connecting to adjacent runway or taxiway may be constructed with PJPCC (Plain Jointed Portland Cement Concrete) or HMA (Hot Mix Asphalt).
  - Paved shoulders will be constructed with PJPCC or HMA.
  - Regardless of construction material or method, the vertical landing surface will have a smooth transition to surrounding safety zones, shoulders, and taxiways.
  - UFGS 32 13 13.42 High Temperature Concrete Paving for Airfields Using Lightweight and Traprock Aggregates now available on WBDG and through SpecsIntact



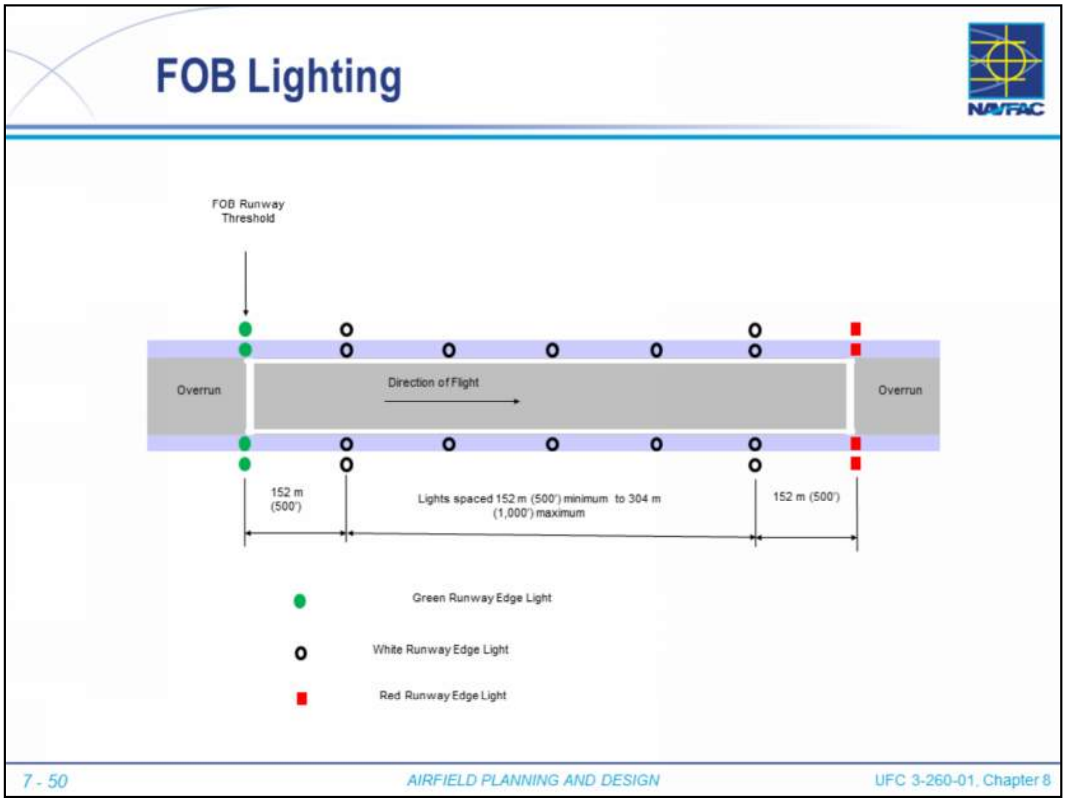
- Forward Operating Base (FOB) Facility
    - Dedicated to short takeoff (STO) and rolling vertical landing (RVL) operations.
    - Shorter and narrower runway dimensions than main airfields
    - STO and RVL operations are performed to minimize ground roll and facility footprint

- FOB are less common than LHD and VL Pad facilities
- Used in austere environments for short-term operations
- In many ways, FOB are to STOVL Aircraft as LZ is to C-17 and C-130
    - In Theater of Operations, might be a highway converted into a FOB

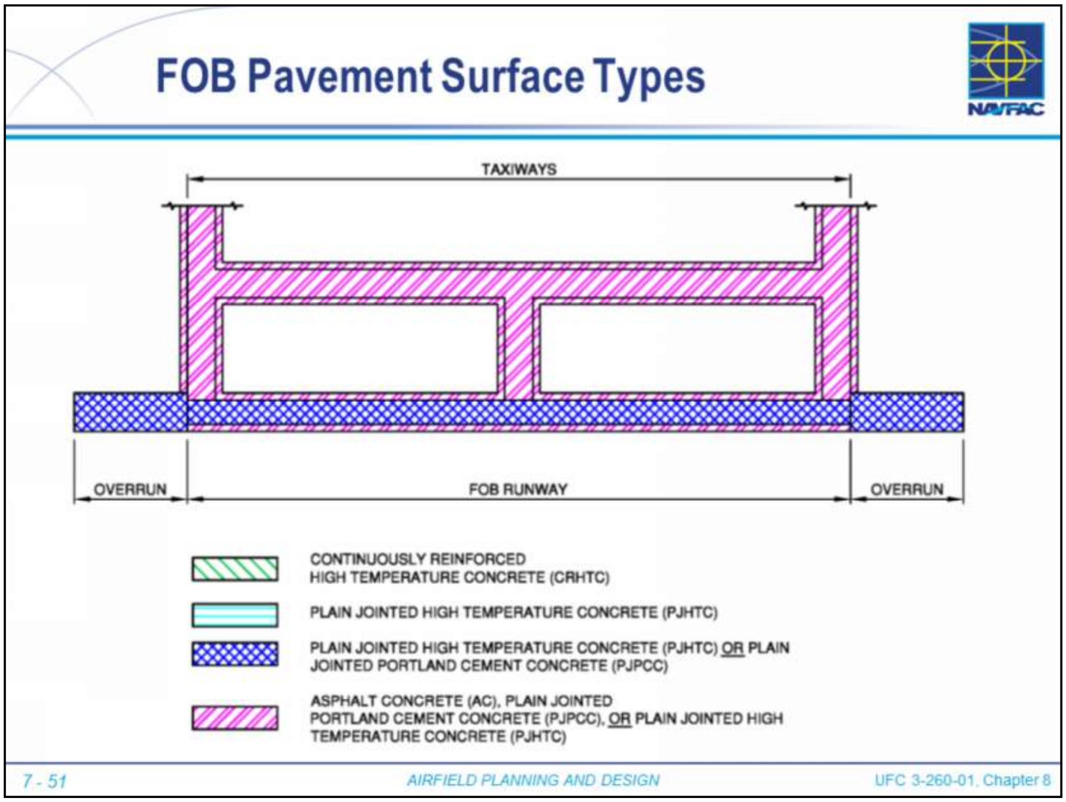
- F-35B use for slow rolling landings and short takeoffs



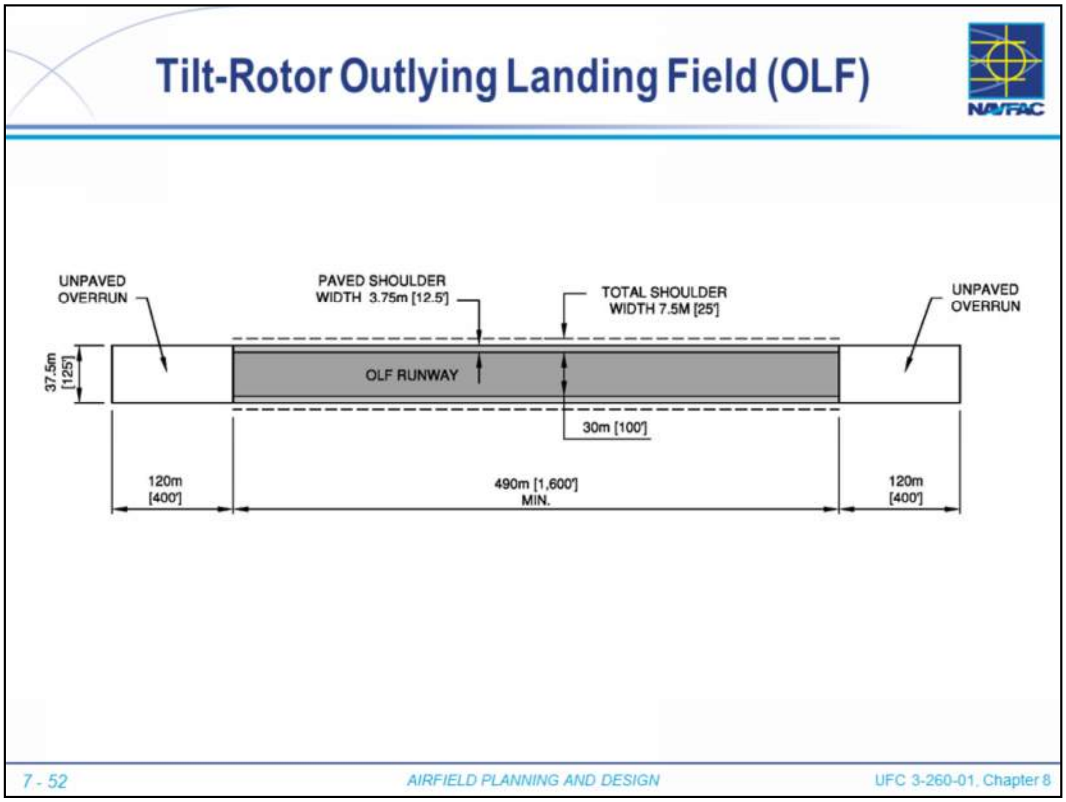
• Figure 8-40. Forward Operating Base STOVL Facility Markings



- Figure 8-41. FOB STOVL Facility Lighting



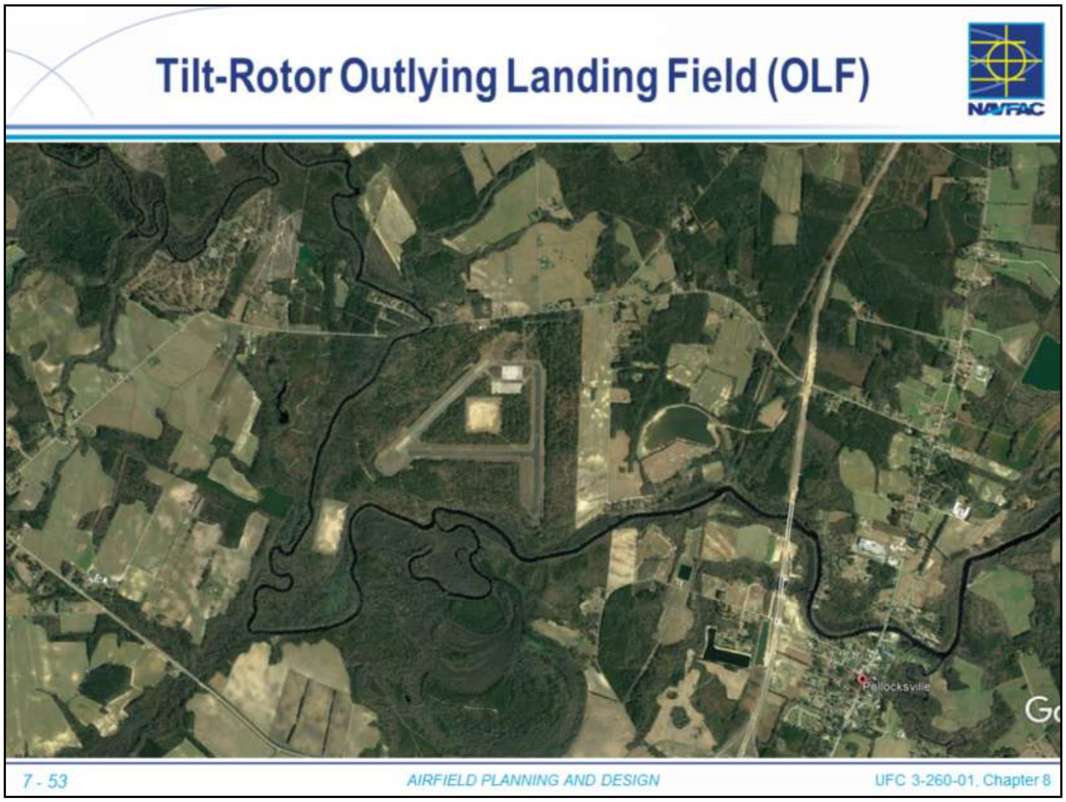
- Figure 8-42. STOVL FOB Pavement Surface Types



•Tilt-Rotor Outlying Landing Field (OLF)

- Auxiliary airfields generally located near and associated with a Naval or Marine Corps Air Station.
- OLF's have no based units or aircraft and only minimal facilities.
- They are usually positioned in an area with low aircraft traffic to provide proficiency training and flexibility for degraded aircraft system recovery.

•These are also less common. Like an LZ specifically for V-22 Ospreys



•OLF Oak Grove, Pollacksville, NC

•OLF to MCAS New River

Tilt-Rotor Outlying Landing Field (OLF)

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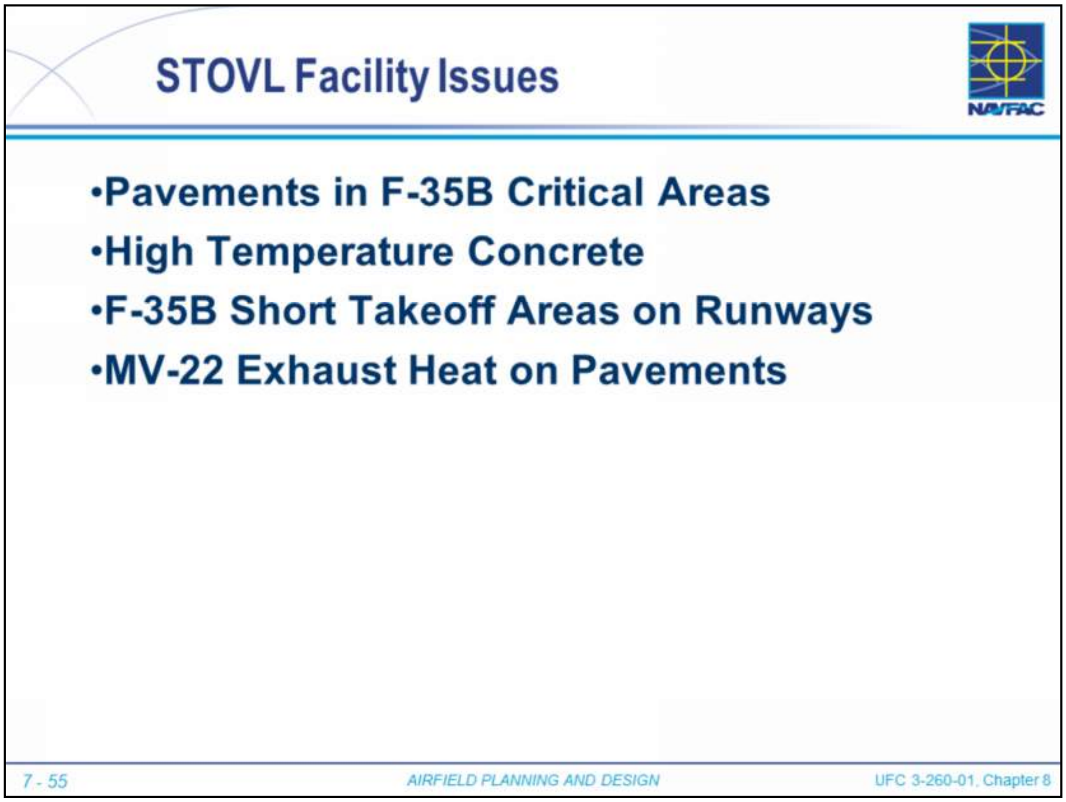
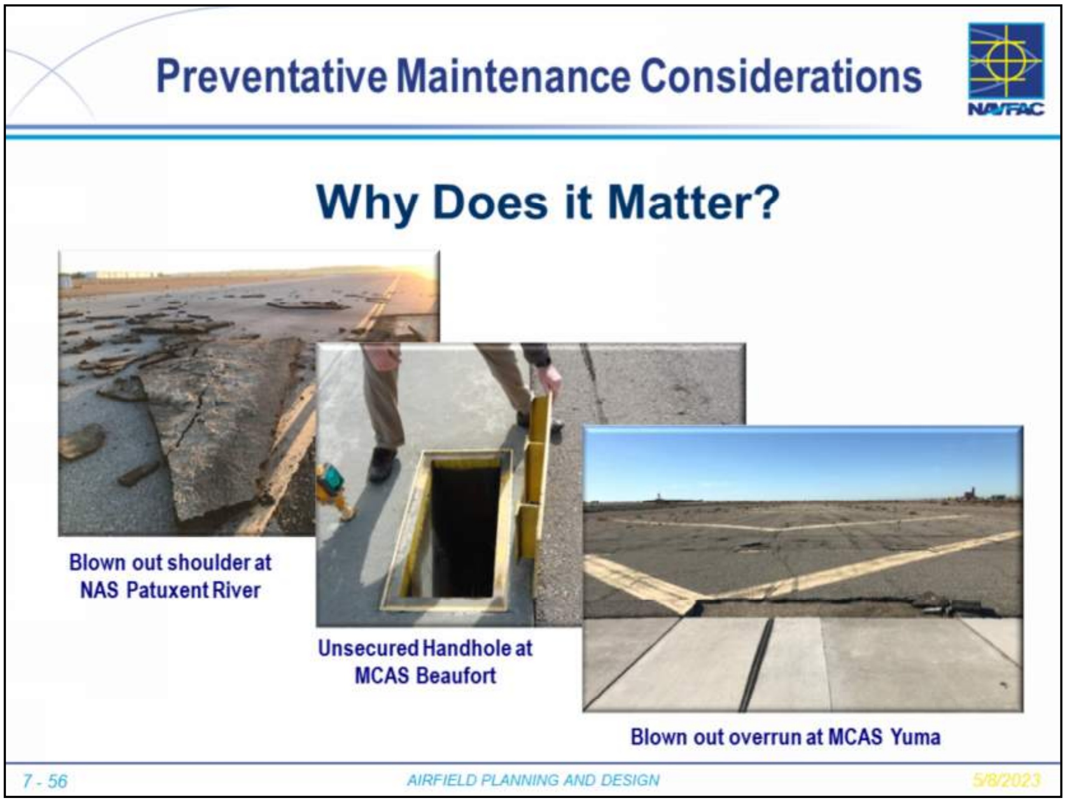
- OLF Oak Grove, Pollacksville, NC
- OLF to MCAS New River



- STOVL aircraft are particularly tough on pavements
  - High pressure jet blast
  - Vectored jet blast
  - High temperature exhaust
- Discuss issues that have come up and some remedies that are in use.



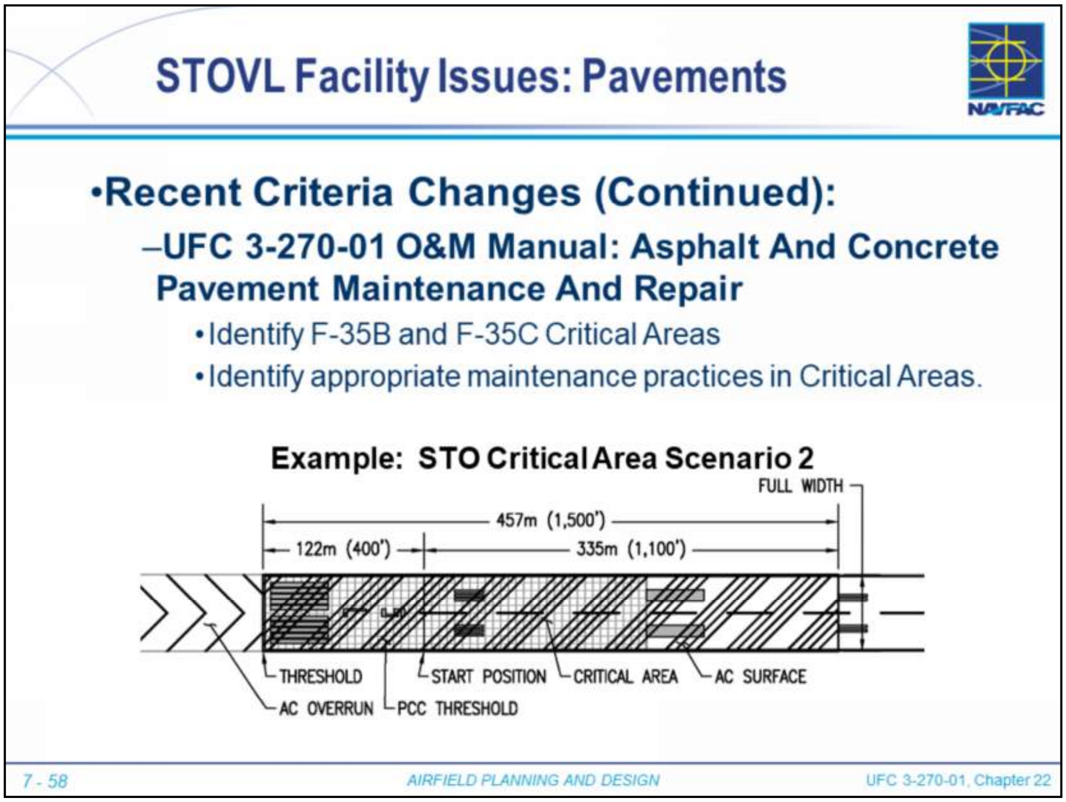
- Facility impacts of STOVL aircraft are real
- Potential for damage to aircraft
- Increased maintenance demand pavements

STOVL Facility Issues: Pavements

- High Temps and High Blast Pressures causing major distress on pavements
  - Short Takeoff (STO)
  - Rolling Vertical Landing (RVL)
  - Slow Landing, Vertical (SLV)
  - F-35C for Field Carrier Landing Practice (FCLP)

- No partial depth repairs, only full-depth patches
- Asphalt vulnerable to blast damage
- See new Chapter 22 in UFC 3-270-01 for maintenance of F-35B/C pavements

- Very low pressure can lift the pavement
  - Jet blast pressure exploits any weaknesses (cracks) in pavement
  - Air gets into joints and cracks and lifts out pavement
- There is no visual way to check for asphalt delamination



•UFC 3-270-1, new Chapter 22

• Maintenance approach on PCC will be to eliminate partial depth repairs and only use full depth repairs, and a more aggressive stance on joint sealant replacement.

• Maintenance approach on AC starts with a warning that this pavement surface is not compatible with the critical areas and any maintenance is only to be considered stop gap maintenance. It includes an aggressive stance on elimination of FOD generating distresses, aggressive crack sealing policy, and deep milling and overlay of AC surfaces with distresses indicative of delamination, or top to bottom cracking (full depth).

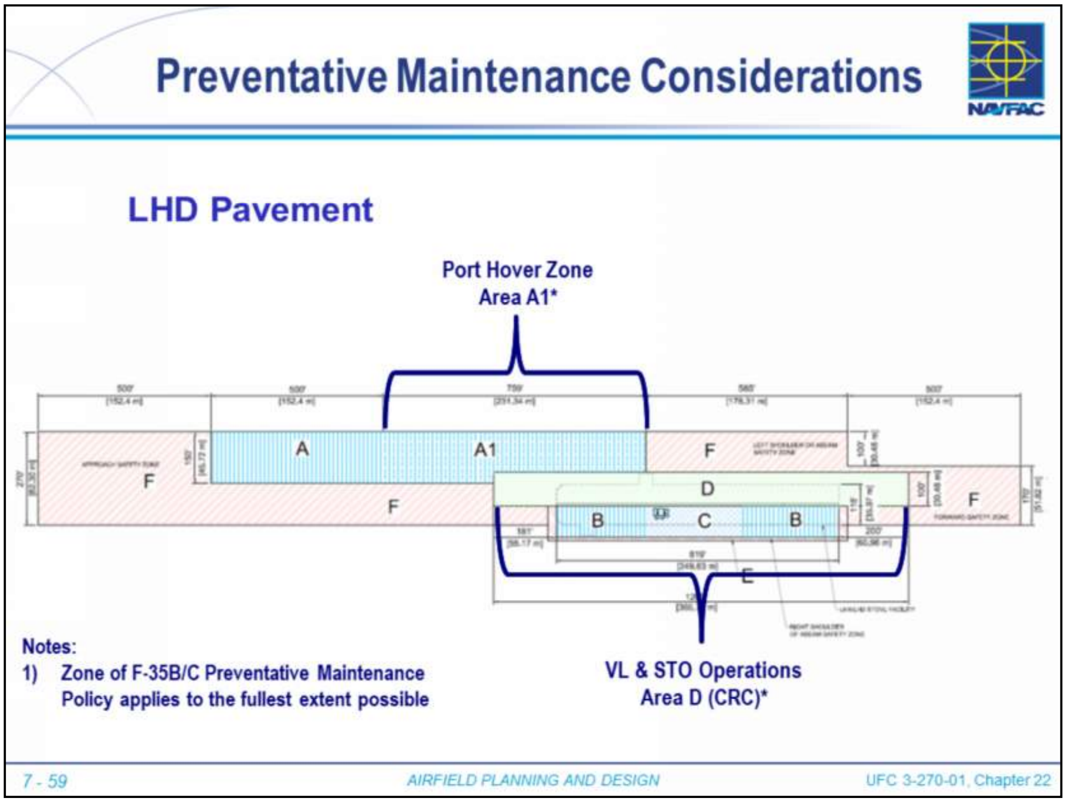
• Thought process of dimensioning of STO critical areas (these are repetitious and channelized events), from the start position, there is an offset of 400' aft, and 1,100 forward that is considered high risk of experiencing repetitious and channelized pressures resulting in early fatigue failures. Apply the policy the full width of the runway because a common work around to the fatigue failures has been for the aircraft to offset from the centerline at the start position.

• Thought process of dimensioning of Simulated Carrier Deck (SCD) critical areas (these are repetitious and channelized events as well), from the athwart bar (start of SCD box) and 1,300 feet aft are also considered high risk of experiencing repetitious and channelized pressures resulting in early fatigue failures. Apply this policy 50 foot right of centerline, and to runway edge left of centerline. This will accommodate 100, 150 and 200 foot wide runways.

• Thought process of why RVLs and SLs are not considered to require critical areas. These are repetitious events, but they are not channelized transversely and unlike operations they are dispersed longitudinally as well. Additionally, the power used for this maneuver is not potent to the pavements. There is a requirement for a 2,500 PCC overrun because of this dispersion, but it is not anticipated that early fatigue will occur from this action in one specific location.

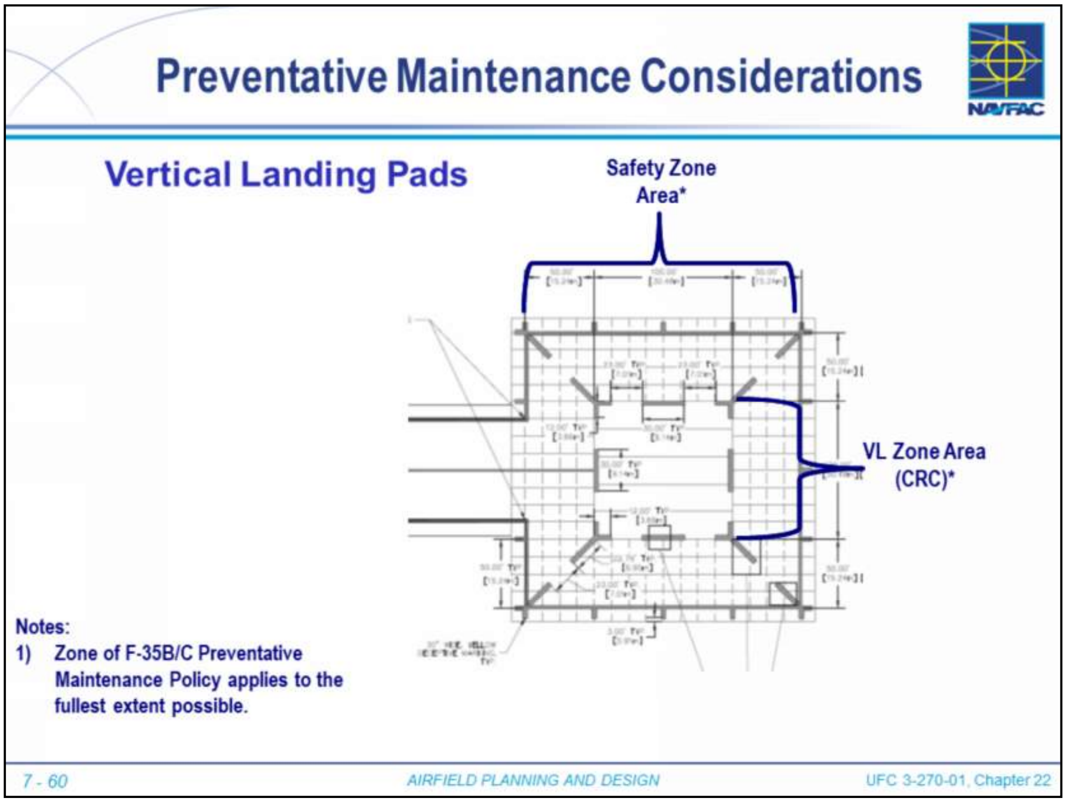
Definitions:

•CRC – Continuously Reinforced Concrete
•FCLP – Flight-Carrier Landing Practice
•HTC – Heat Resistant Concrete
•PJT – Plain Jointed Concrete
•RVL – Rolling Vertical Landing (Vertical Landing on runway with approach speed of ~40? Knots)
•SL – Slow Landing (Vertical Landing on runway with approach speed of ~60? Knots)
•STO – Short Take-off



1) Zone A and A1 requires plain jointed heat resistant concrete (PJHRC). In zone A1 all longitudinal and transverse joints are doweled.
2) Zone B requires PJHRC, and neoprene joint sealant to support MV-22 aircraft.
3) Zone C can be PJHRC or plain jointed Portland cement concrete (PJPCC).
4) Zone D requires continually reinforced high temperature concrete (CRHTC).
5) Zone E can be asphalt concrete (AC), PJPCC, or PJHTC.
6) Zone F can be asphalt concrete (AC), PJPCC, or PJHTC.

7) Areas A1 and D – same maintenance procedures at STO areas



1) VL Zone requires continually reinforced high temperature concrete (CRHTC).
2) Safety Zone can be plain jointed Portland cement concrete (PJPCC), or plain jointed heat resistant concrete (PJHTC).
3) Safety Zone area requires same maintenance procedures listed in ITG

Preventative Maintenance Considerations

Distress Severity	Description	Navy Maint. Policy Work Type	F-35 Maint. Policy Work Type
Medium	JT Seal Damage	No Loc. M&R	Joint Seal (Localized)
Medium	Small Patch	Patching - PCC Partial	Patching - PCC Full Depth
High	Small Patch	Patching - PCC Partial	Patching - PCC Full Depth
Medium	Large Patch	Patching - PCC Partial	Patching - PCC Full Depth
Medium	Joint Spall	Patching - PCC Partial	Patching - PCC Full Depth
High	Joint Spall	Patching - PCC Partial	Patching - PCC Full Depth
Medium	Corner Spall	Patching - PCC Partial	Patching - PCC Full Depth
Low	Corner Spall	Patching - PCC Partial	Patching - PCC Full Depth

Notes:

1. Apply zone of F-35B/C Preventative Maintenance Policy to the fullest extent possible when performing maintenance on continuously reinforced concrete.

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- Partial depth PCC repairs (aka spall repairs) will not be allowed.
- Previous partial depth PCC repairs will be replaced with full depth PCC repairs.

Preventative Maintenance Considerations

Distress Severity	Description	Navy Maint. Policy Work Type	F-35 Maint. Policy Work Type
Low	Block Cr.	No Loc. M&R	Patching – AC Deep
Medium	Block Cr.	Crack Sealing - AC	Patching – AC Deep
High	Block Cr.	Crack Sealing - AC	Patching – AC Deep
Low	Corrugation	No Loc. M&R	Patching – AC Deep
Medium	JT Ref. Cr.	Crack Sealing - AC	Patching – AC Shallow
Medium	L & T Cr.	Crack Sealing - AC	Patching – AC Shallow
Low	Shoving	No Loc. M&R	Patching – AC Shallow

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- Do not allow cracks to form in this area that propagate the full depth of the asphalt concrete layer.
- Do not allow conditions that indicate the disbanding of asphalt concrete layers.

STOVL Facility Issues: High Temp PCC

- UFGS 32 13 13.43 High Temperature Concrete Paving for Airfields Using Lightweight and Traprock Aggregates, Feb. 2018
  - Published February 2018
  - 3 Components for Heat Resistance
    - Aggregates
    - Polypropylene Fiber
    - Sodium Silicate
- UFC 3-270-01, Chapter 20
  - Maintenance of Heat-Resistant Concrete

•Spec is written to place continuously reinforced concrete pavements and plain jointed concrete projects, large and small (lump sum and pay for performance).

•3 Changes from standard PCC to achieve Heat Resistance

- •Aggregates – lightweight or traprock, proven to provide heat resistance
  - •Special aggregates likely not locally available. May require shipping long distances. $$$
- •Polypropylene Fibers (not required for V-22 only facilities)
- •Sodium Silicate
  - •Surface hardener applied after placement
  - •Spray-on liquid

STOVL Facility Issues: MV-22 Exhaust

Stationary for 10 minutes, the MV-22 can produce a surface temperature between 450 to 500° F producing progressive scaling after repeated cycling

Factors for concrete degradation:

1. **Thermal fatigue**
2. **Vapor pressure**
3. **Chemical degradation**

•Thermal Fatigue – expansion/contraction of materials heating and cooling

•Vapor Pressure – high pressure jet blast

•Chemical Degradation – POL leaks from engines soak into concrete, then when heated causes reaction in concrete

•Other studies are underway to find other sealants that can be applied to existing pavements

•MCAS New River Apron for MV-22

•Slabs under engine nacelles have been removed and replaced with HTC due to deterioration

High Temp PCC Mitigation and Maintenance Summary

- **Pavement Markings**
  - Expect debonding and discoloration
- **VL Pad and LHD Deck Surface Grinding**
  - 1/8th to ¼ inch
  - Every 3 to 7 years
  - 2 inch maximum
- **Surface Sealing**
  - Re-apply sodium silicate after grinding
- **Patching**
  - Partial Depth Patches prohibited in areas subjected to F-35B Short TO

•In summary, pavements subjected to high temperatures and jet blast require special attention and will demand maintenance different than traditional airfield pavements.

•Pavement Markings – expect markings to deteriorate rapidly

•Surface Grinding – Should be used to periodically renew the surface

•Surface Sealing – After grinding, apply sodium silicate again

•Patching – no partial-depth patches are allowed – must have mechanical interlock. Therefore, full-depth patches with tie bars and dowels are required when repairing medium or high severity corner and edge spalls.

- Chapter 9 applies to the following aircraft.
  - MQ-9A Reaper
  - MQ-1B Predator
  - MQ-1C Gray Eagle
  - RQ-4A/B Global Hawk
    - Requires Class B Runway to operate
  - MQ-4C Triton
  - RQ-7Bv2 Shadow (or earlier versions)
  - MQ-8B/C Fire Scout

- Because UAS are quickly developing, new criteria may be required as new systems are developed.

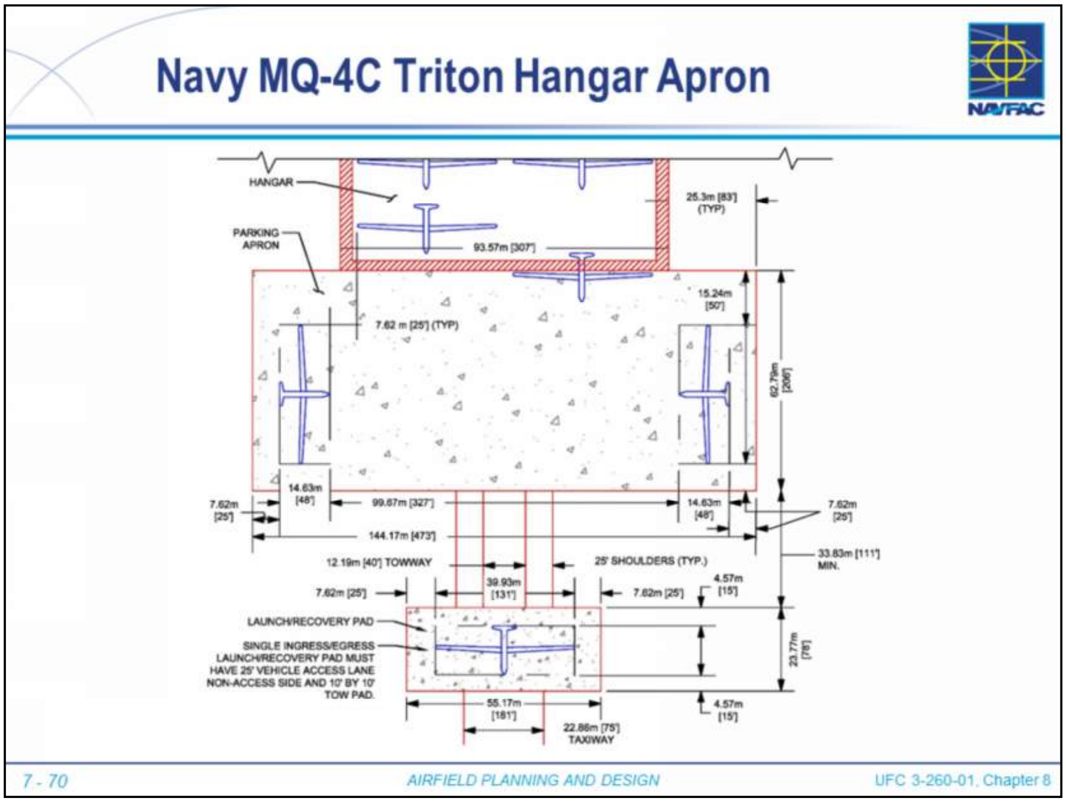
- UAS are radio-controlled
  - Need Line of Site (LOS) between the aircraft and the Antenna tower – holds several antennas necessary for UAS launch and recovery operations.
  - Location of the antennas is one of the most critical portions of the planning and design effort for our aircraft.
  - This creates a potential conflict with airspace clearances or other buildings on the airfield – tower must be considered when planning multiple facilities.
  - Example: a new hangar was being awarded before they started planning for the UAS. Only one location (behind the new hangar) on the airfield would work to provide LOS to the apron, launch points, taxiways and runways, and that tower will be ~100' tall to achieve needed LOS. The tower currently holds two UHF/VHF Line of Sight and three NTCS antennas. The NTCS antennas are used to communicate with local area traffic control.

Siting

- Runway location and orientation are paramount to airfield safety for UAS aircraft.
- Wind direction and velocity is a major consideration for siting runways.
- With respect to UAS operations, prevailing winds and velocities may actually prevent operations if the runway cannot be aligned with them.
- To be functional, efficient, and safe, the runway should be oriented in alignment with the prevailing winds, to the greatest extent practical, to provide favorable wind coverage.
- Wind data, obtained from local sources, for a period of not less than five years, should be used as a basis for developing the wind rose to be shown on the airfield general site plan.

- Geometry, Grading and Airspace are included for different UAS

- UAS-only runway at Ft Drum, NY
- Note:
    - Short runway
    - UAS designator
    - Minimal centerline marking



- Figure 9-10. Hangar, Apron, and Launch/Recovery Pad.
  - Facilities and configuration to allow the GPS codes to be incorporated into the aircraft's mission plan for airfield ground taxi operations.
  - The aircraft will utilize the UAS launch point for all programmed start and stop airfield operations.
  - UAS dedicated aprons do not require peripheral taxiways.

- NOTES.

1. This is a basic apron layout and may be site adapted to meet additional customer requirements.
2. Layout of parking apron and Launch/Recover pad allows for simultaneous operations. An offset of 111' is required.
3. An offset of 25' is required between pavement edge and wingtip clearances for maintenance and safety.
4. Wingtip clearance radii are based on a 45-degree turn.
5. Peripheral taxiway for hangar apron is not included

Navy MQ-4C Triton Hangar Apron

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- Rendering for an MQ-4C Triton Hangar
- Apron space in front of hangar
- Does not include Launch/Recovery Pad

- Hangar P-154 at Mayport Naval Station, Jacksonville, FL

Navy MQ-4C Triton Hangar Apron

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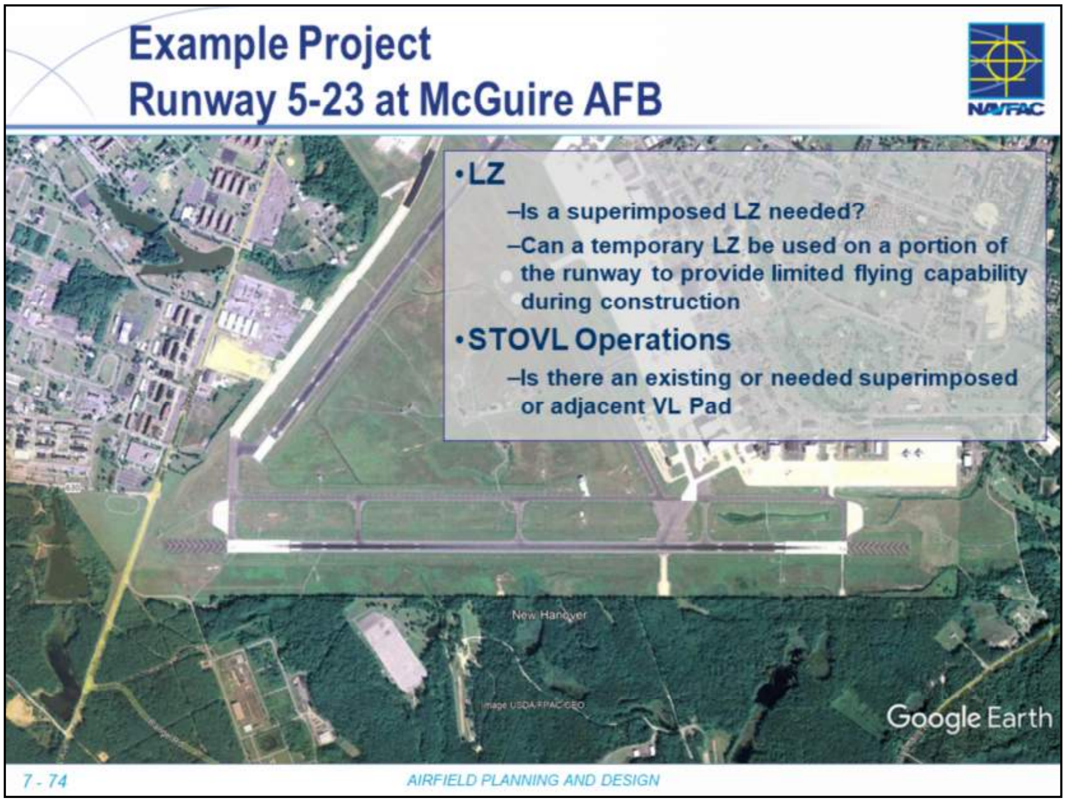
- Hangar P-154 at Mayport Naval Station, Jacksonville, FL



- Landing Zone
    - Determine whether there is a need for a superimposed LZ on the runway. C-17? C-130?
    - Markings
    - Lighting – overt/covert?
- STOVL
    - VL Pads needed?
    - VL Pads active during construction?

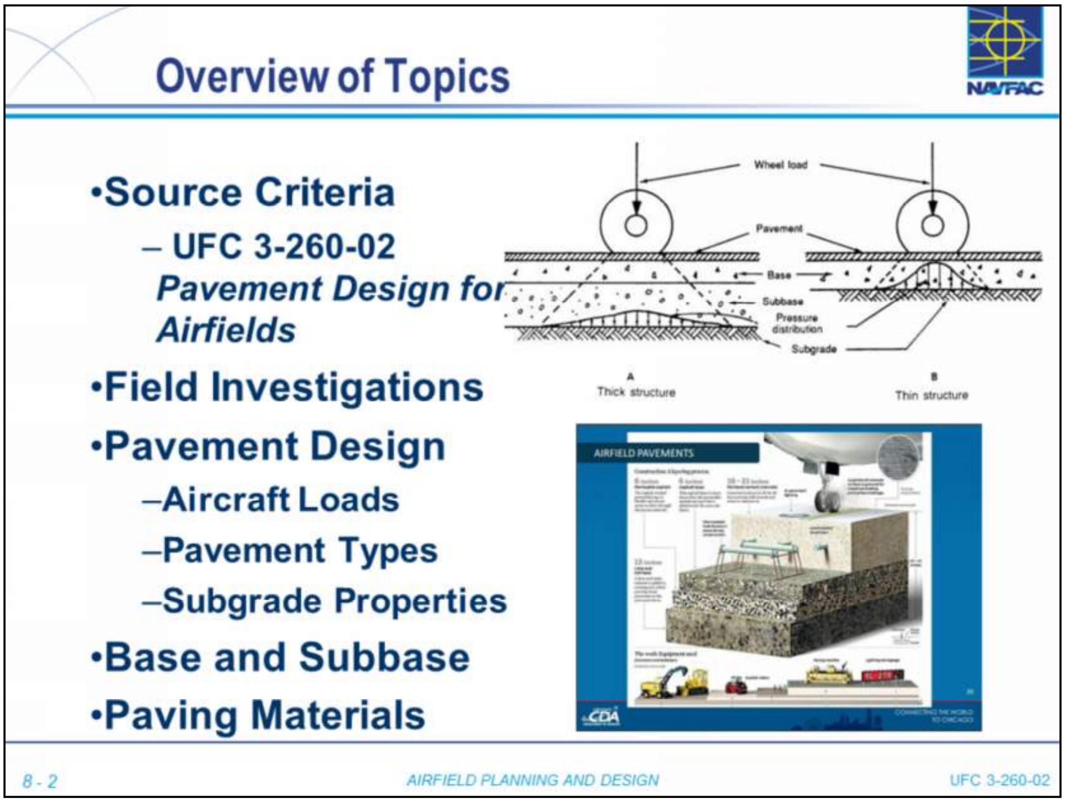
- Key Points of Section
  - Landing Zones
    - C-17 and C-130
    - Narrower, shorter
    - Contingency Operations
  - STOVL
    - LHD, VL Pad, FOB, OLF
    - Standard Drawings Available
    - Special Materials Requirements
  - UAS
    - Antennas need line of site to all places UAS operates
    - Unique geometric requirements for each UAS type

- LHA/LHD
- VL Pads
- Clear Zones well defined by trees

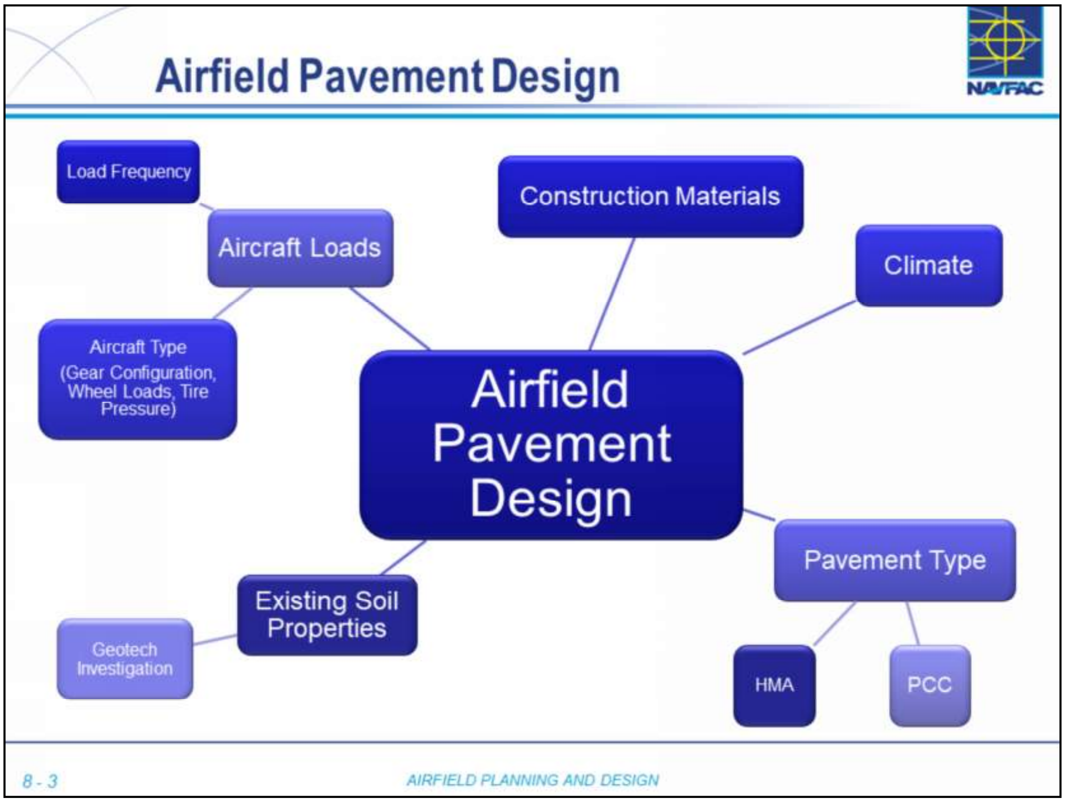
Section 8
Airfield Pavements Design and Evaluation

AIRFIELD PLANNING AND DESIGN
CRITERIA TRAINING

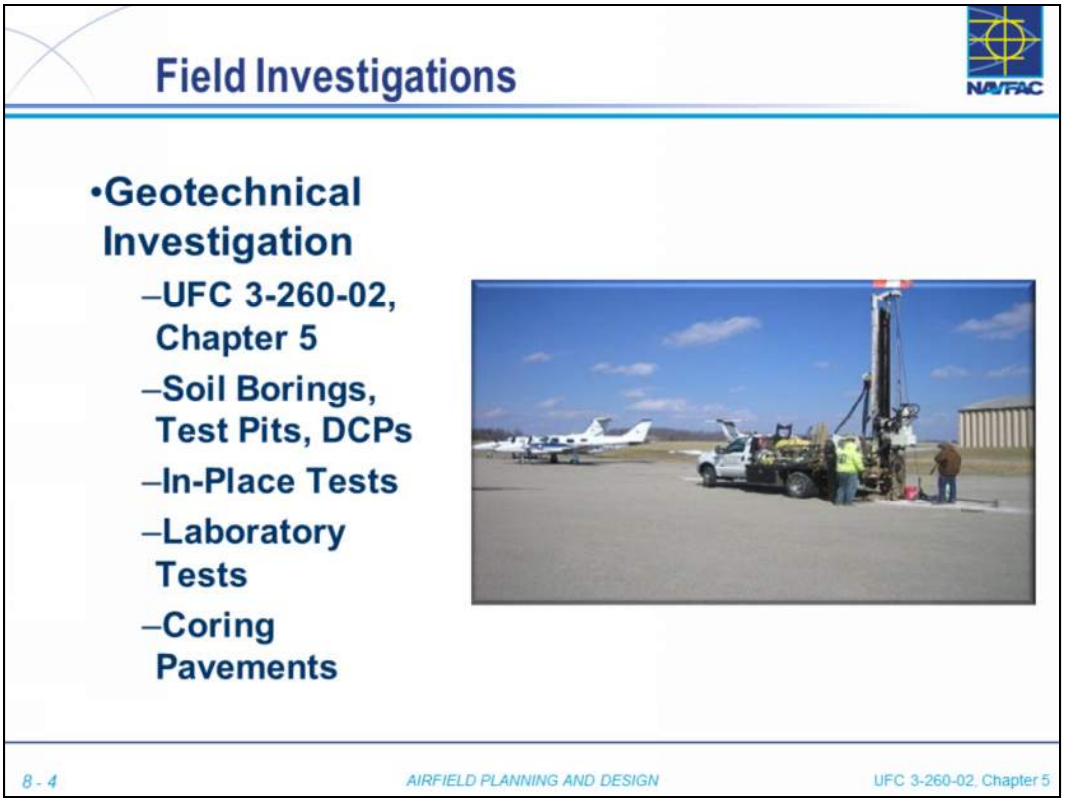
5/8/2023



- UFC 3-260-02 specifies pavement design procedures
    - Field Investigations
    - Pavement Designs
        - Aircraft Loads and Types
        - Pavement Types
        - Subgrade Properties
    - Base and Subbase Types, Minimum Thickness
    - Paving Materials described
    - PCC Jointing Details
- Quality pavements are critical for successful operations



- Many factors go into developing a pavement design for an airfield project
    - Aircraft Loads
    - Existing Soils – Subgrade Support Conditions
    - Construction Materials
    - Pavement Type
    - Climate

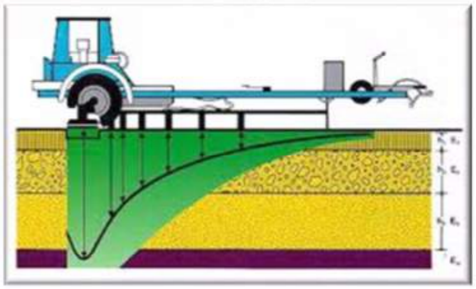


- Geotechnical Investigation
  - See UFC 3-260-02, Chapter 5 for guidance
- Geotech investigation should include soil borings – 10-ft depth typical
  - Test pits when possible, especially on new construction (not reconstruction)
  - Dynamic Cone Penetrometer tests can be useful to identify insitu layer strengths and thicknesses
- In place tests can include CBR (through corehole) or plate bearing (in test pits)
- Common laboratory testing includes soil classification (gradation, LL, PL), Proctor, soaked CBR

  •Plate bearing tests are ideal for PCC pavements, but very difficult to accomplish in practice.
  - Soaked CBR on Modified Proctor for design subgrade strength
  - Subgrade Strength based on existing soils unless stabilization is included in design (85th Percentile)
- Pavement Cores – useful for determining existing pavement structures – sometimes pavement cores and base course thickness are determined without doing a 10-ft boring

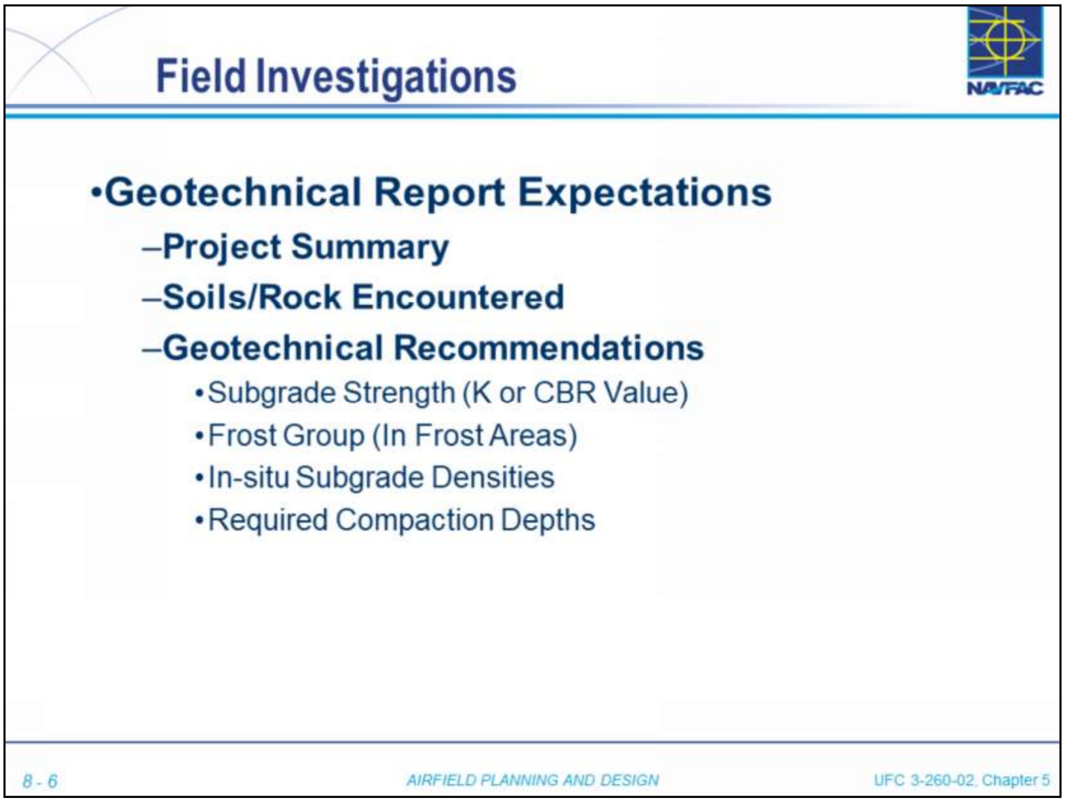
Field Investigations

- **Geotechnical Investigation (cont'd)**
  - **Non-Destructive Testing (NDT)**
    - Heavy Weight Deflectometer (HWD)
  - **Evaluate**
    - Local Borrow Sources
    - Local Aggregate Sources

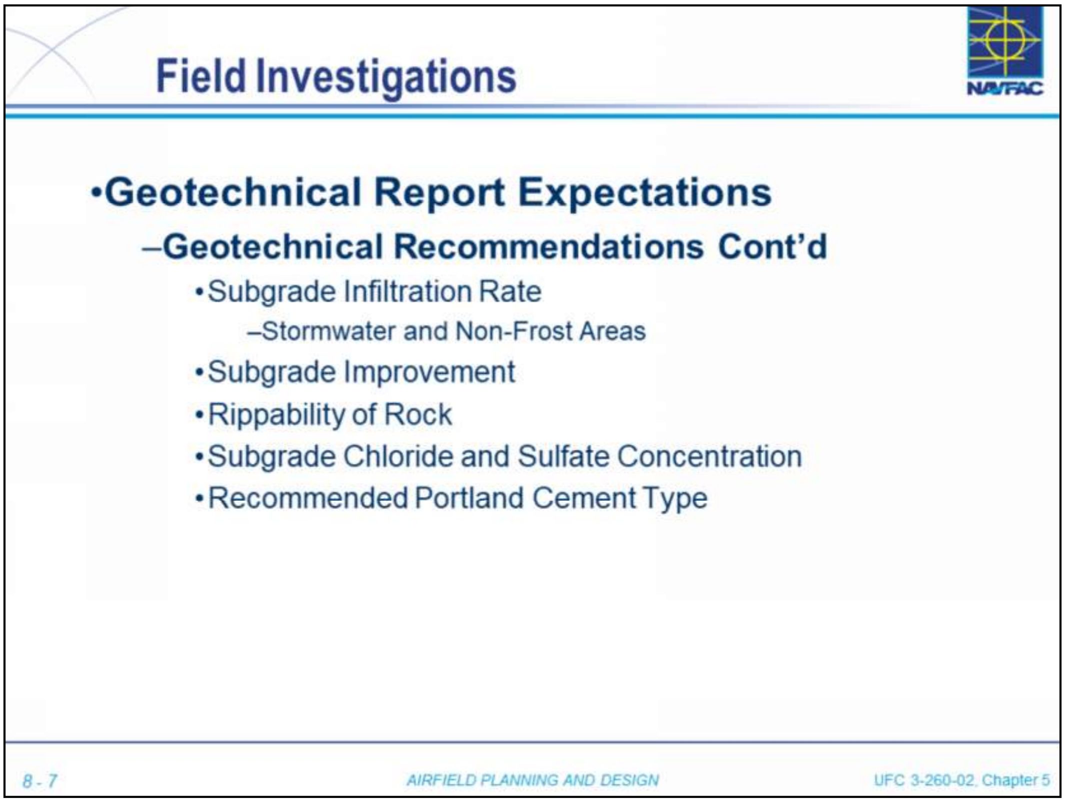


8 - 5 AIRFIELD PLANNING AND DESIGN UFC 3-260-02, Chapter 5

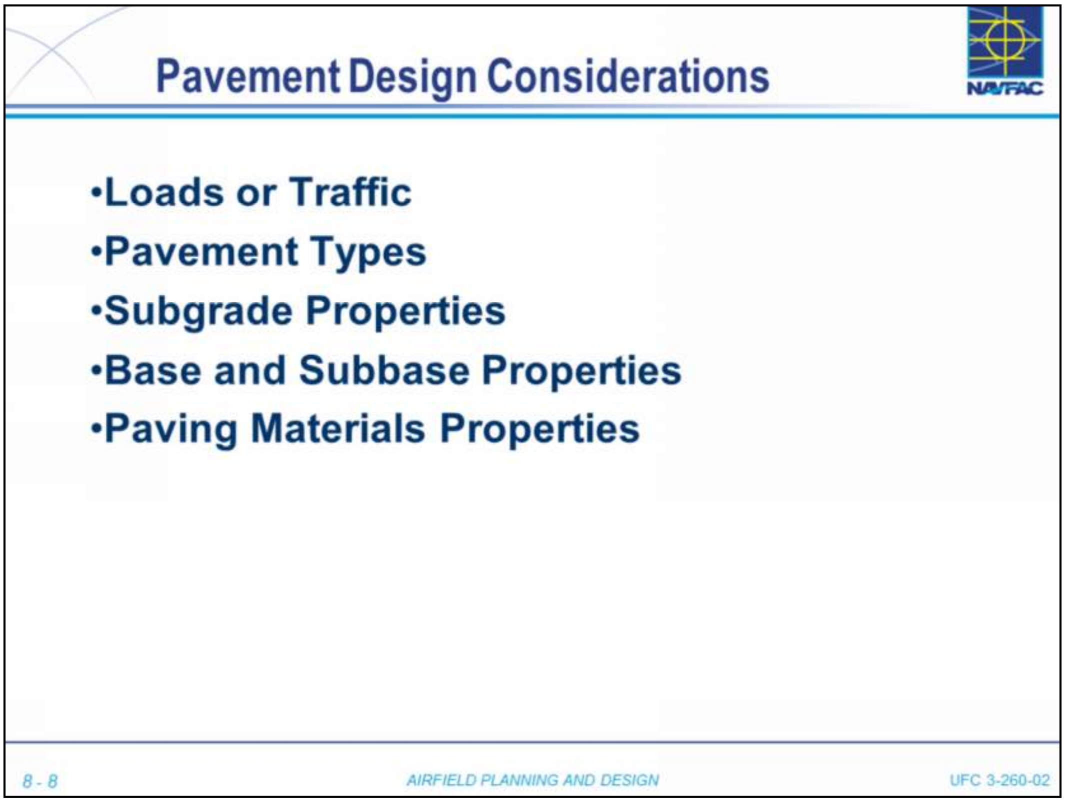
- Geotechnical Investigation
  - NDT with HWD is good for testing large expanses of pavements to identify weak zones – often good to do this before cores/bores to find those weak zones.
  - Geotech investigation may evaluate
    - Local Borrow Sources for embankment fills – more cost effective for on-site soils
    - Local Aggregate Sources – sometimes do testing to determine suitability of local aggregates (durability, ASR) for paving materials
  - Geotech Investigation is essential to good design
    - Don't skimp on investment
    - Reduces risks during construction because identifies potential problems and pitfalls



- Geotechnical Report Expectations
  - Must be thorough and follow guidance
  - Certified Testing Laboratories
  - Reports should be more than just boring logs and lab test data.
  - Should include interpretation of results and recommendations
  - Project Summary – general description of project. Geotech Engineer needs to understand the intent of the project to make good recommendations.
  - Description of Soils/Rock encountered – identify whether soils are native or fills, how those soils compare to expectations
  - Geotechnical Recommendations – synthesis of field and lab results to make design recommendations
    - Subgrade strength – interpret test results and discuss potential variability in strength over site
    - Frost Group – typical frost depth and soil susceptibility to weakening
    - In-situ subgrade densities – identify loose, poorly compacted soils
    - Required compaction depths – identify required compaction depths per UFC 3-260-02



- Geotechnical Investigation (cont'd)
  - Subgrade Infiltration Rate – important for stormwater runoff modeling and subsurface drainage
  - Subgrade Improvement – if weak subgrade, recommend materials/procedures/options for improvements (e.g. lime, cement, etc.)
  - Rock – if shallow rock is encountered – can it be cut by a trencher or ripped by a dozer?
  - Chloride and Sulfates in soils – high levels in soils/groundwater can attack base materials
  - Portland cement – identify appropriate type for subgrade chemistry (e.g. low alkali)



- Several factors go into a pavement design
    - Understanding each of these items is critical to ensuring a well-designed and constructed pavement that will perform as needed to support the mission.

- Following slides will address each of these items

Aircraft Loads

- Aircraft traffic is critical component of the pavement design
  - Aircraft types (gear configurations)
  - Maximum gross weight of each aircraft type
  - Lateral wander associated with each aircraft type
  - Predicted number of operations of each aircraft type of the design life of the pavement.
  - Expected life of pavements
    - Minimum design life for Navy and Marine Corps is 20 years
- For Design-Build Acquisition, very important to define design traffic in Requirements Document

Loads

NAVFAC

- **UFC 3-260-02, Chapter 4**
- **Individualized Traffic**
  - –Navy
  - –Use standard design aircraft types when site-specific loadings are not available

Standard Design Aircraft Types

Landing Gear Assembly	Representative Aircraft	Tire Pressure Mpa (psi)	Design Gear Load, kg (lb)
Single	F-14	1.65 (240)	13,608 (30,000)
Dual	P-3	1.31 (190)	30,845 (68,000)
Single Tandem	C-130	0.65 (95)	38,100 (84,000)
Dual Tandem	C-141	1.24 (180)	70,310 (155,000)
Twin Delta Tandem	C-5A	0.79 (115)	86,190 (190,000)

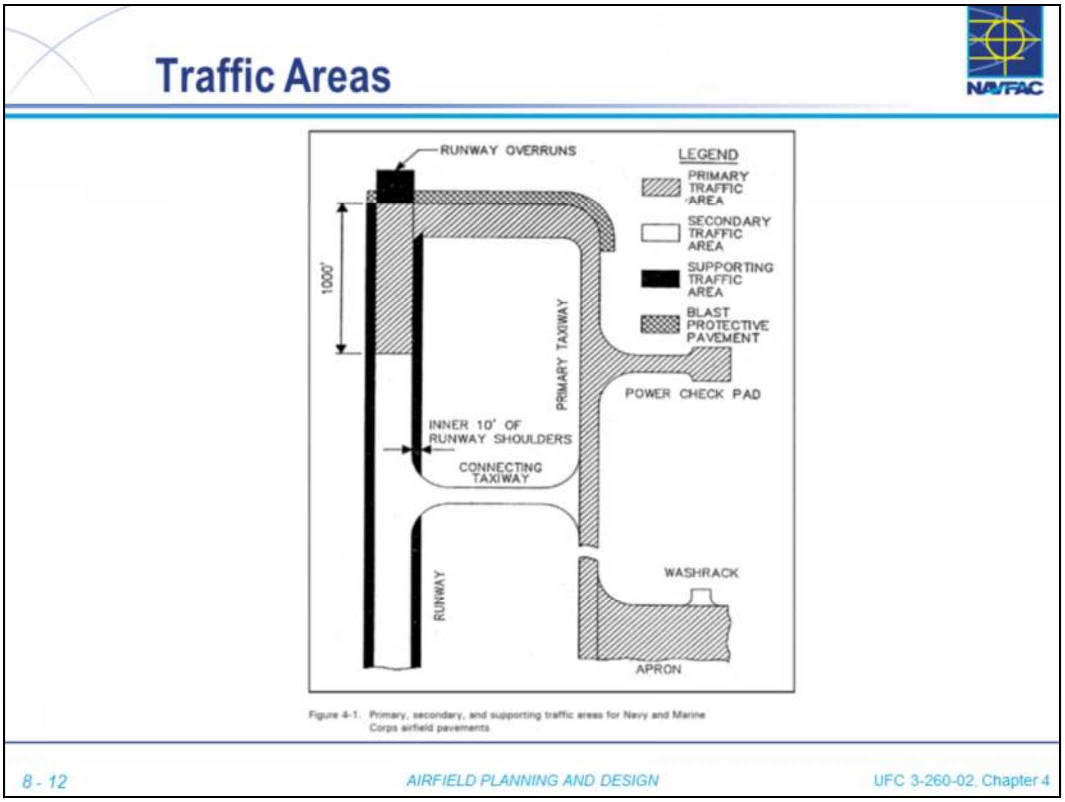
8 - 10 AIRFIELD PLANNING AND DESIGN UFC 3-260-02, Chapter 4

- UFC 3-260-02 defines the loading requirements for airfield pavement design – should be listed on DD1391
  - Chapter 2 – Army
  - Chapter 3 – Air Force
  - Chapter 4 – Navy
- **Navy** - Use traffic mix specific to your airfield
- Shoulders and Overruns
  - Navy: Designed to support 10,000 lbs single wheel load with 100 psi tire pressure. Number of coverages is not specified.
  - Army: 5,000 coverages by 10,000 lbs. single wheel with 100 psi tire pressure
  - Air Force:
    - Shoulders: 5,000 coverages by 10,000 lbs. single wheel with 100 psi tire pressure.
    - Overruns: See traffic in Table 3-1. Dependent on Airfield Type
- CAUTION: Do not over-design or under-design pavements. Be realistic.
- Get Service SME to verify aircraft traffic if uncertain

- **NOTE**: Navy will be updated standard traffic and pass intensity levels in the next 3-260-02 update.

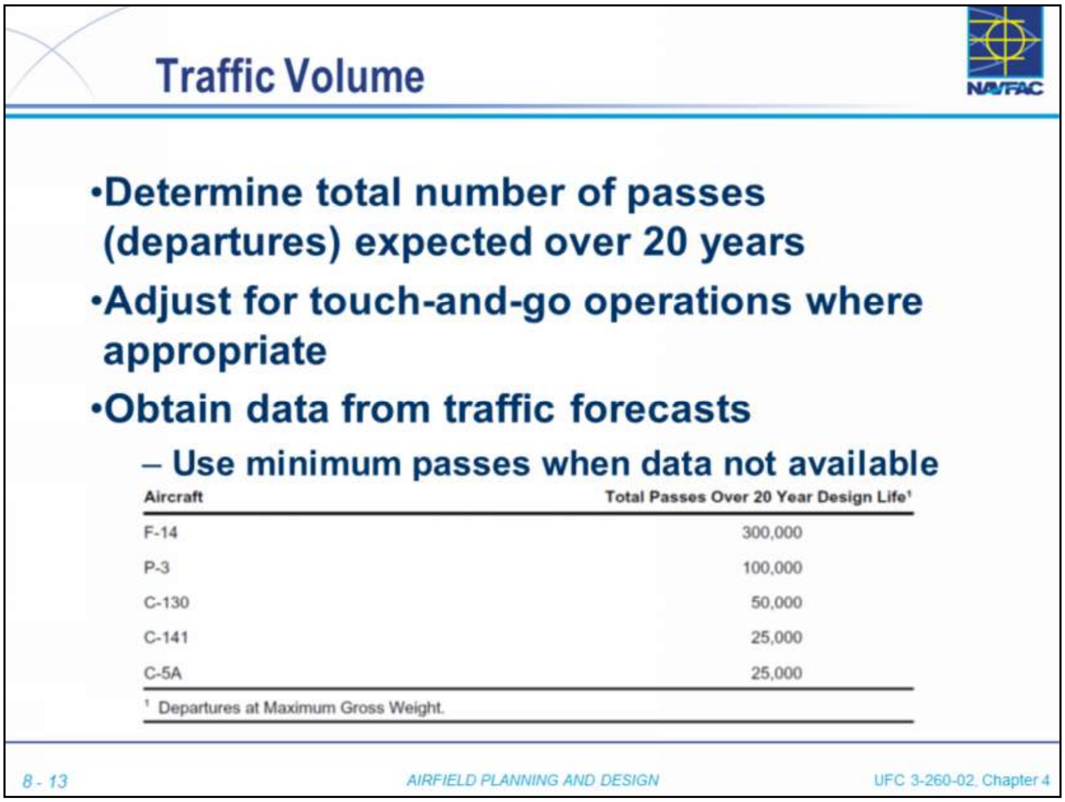
Loads

- Overruns
  - Chapter 10, Para 8c
  - AC Surface Course
  - Design for 200 passes at 75% gross weight of design aircraft
- Blast Protection Areas
  - Design for 200 passes at 75% gross weight of design aircraft
- Shoulders
  - Design for 200 passes at 75% gross weight of design aircraft



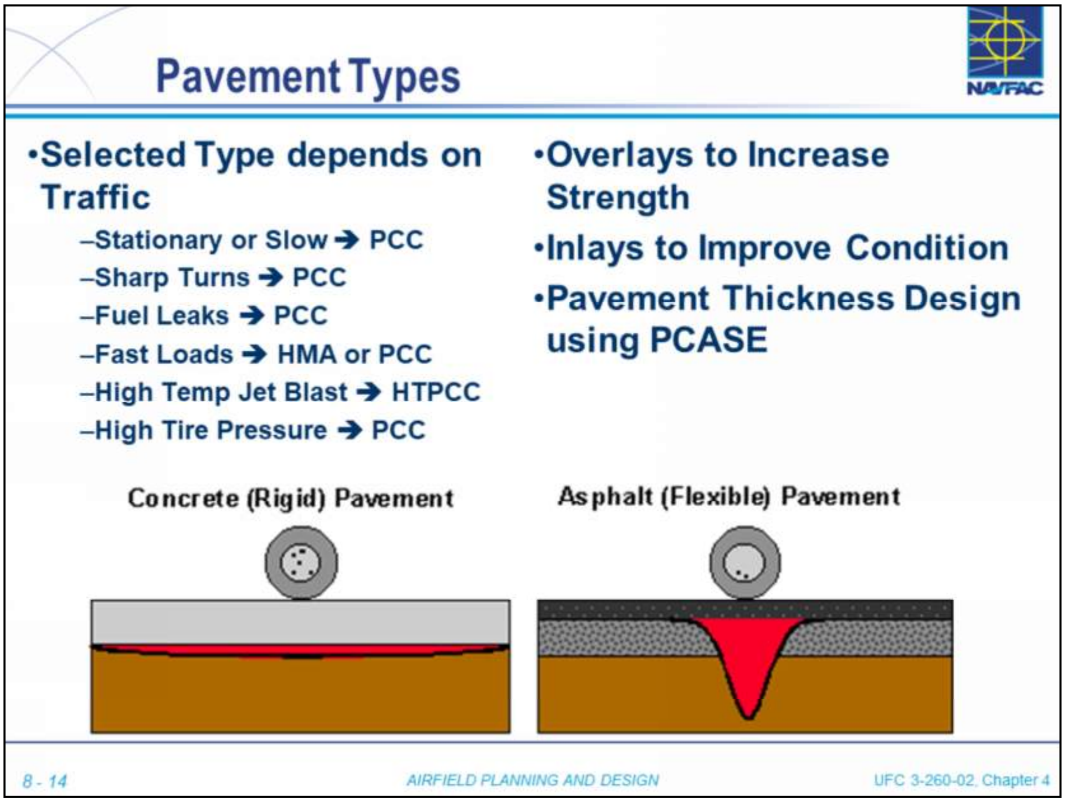
- Example Figure 4-1 used to define the different traffic areas for Navy – Primary, Secondary and Supporting.
    - 1,000 ft Runway Ends are Primary
    - Parallel Taxiway and End Connectors are Primary
    - Runway center portion and secondary connectors are Secondary
        - This is because aircraft is moving faster in middle portion of the runway, plus traffic is more widely distributed
    - Aprons are Primary
    - Shoulders and Overrun are Supporting

- **NOTES**:
    - Figure will be updated in next publication of UFC 3-260-02.
    - Figure is incompatible with PCASE design because Traffic Areas A, B, C, D must be selected in PCASE, but are not defined in this figure.
    - Until publication, Navy designers should follow Air Force Modified Heavy figure to determine Traffic Areas A, B, C or D.



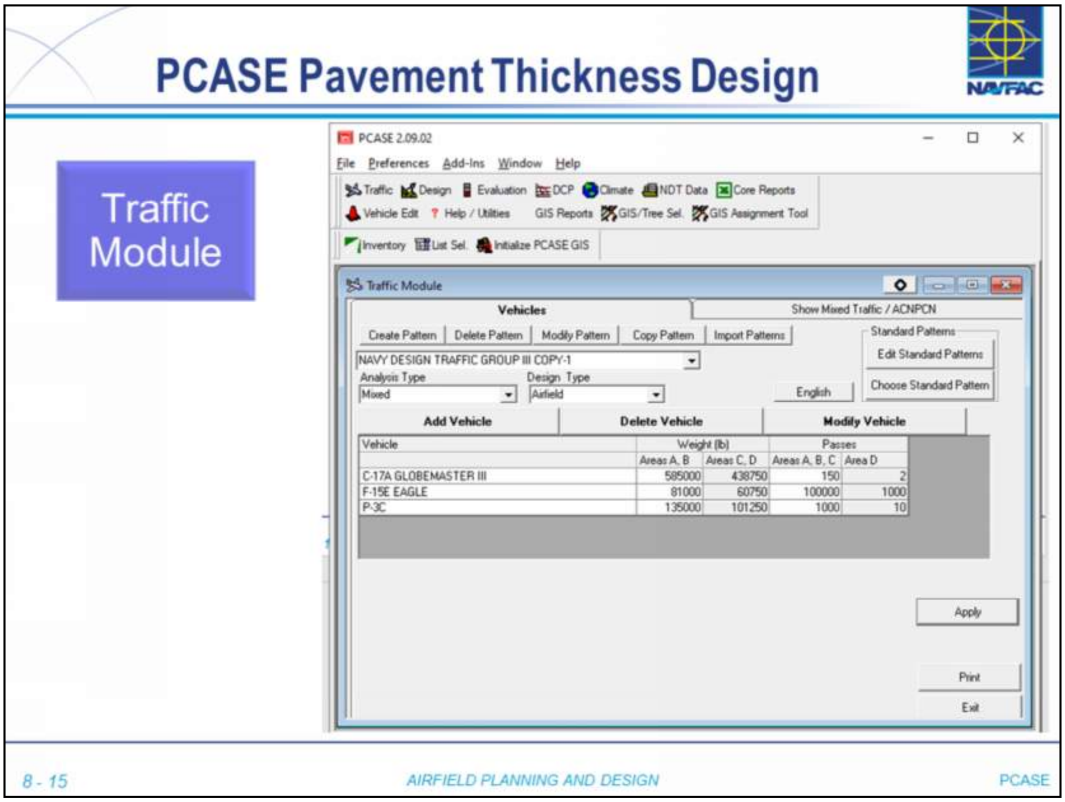
- DoD traffic is number of passes for total life of pavement, not annual departures like FAA design.
- In PCASE, program can design for individual aircraft or Mixed Traffic
    - Mixed Traffic – used for DoD designs
    - Individual Traffic – used for pavement evaluation purposes
- If available, use forecast traffic mix for the airfield
- Also check combined mixed traffic listed in table.
- Use most conservative (thickest) result

- **NOTE**: This table will be updated in future UFC 3-260-02 publication to current aircraft and pass levels

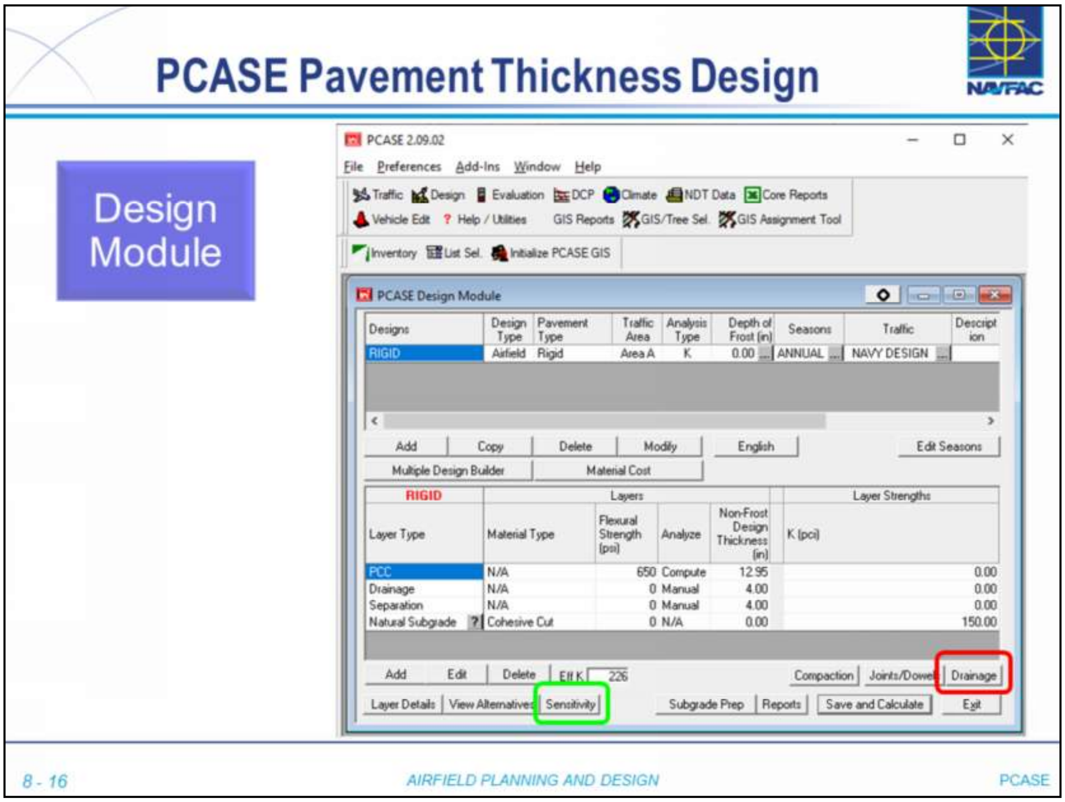


- Determine what pavement type is most suitable for the expected aircraft traffic loads.
- Different factors play into the pavement type decision, including:
  - Stationary or slow-moving loads favor PCC (Aprons)
  - Sharp turn areas favor PCC (aprons and runway ends)
  - Areas with fuel spills favor PCC (aprons)
  - Fast-moving loads can be either PCC or HMA
    - Life-cycle cost analysis may be needed
  - F-35B or V-22 hot exhaust – High temperature PCC is required
  - High Tire Pressure – many fighters now have tire pressures over 300 psi. This requires PCC per UFC.
- Depending on the existing pavement structure (and the condition) overlays, inlays, or some other approach may be appropriate.
- Specialized unpaved airfields (Landing Zones) are sometimes constructed for contingency or training operations
- Chapter 4, Para 8. PAVEMENT DESIGN POLICY. The Navy recognizes PCASE rigid and flexible pavement design programs and consensus industry standard programs in addition to the traditional Navy rigid pavement design program. Designers are encouraged to consider life cycle costs when designing new pavements. When the life of the pavement can be extended by more than 10 times, it is acceptable to increase the pavement thickness by 1 inch or less as determined by the Navy's traditional rigid pavement center panel loading procedure. Use of the Army/Air Force edge loading condition is another way to provide for improved pavement life cycle costs. Designers shall complete a sensitivity analysis of the above-mentioned programs and review with the senior airfield designer in their geographic area of responsibility.
- Life cycle cost should be used for pavement type determination when both HMA and PCC are suitable.

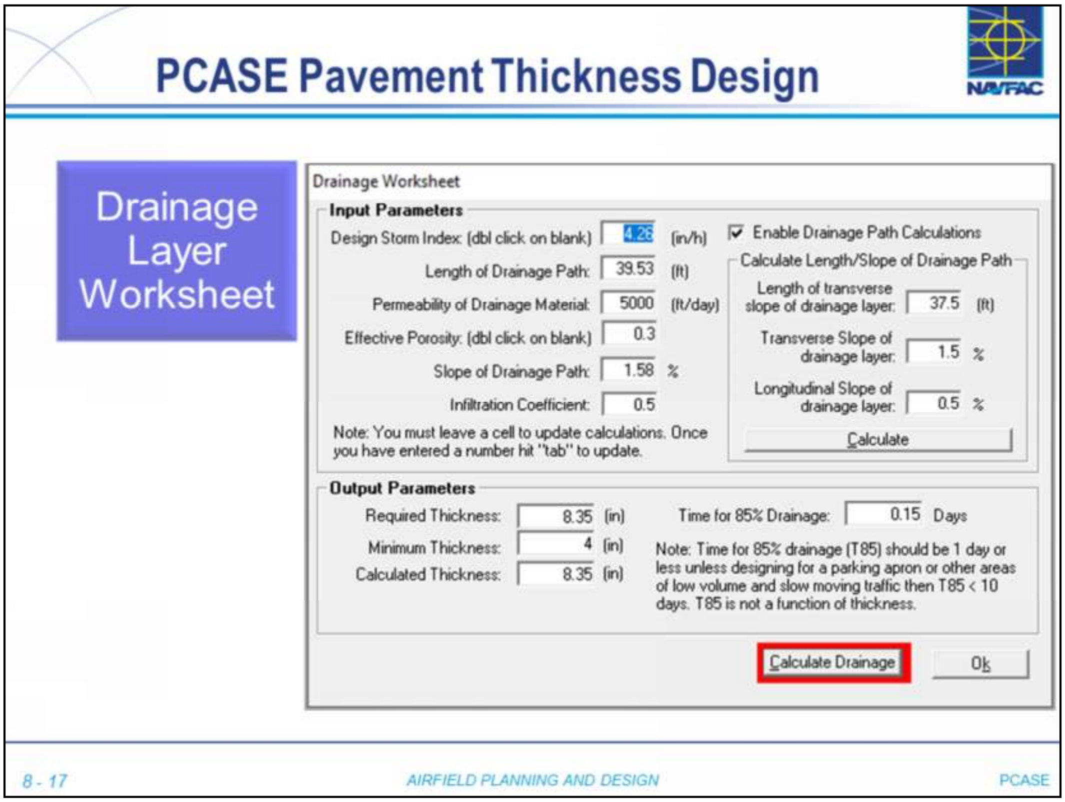
- NOTE: Although reinforced pavement design procedures are described in UFC 3-260-02, in practice only Plain Jointed PCC pavements are used on military airfields (except special situations for HTC like LHD and VL Pads). Reinforcement complicates construction, and more importantly, greatly complicates bomb damage repair.



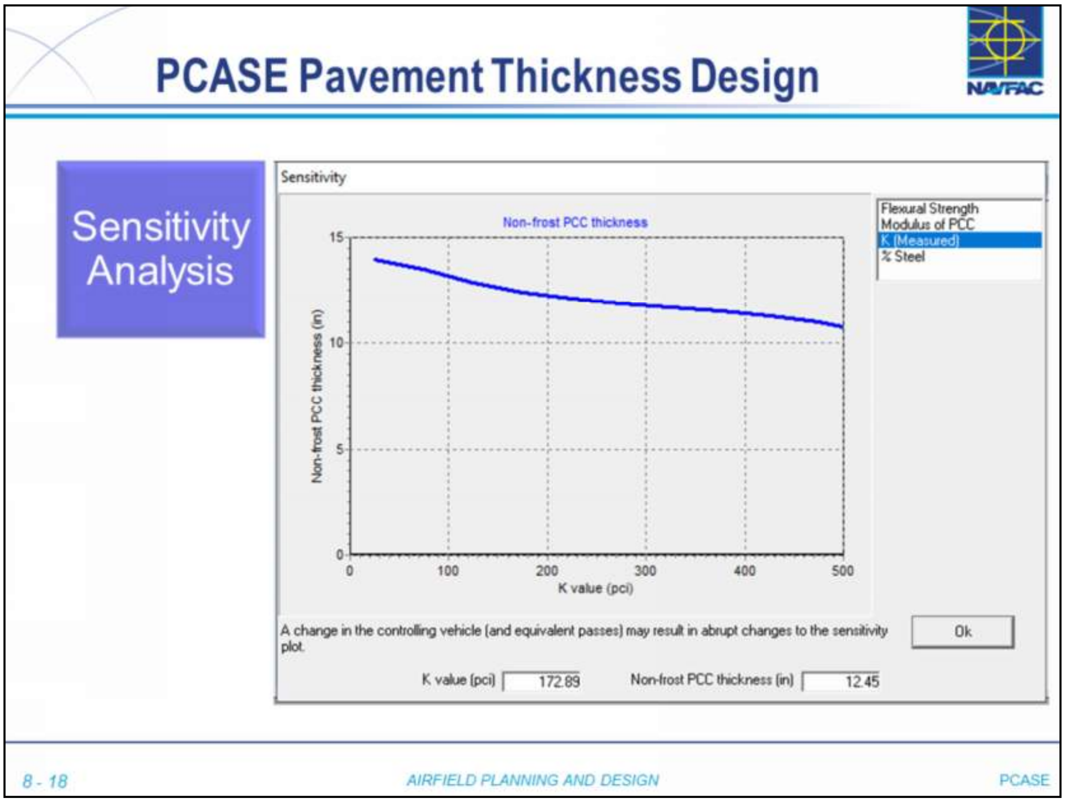
- Pavement Transportation Computer Assisted Structure Engineering (PCASE)
- PCASE v 2.09.03
  - Free download (https://transportation.erdc.dren.mil/pcase/)
  - Relatively Straightforward
  - Training Workshops Available through USACE - TSC
  - Traffic Module
    - Standard or Customized Traffic Patterns
    - Broad Aircraft Database
    - Adjust Weight and Passes (over entire pavement life, not annual)



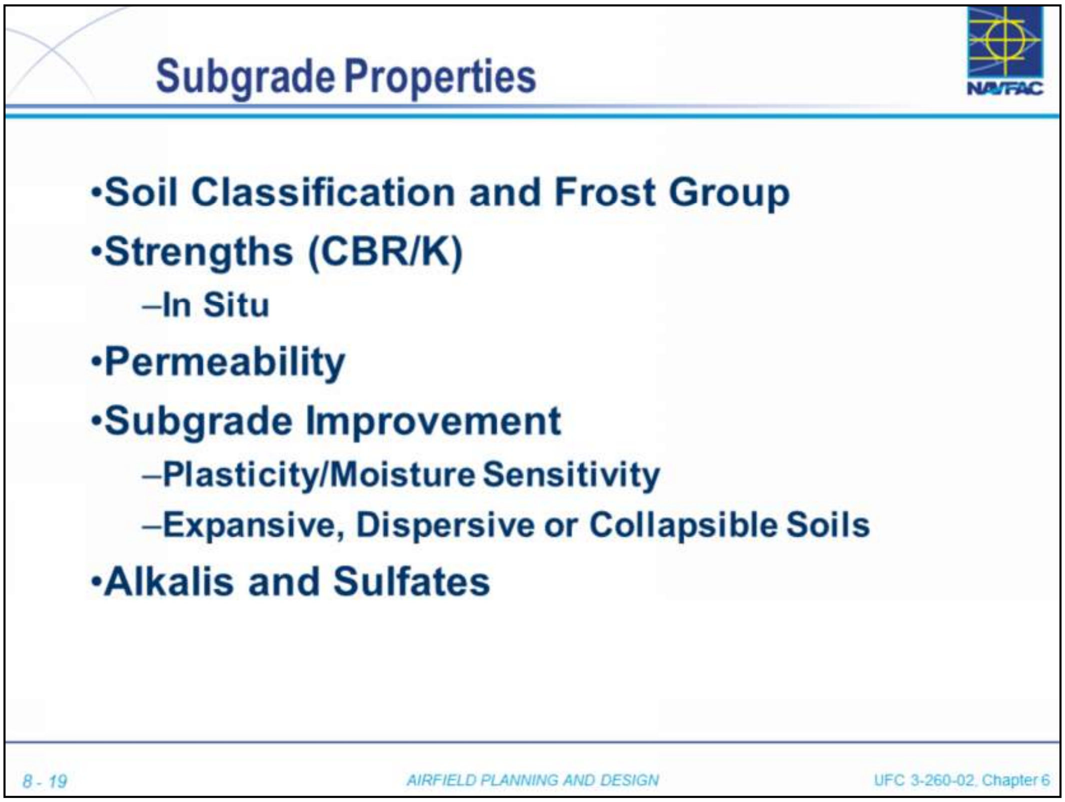
- Design Module
    - Airfield or Roadway pavement
    - Rigid (PCC) or Flexible (Asphalt) pavements
    - Drainage Layers
    - Base Course Layers
    - Subgrade – strength in K (rigid) or CBR (flexible)
- Will explain the Drainage and Sensitivity features



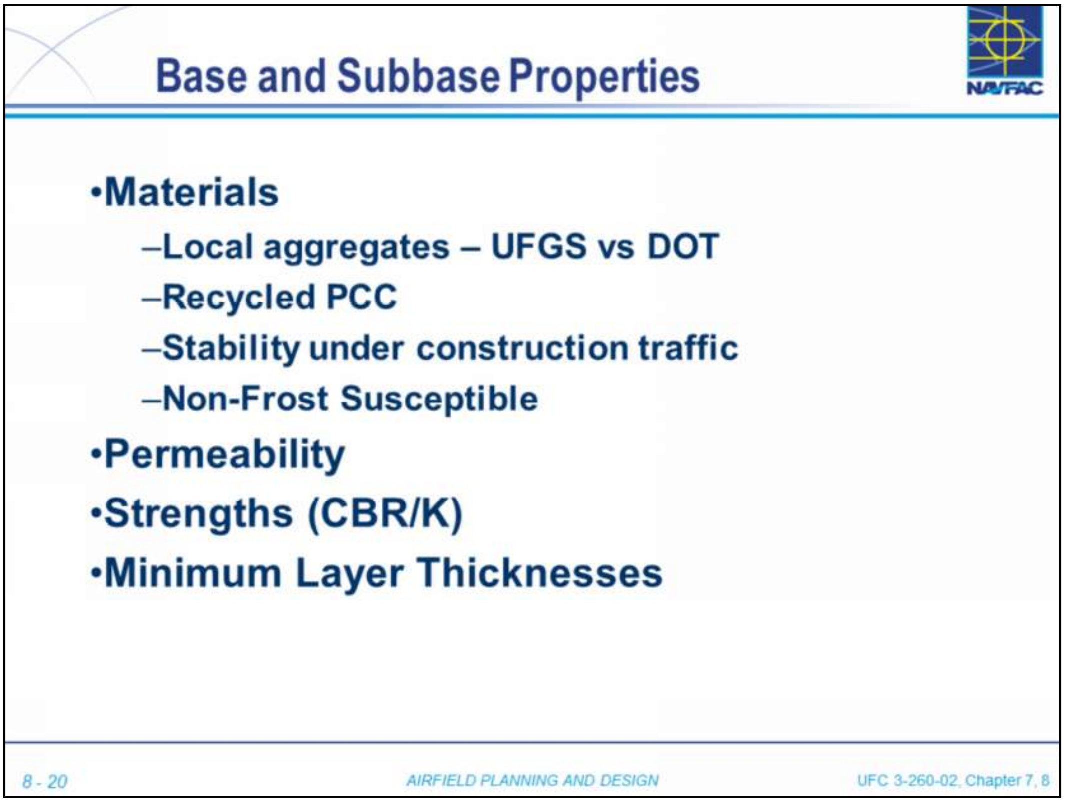
- Drainage Layer Worksheet
  - Used to calculate DL thickness
  - Multiple variables to input
    - Design Storm Index
    - Pavement Slopes
    - Permeability
    - Porosity



- Built-in Sensitivity Analysis for thickness vs.:
    - PCC Flexural Strength
    - Modulus of PCC
    - Subgrade Strength (k)
    - % Steel



- The subgrade is the foundation for the pavement and is very important to successful performance of the pavement structure
- Determine Soil Classification (Clay, Silt, Sand, Gravel)
    - Frost Group dependent on Soil Classification, <#200 Sieve Fraction
    - Frost Group often is controlling factor in design subgrade strength
- Strength - Determine design strength in laboratory from soaked CBR test
    - In Situ test from NDT or DCP, but not necessarily used for design
- Permeability important when determining whether Drainage Layer is required
    - DL required when subgrade permeability < 20 ft/day
- Decide whether subgrade improvement is needed
    - Soils sensitive to changes in moisture content may require improvement
        - If structural credit taken for stabilization, then strict UFGS specifications for stabilization (including QC) are required
    - Sometimes build a “construction platform” to improve schedule adherence and limit weather delays, but with no structural credit
- Special circumstances sometimes impact treatment or overlying materials
    - Sulfates in soil/groundwater can attack crushed PCC resulting in pavement heaving (Holloman AFB)
    - Highly alkali soils/groundwater can promote alkali-silica reaction



- Locally-available base and subbase materials can be an economical way to build pavements with local materials
    - Check local DOT specifications (quality and gradations) and compare to UFGS
    - Consider the availability of crushed, recycled PCC as a base or subbase material
        - Beware of re-using crushed PCC if the old PCC had alkali-silica reaction
        - Check TSPWG M 3-250-07.07-7 (old AF ETL 07-06) for Risk Assessment for Recycled Concrete Use
    - Stability is important for constructability
    - Beware of old sand layers – were commonly used in old pavement construction under PCC. Sands can be uniformly graded and very unstable under wheeled traffic, requiring removal or cement stabilization to support construction traffic
- Permeability important for drainage layer materials – avoid too much <#200 material
- Be conservative in strength assumptions, particularly if re-using existing base layers.

Pavement and Base Minimum Layer Thickness – Flexible Pavement

Table 8-4
Minimum Flexible Pavement Surface and Aggregate Base-Course Thickness Requirements for Navy and Marine Corps Flexible Pavement Airfields

Aircraft Gross Weight kg (kips)	Tire Pressure MPa (psi)	Minimum Thicknesses, mm (in.)		
		Surface	Base[1]	Total
< 5,440 (<12)	All pressures	50 (2)	152 (6)	203 (8)
5,440 to 13,600 (12 to 30)	<1.38 (200)	76 (3)	152 (6)	228 (9)
5,440 to 13,600 (12 to 30)	1.38 (200) or greater	102 (4)	203 (8)	305 (12)
>13,600 (>30)	All pressures	102 (4)	203 (8)	305 (12)

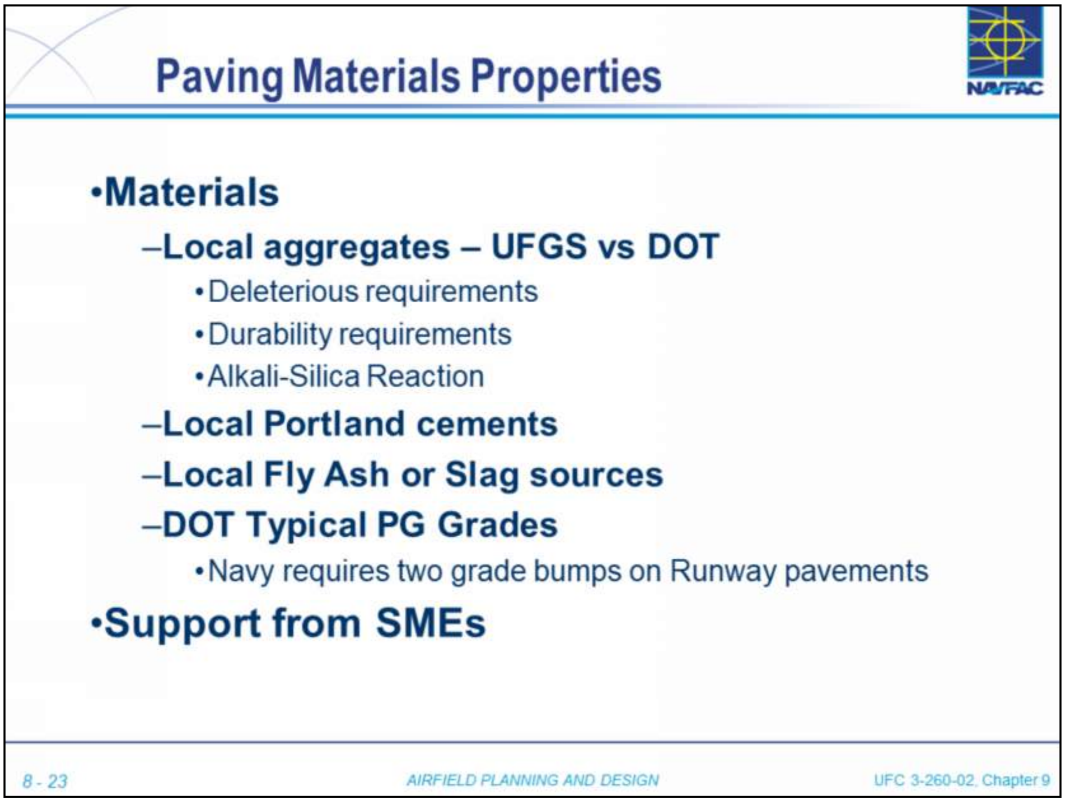
[1] Unbound or stabilized.

Base Minimum Layer Thickness – Rigid Pavement

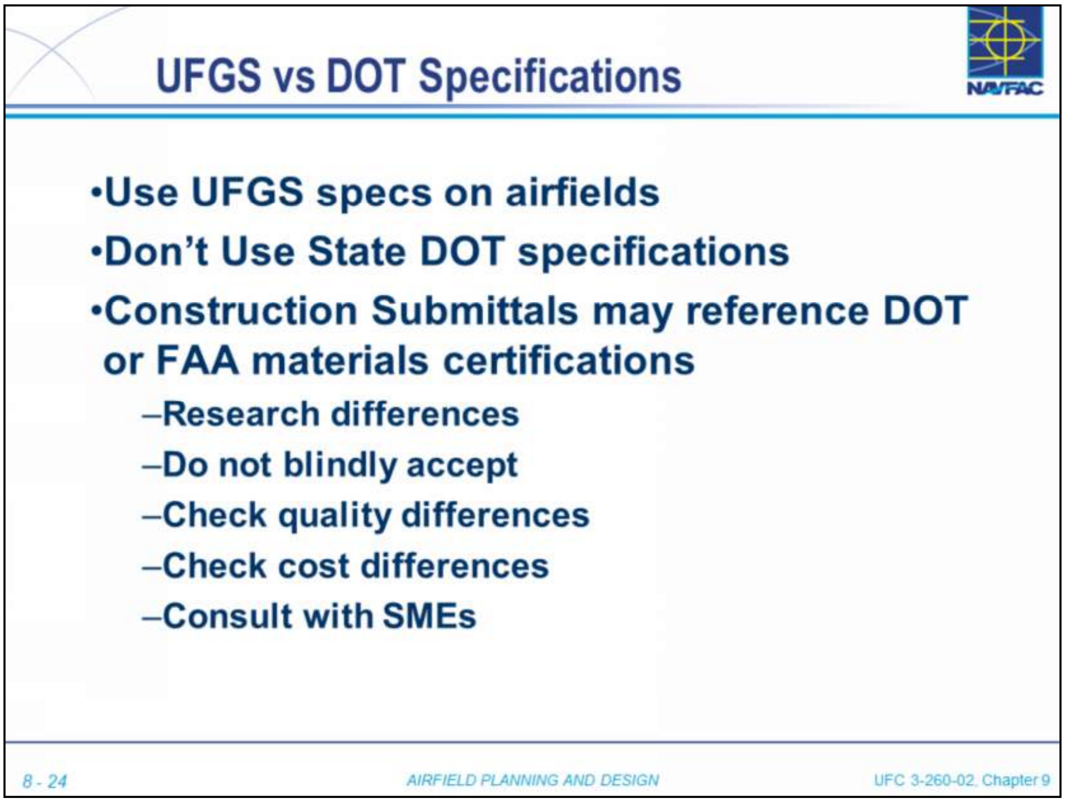
Table 8-6
Aggregate Base-Course Minimum Thickness Requirements for Navy and Marine Corps Rigid Pavements

Base Material	Minimum Thickness
Granular Material	152 mm (6 in.)
Cement Stabilized	152 mm (6 in.)
Asphalt Stabilized	152 mm (6 in.)
Asphalt Concrete	102 mm (4 in.)
Lean Concrete Mixture	102 mm (4 in.)

Note: For subgrades classified as CH, CL, MH, ML, or OL, the minimum granular base-course thickness shall be 203 mm (8 in.).

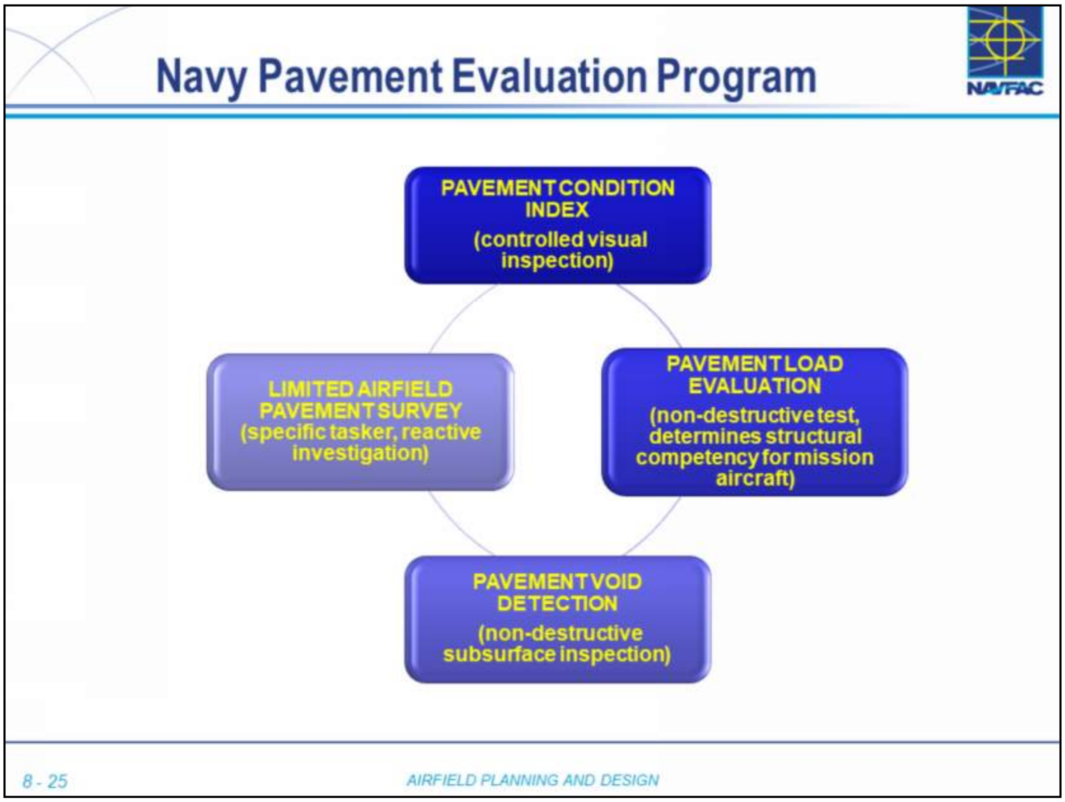


- Paving Materials
  - Good materials critical to pavement long-term performance
  - Extensive work by DoD to develop UFGS – very important to follow, particularly for Hot Mix Asphalt and Portland Cement Concrete pavements
- Local Aggregates
  - Check DOT specifications and Local Quarries to determine availability of aggregates that will meet UFGS specifications for quality
  - DoD testing takes considerable time (~90 days) and requires large sample.
  - Plan time into the contract for this requirement (e.g. 120 days mobilization/submittals period before construction starts on airfield).
- Quality waivers on aggregates generally not allowed – all testing proven important to good performance
  - Deleterious materials
  - Durability testing
  - ASR testing
- Get Support on these issues from SMEs

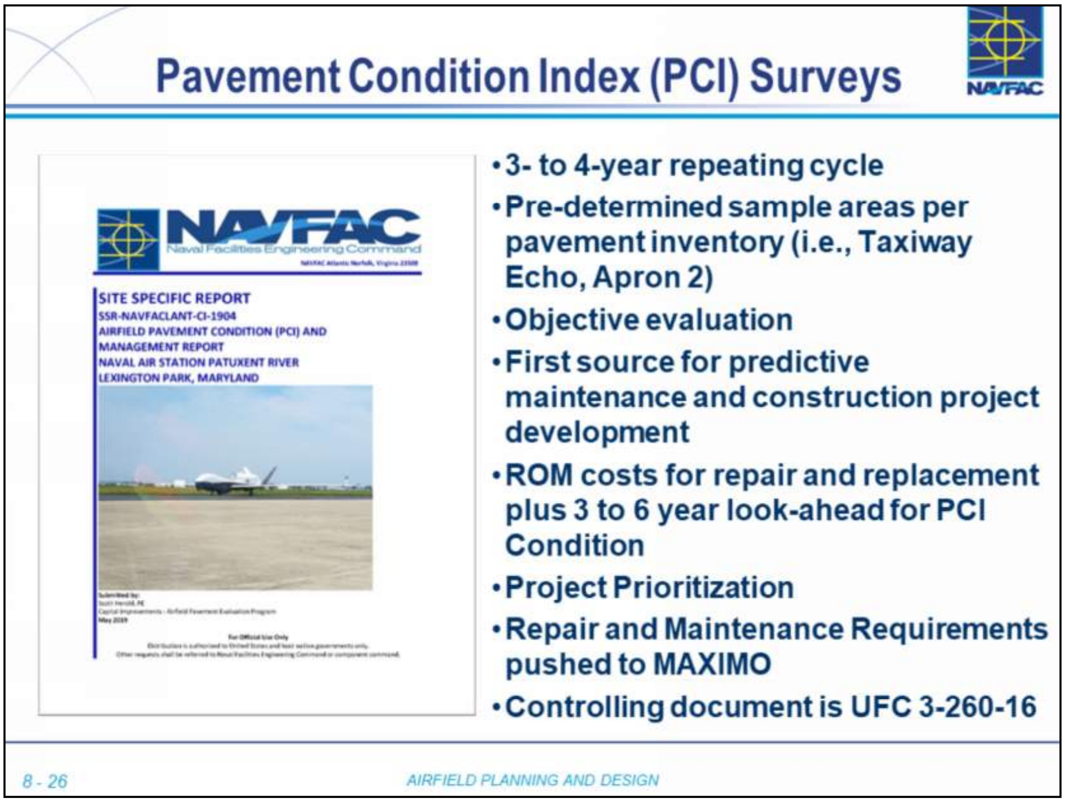


- DoD must use Unified Facilities Guide Specifications (UFGS)
- However, sometimes difficult to get UFGS, especially for small quantities
- Research differences
- Don't blindly accept that State DOT is acceptable
- Check quality differences
- Check gradation differences
- Check cost differences
- Use good judgment
- Consult with SMEs

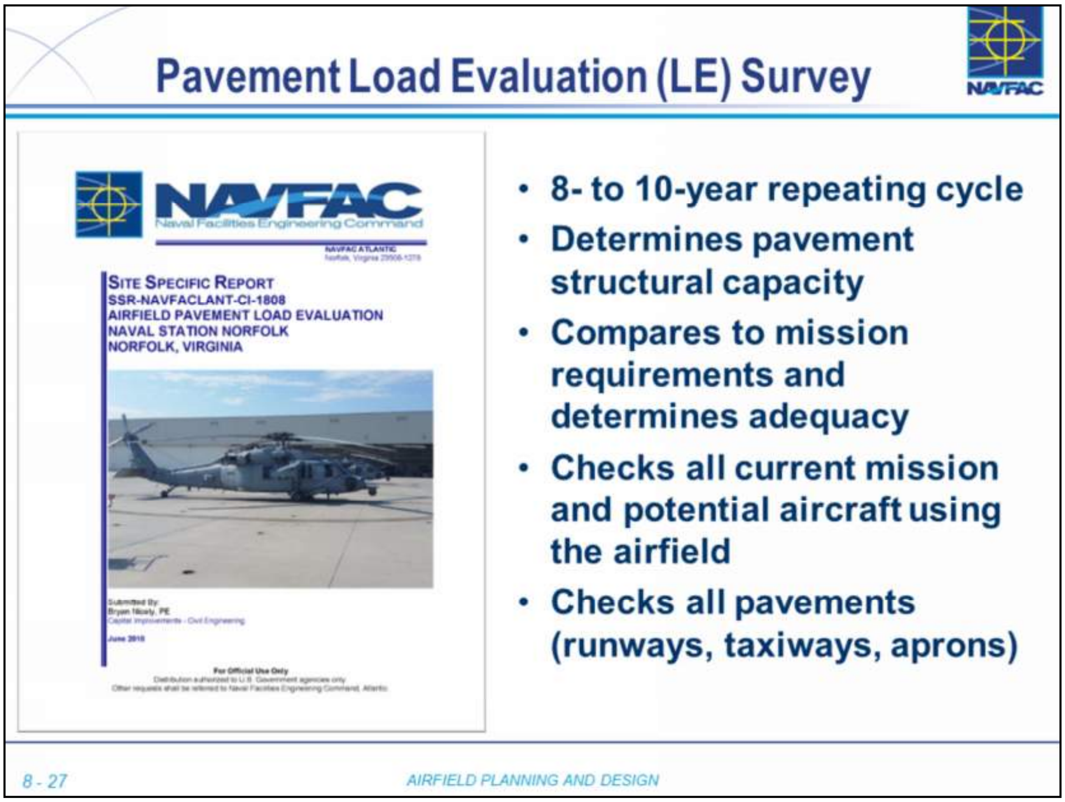
- **NOTE**: Example – changing the aggregate gradation in PCC changes the basis of design. Design procedure counts on (assumes) aggregate interlock to provide load transfer at contraction joints. If the gradation is changed to smaller maximum aggregate, then less load transfer at the joint will occur because the contraction joint crack will be less rough.



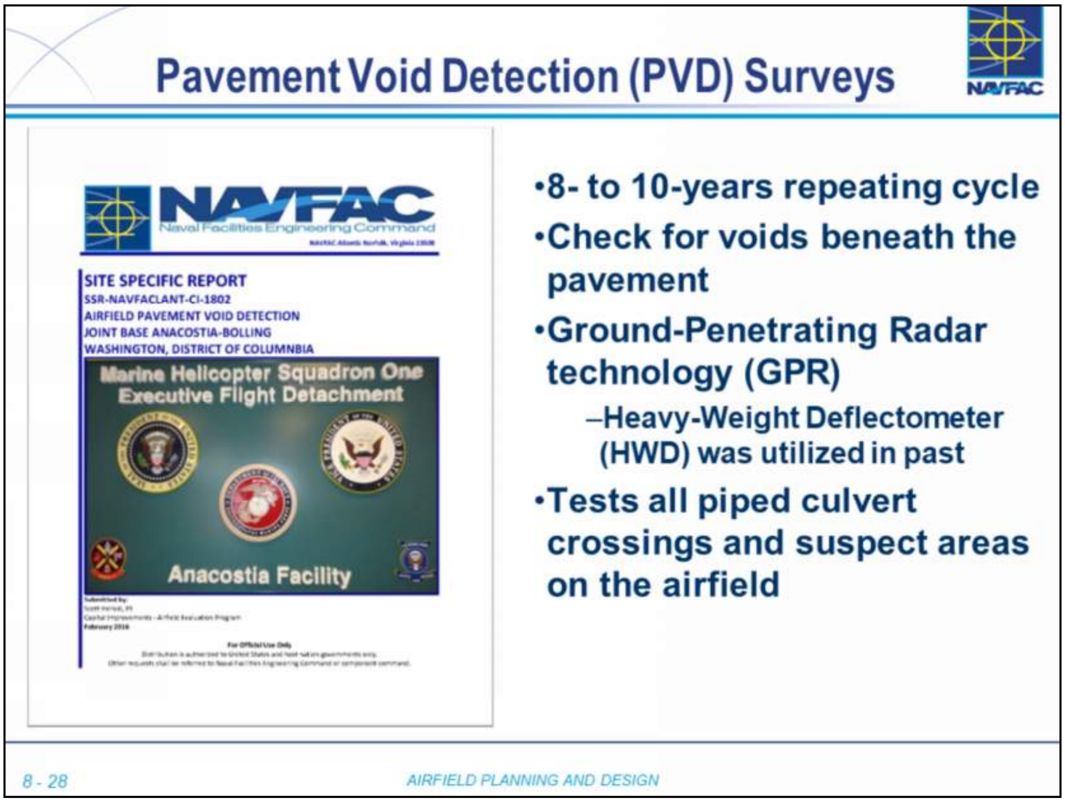
- 4 Types of Pavement Surveys completed by Navy



- Done every 3-years for primary airfields and every 4-years for outlying and/or auxiliary landing fields.
- Conducted on pre-determined sample areas per pavement inventory (i.e., Taxiway Echo, Apron 2).
- Is an unbiased evaluation independent of the person performing the work (apples to apples).
- Intended as the first source for predictive maintenance and the development of construction projects.
- Includes rough order of magnitude costs and 3, and 6-year look ahead.
- Utilized by CNIC and Regions to prioritize maintenance, and minor and major repair projects (in concert with the MDI).
- Identifies repair and maintenance requirements and pushes those requirements to MAXIMO.
- Controlling document is UFC 3-260-16.



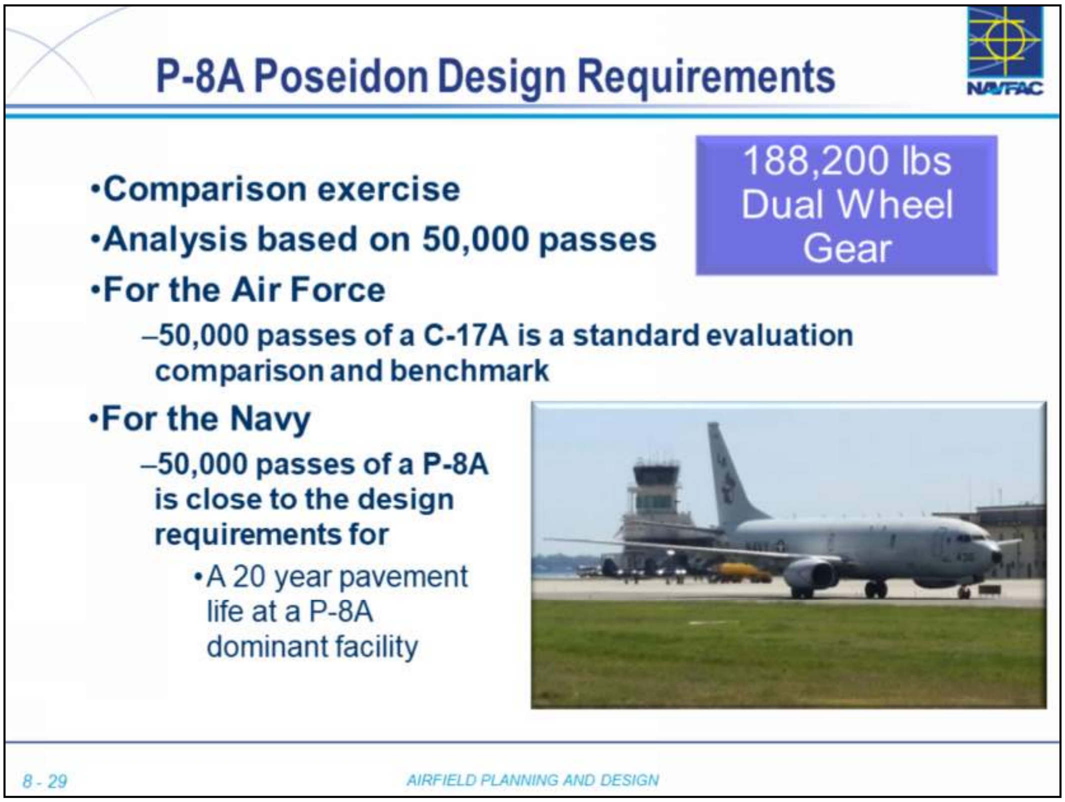
- Load Evaluation (PCN) – Done every 8 to 10-years or upon a change in mission
- Compares the stresses imposed by aircraft to the pavement's structural capacity to determine if the pavement is adequate for the mission.
- Assumes all mission and potential aircraft utilizing that particular airfield.
- Results reported to AMC's Airfield Suitability Desk, compiled in reports



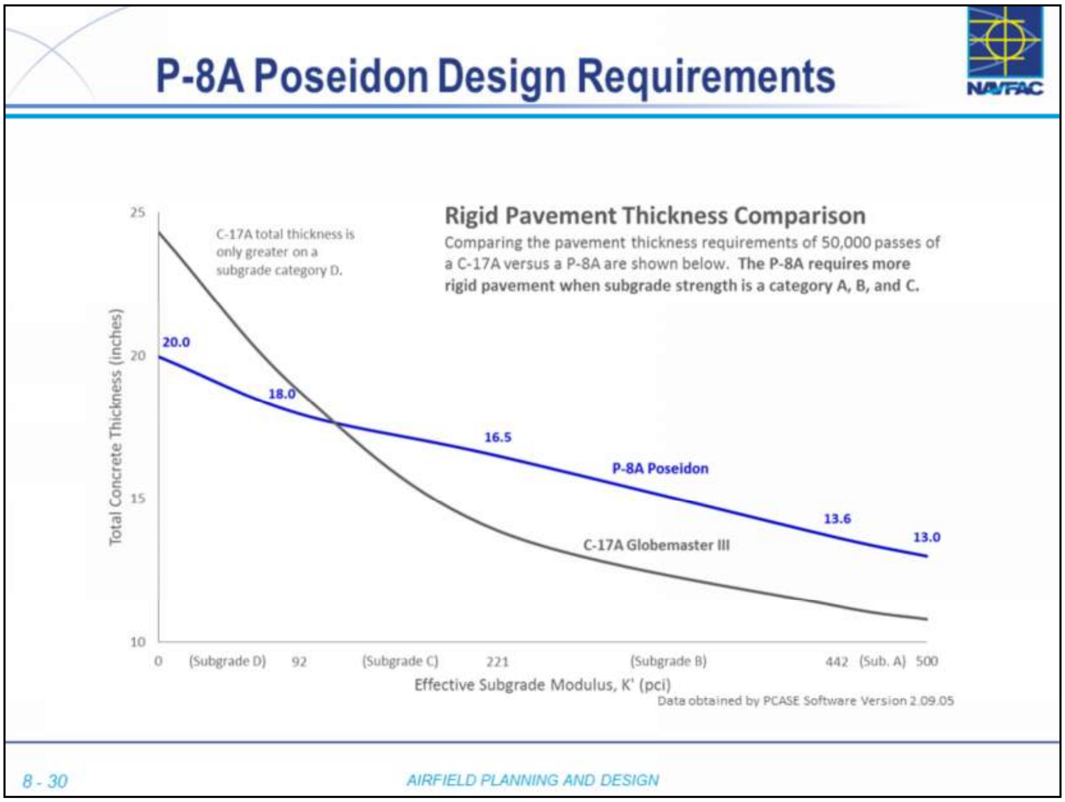
- Done every 8 to 10-years – is accomplished to determine the existence of voids beneath the pavement.

- Current methodology utilizes Ground-Penetrating Radar technology (GPR). In the past, the Heavy-Weight Deflectometer (HWD) was utilized.

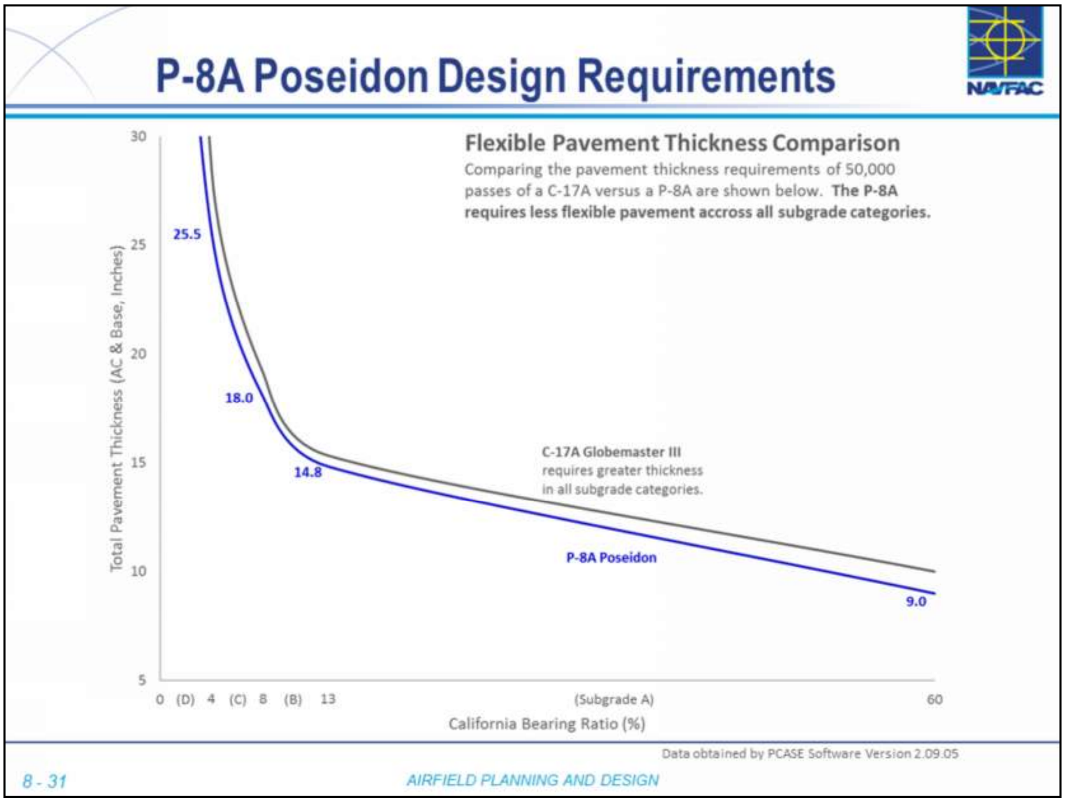
- Done at all piped culvert crossings and suspect areas on the airfield.



- P-8 is a heavy dual-wheel aircraft
  - Much more significant than fighter traffic
  - Individual wheel load (~44.6 kips) comparable to C-17 (~46.3 kips)
- P-8 will most likely be the design critical aircraft for most Navy airfields



- Compares PCC pavement thickness required for 50,000 passes of P-8A (blue line) vs 50,000 passes of C-17
- P-8 requires slightly more PCC, except when subgrade k < ~100 pci



- On Flexible pavements, P-8A thickness required is nearly identical to C-17

P-8A Poseidon Design Requirements

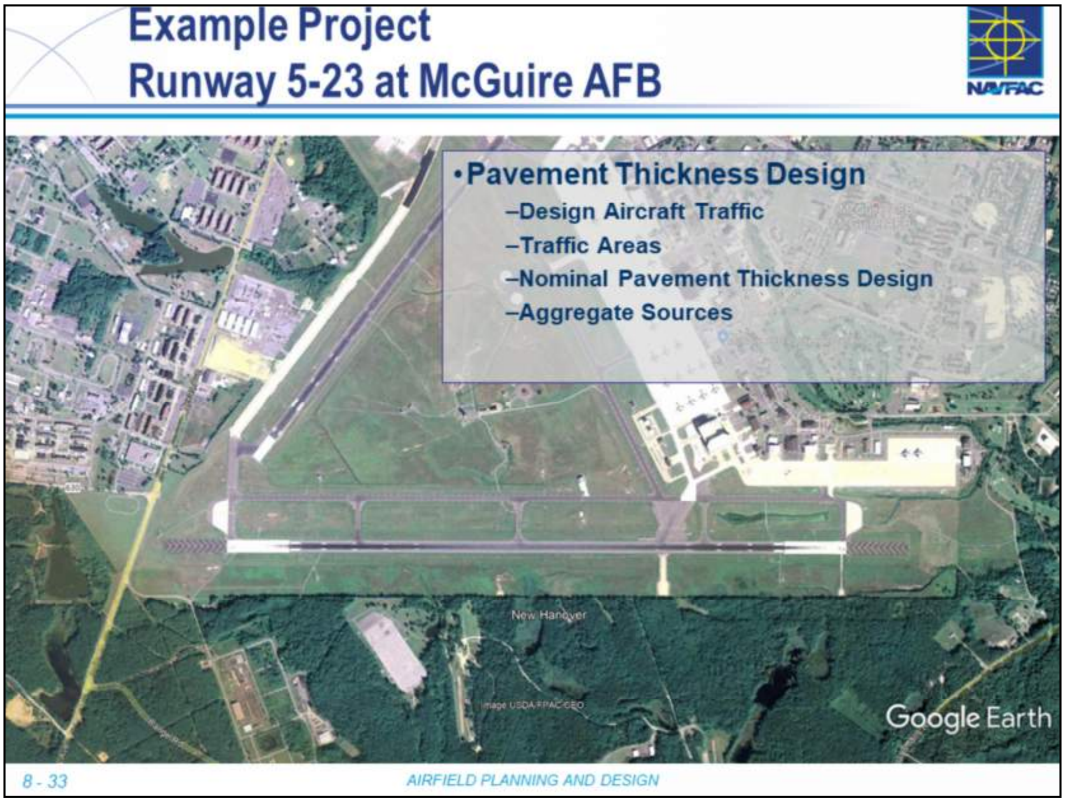
NAVFAC

Key Take-away

- **P-8A requires a more robust rigid pavement**
- **Critical areas**
  - **Rigid pavements with a subgrade category of A, B, or C**

8 - 32 AIRFIELD PLANNING AND DESIGN

- Implementation of P-8 in the Navy inventory (and therefore in pavement thickness designs) is driving thicker pavements
- Damage to existing pavements where P-8's are flying is becoming common



- Pavement Thickness Design during Planning & Programming
    - Determine/Stipulate Aircraft Traffic Mix for Design
    - Decide Traffic Areas that will be applied
    - Use historical data (Pavement Evaluation Reports) to determine subgrade strength
    - Use PCASE to calculate a nominal (conservative) pavement thickness for each traffic area

- Key Points of Section

- Pavement Design Development is Critical for Long-life pavement
    - Many factors contribute to pavement design
- Thorough geotechnical investigation is important to understanding subgrade support and potential pitfalls during construction
- Aircraft Traffic (Load) is major influence on pavement thickness and pavement type
    - PCC vs HMA
    - PCC pavements are plain jointed PCC. No keyways or tie bars. Dowels and thickened edges used.
- Paving Construction Materials are critical component
    - Very high quality materials needed for long-term durability
- Navy Pavement Evaluation Program
    - Different Types of Evaluations
    - Cyclical

Name the Airfield

8 - 35 AIRFIELD PLANNING AND DESIGN

- Precision Runway with blast pads
- Extra Wide Shoulders - previously 300-ft runway
- Helipads dispersed throughout
- Hazardous Cargo Pad for two aircraft
- Rotary Runway at east end

Section 9
Airfield Surface and Subsurface Drainage

AIRFIELD FACILITIES PLANNING AND DESIGN CRITERIA TRAINING

5/7/2023

Overview of Topics

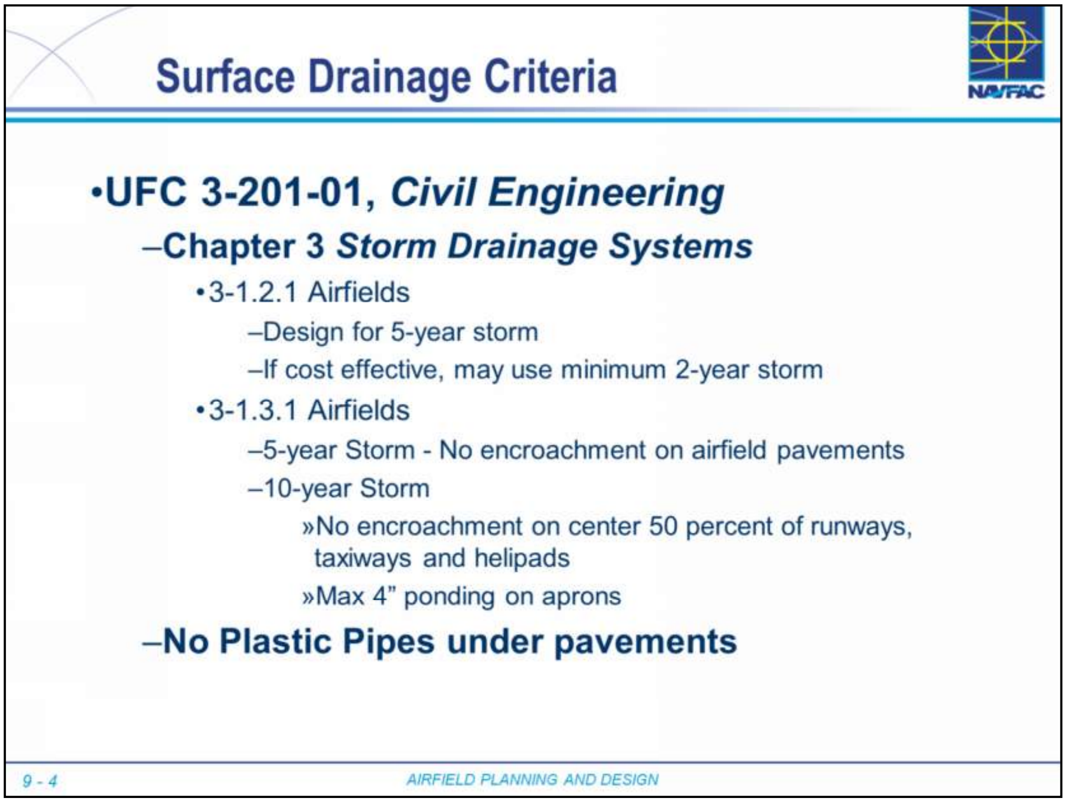
- **Source References**
  - **UFC 3-201-01 *Civil Engineering***
  - **UFC 3-250-01 *Pavement Design for Roads and Parking Areas***
    - Chapter 20 – Design of Subsurface Drainage Systems
- **Stormwater Drainage Design Requirements**
- **Stormwater Design Considerations Near Airfields**
- **Subsurface Drainage Systems**

Surface Drainage

- General requirements for surface water drainage and management of runoff
- Problems with stormwater management facilities on or near airfields
- Typical features/design details for stormwater structures and pipes on airfields
  - –Inlets, Manholes, Headwalls, Trench Drains
  - –Structural Design Requirements

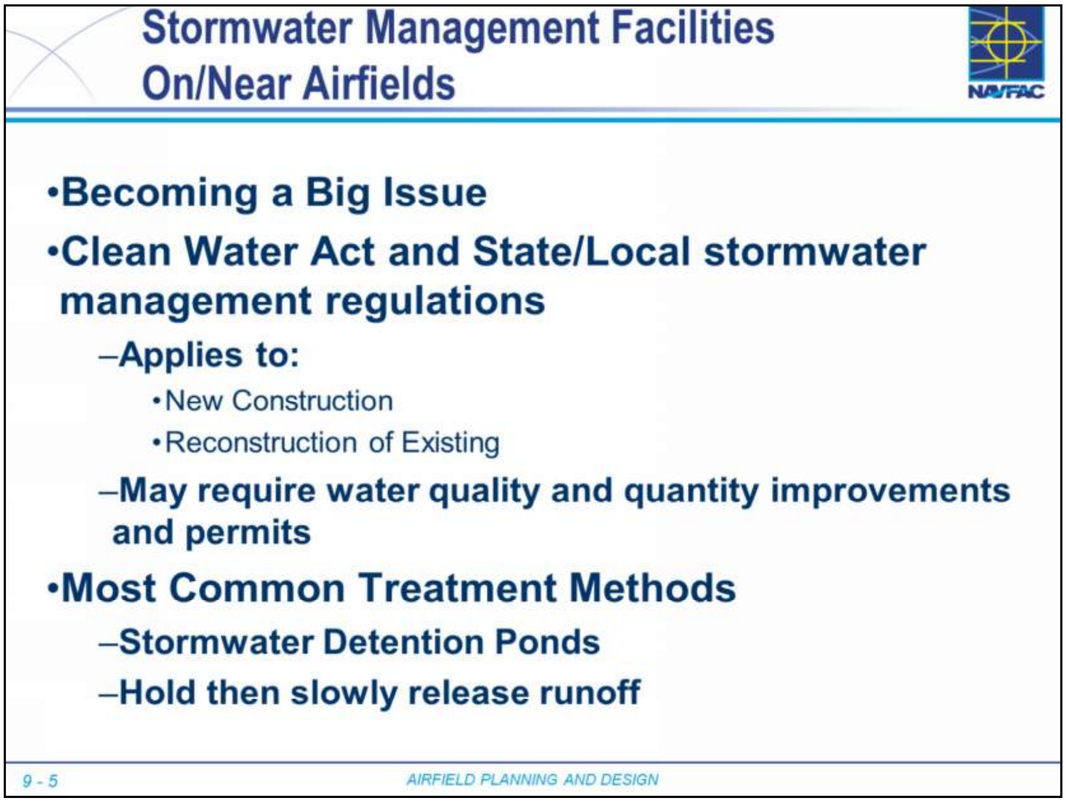
9 - 3 AIRFIELD PLANNING AND DESIGN

- Key points
  - Requirements
  - Problems
  - Typical Features
- Answer the following questions
  - What are the requirements for drainage on an airfield? How do I size the pipes on an airfield?
  - Is it a good idea to have stormwater management facilities next to a runway?
  - What type of load should a stormwater inlet on an apron be design to support?

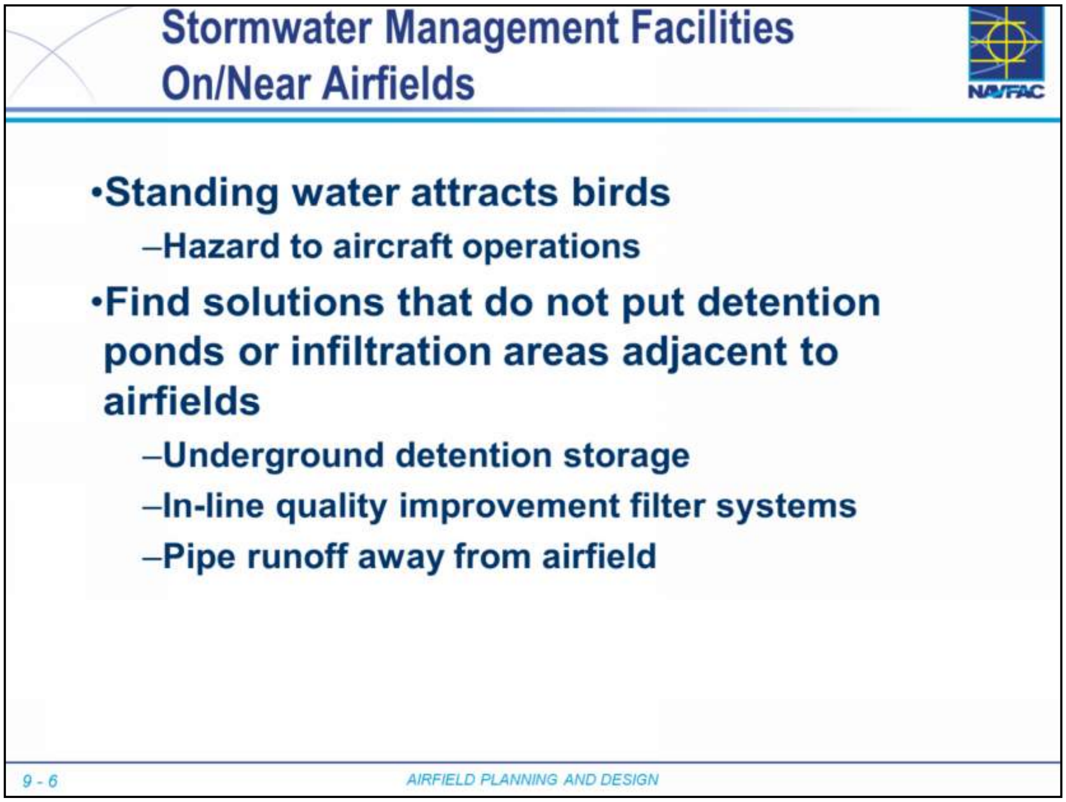


- UFC 3-201-01
    - Primary adopted guidance for airfields
- Chapter 3 addresses storm drainage
    - 3-1.2.1 Airfields
        - New construction, design for 5-year storm event
        - Reconstruction or Retrofit, may design for 2-year storm event
    - 3-1.3.1 Airfields
        - 5 year Storm Event – no encroachment on airfield pavements
        - 10-year Storm Event – no encroachment on center 50 percent of runways, taxiways or helipads and maximum 4” ponding on aprons

- No plastic stormwater pipes under airfield pavements, except subsurface drainage pipes

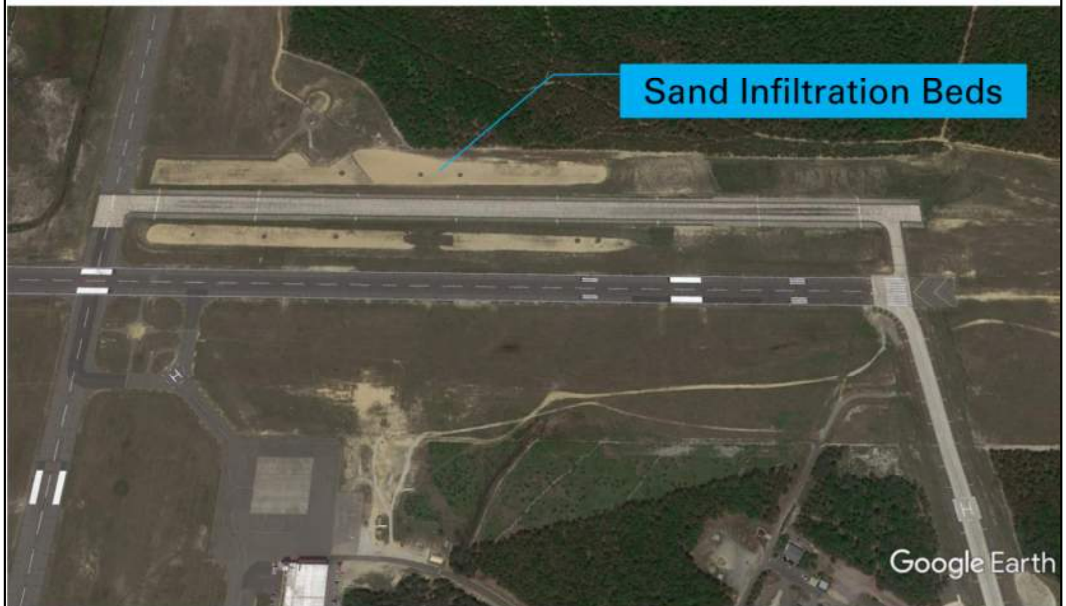


- Stormwater management facilities are becoming a bigger issue on airfields
    - Many states or local jurisdictions are imposing regulations on both new construction and reconstruction of existing facilities
    - Runoff quantity (rate) is no higher than before construction
    - Runoff quality (amount of contaminants) is equal to or better than conditions prior to construction.
- Most common treatment method in new developments
    - Create one or a series of stormwater detention ponds to collect the rapid runoff from pavements
    - Slowly release stored water to drainage channels exiting the property
- Must meet Clean Water Act requirements and State/Local Requirements
    - Erosion and Sediment Control Permit usually required during construction
    - Stormwater Permits may also be required, depending on state/local rules



- Stormwater detention ponds often attract birds and other wildlife
  - Not desirable on or around airfields.
  - Detention ponds that are designed to be dry-bottom require continued maintenance to make sure they don’t hold water
    - In practice, this often doesn’t happen.
- Designers need to find stormwater management solutions that don’t create standing water. Examples:
  - Underground storage chambers – buried pipes or boxes that can store significant volumes and slowly release it back to pipes
  - Filtration systems – buried drainage structures with filter cartridges to remove pollutants
  - Move the runoff a significant distance away from the airfield and away from clear zones
- All of these systems can be expensive and often require additional space – all challenges for the design.

Stormwater Management Facilities On/Near Airfields

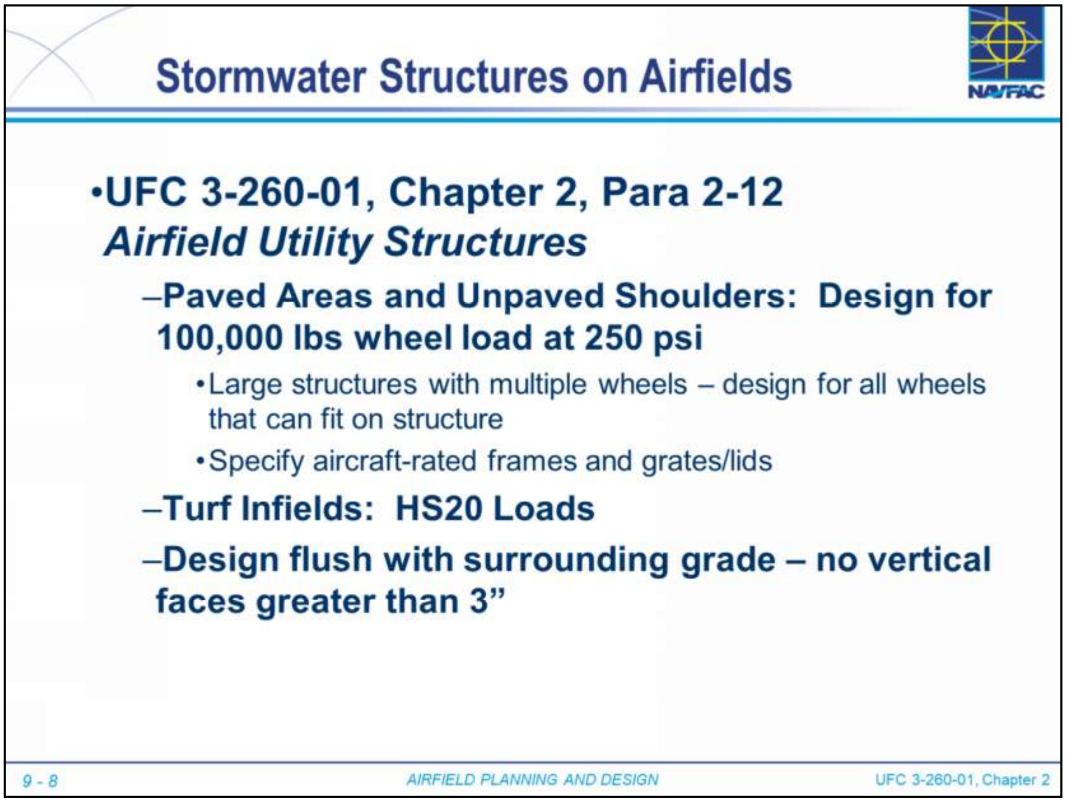


9 - 7 AIRFIELD PLANNING AND DESIGN

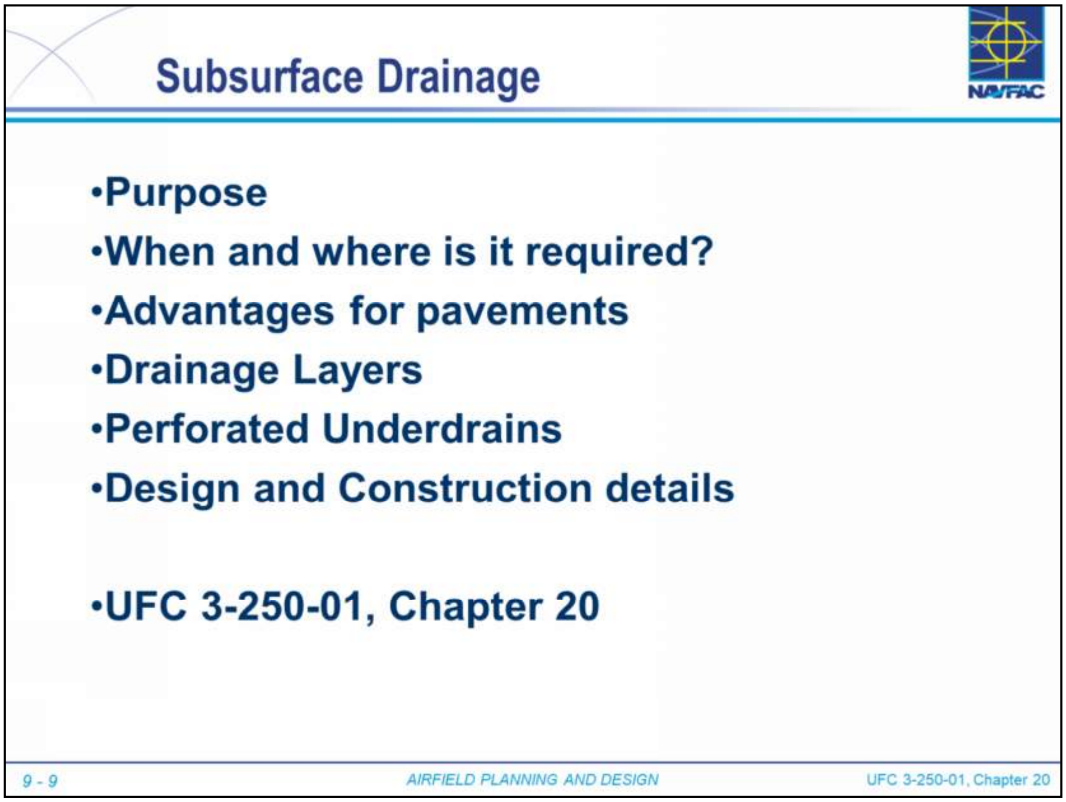
Example – Lakehurst airfield at JBMDL

- When LZ was constructed, sand infiltration beds were constructed adjacent to LZ
- Two Problems
    - Inlet structures had control weirs to limit inbound flow and the tops of the structures stuck up 6” above surrounding grade
    - Infiltration rate is slower than designed, resulting in standing water for longer than desirable immediately adjacent to runway

Other examples?



- “Buried Utility Structures” was the selected terminology because this applies to more than just stormwater inlets and manholes
- Also applies to electric or communication handholes and manholes, and any other buried items that may get trafficked by aircraft
- Two different design scenarios are presented
    - Paved Areas (runways, taxiways, aprons, shoulders) and Unpaved shoulders (the areas immediately adjacent to the pavement)
        - Design to support the heaviest potential aircraft loads – 100,000 lb. wheel load at 250 psi. – contact area is 400 sq. inches, or 20”x20”
        - If structure is large enough that two wheels of an aircraft could fit on it simultaneously, then design for those additional wheel loads
        - Be sure to spec aircraft-rated frames and grates/lids for your structures – the big casting companies like East Jordan and Neenah carry these heavy-weight castings.
    - Turf Infields – design for AASHTO HS 20 Loads (tractor trailer wheels)
- Structures must be flush with the surrounding grade, with no more than 3” vertical face.
- Vertical headwalls are not allowed within Shoulders, Graded Areas of Runways or Taxiways, Graded Area of the Clear Zone



- Now switch to subsurface drainage.
    - On next slides, will address these issues
    - When and where required?
    - Advantages
    - Drainage Layers
    - Perforated Underdrains
    - Design and Construction Details

Then we will discuss the design and construction of drainage layers and perforated underdrain pipe systems

Definitions

- Drainage Layer – a layer in the pavement structure that is specifically designed to allow rapid horizontal drainage of water from the pavement structure.
- Effective Porosity – the ratio of the volume of voids drainable by gravity to the total volume of a unit of aggregate.
- Coefficient of Permeability – the rate at which water passes through a unit area in a given amount of time under a unit hydraulic gradient.

Review the definitions

Definitions (cont'd)

NAVFAC

- Rapid Draining Material (RDM) – a granular material with a high permeability (1,000 to 5,000 ft/day) and stability to support construction equipment and act an a structural pavement layer.

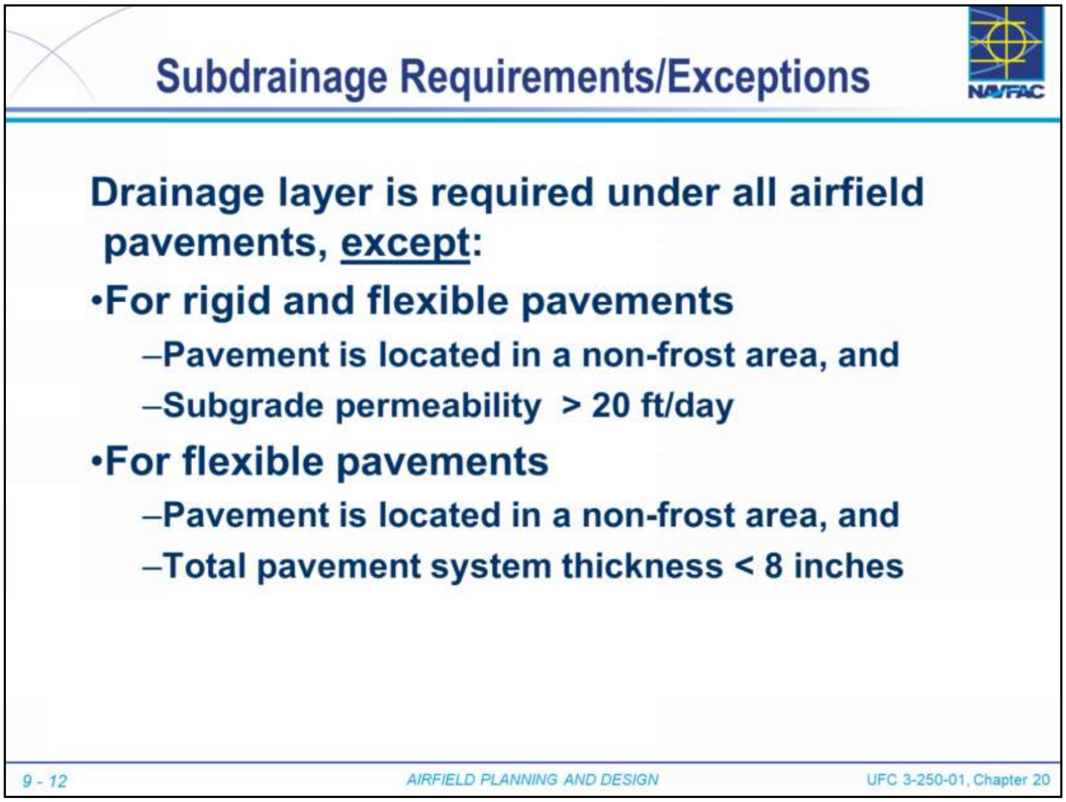
- Open Graded Material (OGM) – a granular material having a very high permeability (> 5,000 ft/day), and requiring stabilization to support construction equipment or act as a structural pavement layer

9 - 11 AIRFIELD PLANNING AND DESIGN UFC 3-250-01, Chapter 20

Review the definitions

- RDM vs OGM
  - When to use each
  - Depends on soil conditions and availability of materials and stabilizing agents
  - Stabilized OGM is more stable for supporting heavy construction equipment

- RDM: 4" too thin – must be 6" min
- OGM: 4" OK with stabilization



For the DoD, drainage layers are required in the pavement structure on all airfield pavements, except the following:

- When the airfield is in a non-frost area (frost penetration depth < pavement structure depth)
- Subgrade permeability is very high (>20 ft/day). Examples of areas where you might get this level of permeability include arid sandy, gravelly soils.
- Regardless of permeability, for flexible pavement structures (asphalt plus base) less than 8" thick, a drainage layer is not required as long as the airfield is in a non-frost area.

Advantages of Pavement Subdrainage

NAVFAC

- Promote horizontal drainage of water from pavement
  - Increased subgrade strength
  - Lower water table
- Prevent buildup of hydrostatic water pressure
- Facilitate drainage of water generated by cycles of freeze and thaw

9 - 13 AIRFIELD PLANNING AND DESIGN UFC 3-250-01, Chapter 20

Subdrainage Advantages

- Allows water to drain out of the pavement structure
  - If the soil is completely saturated, the individual soil particles are forced apart, reducing the important frictional component of soil strength, resulting in subgrade with greatly reduced strength
  - Lowers water table underneath the pavements
- Prevents buildup of hydrostatic water pressure in the subgrade soil caused by dynamic loading, which can lead to subgrade loss by pushing soil out of the structure

- Prevents thaw weakening during freeze-thaw cycles

Importance of Drainage Layers

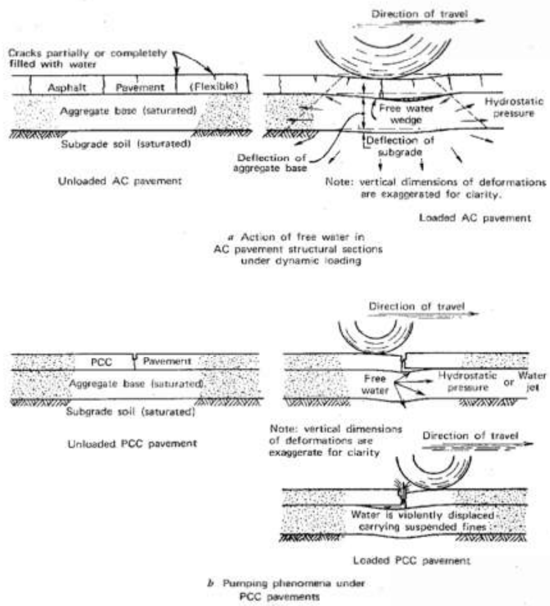
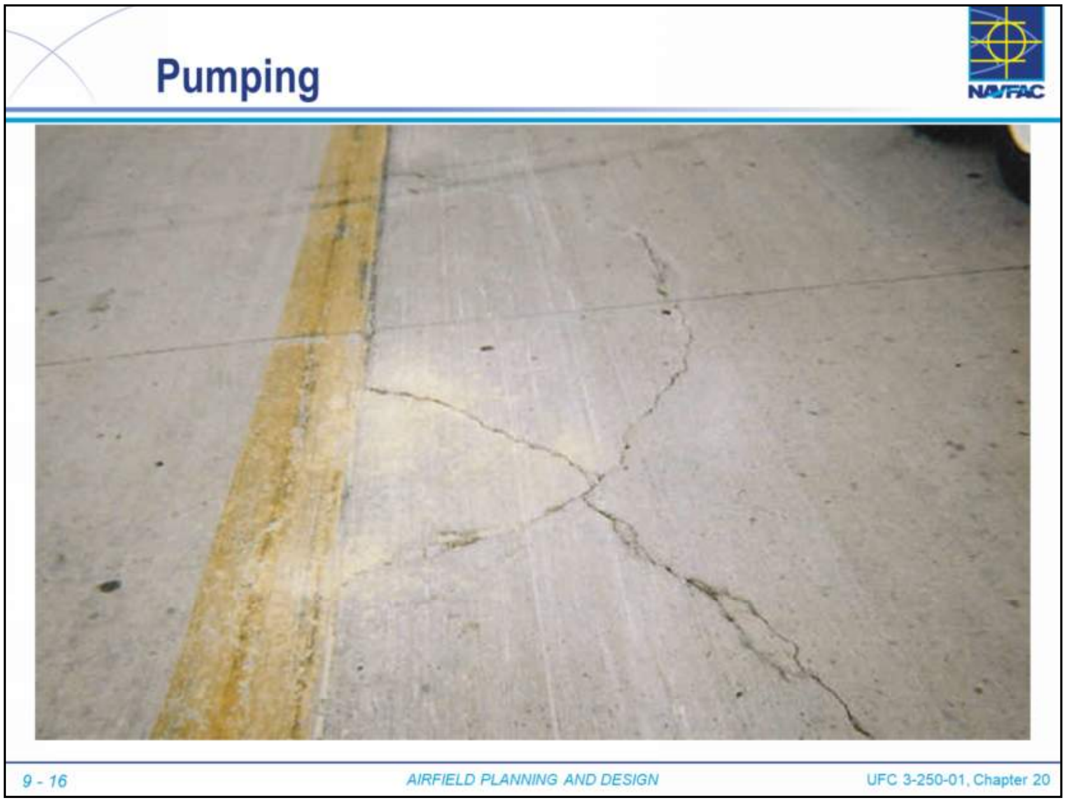


Illustration of hydrostatic pressure caused by dynamic loading

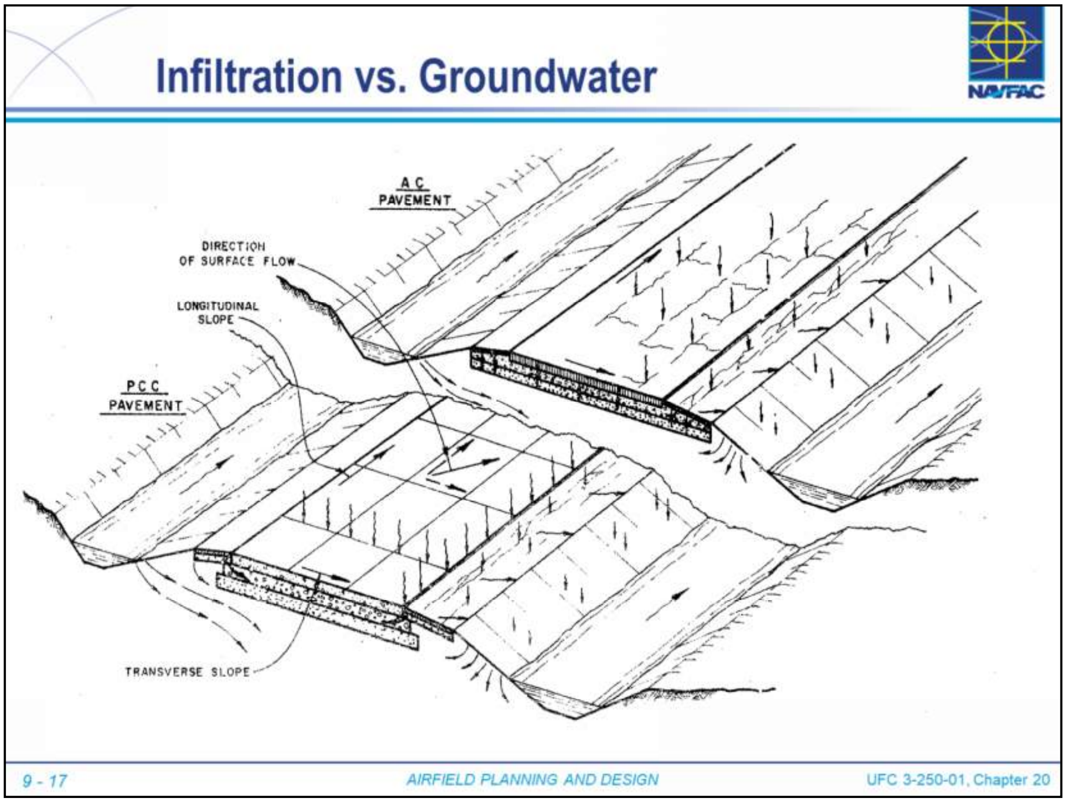
- Can lead to rutting in asphalt pavements
- Can lead to pumping combined with settlement or faulting in PCC pavements

- Explain the illustrations
  - This can’t happen if the area under the pavement is not saturated

- Good example of a badly deteriorated roadway, with rutting, alligator cracking and potholes.
- Subgrade is very weak in this structure.
- Situation only gets worse
    - Ruts collect water
    - Water moves through the cracks in the ruts
    - Base and subgrade stay saturated
    - Leads to more weakening.

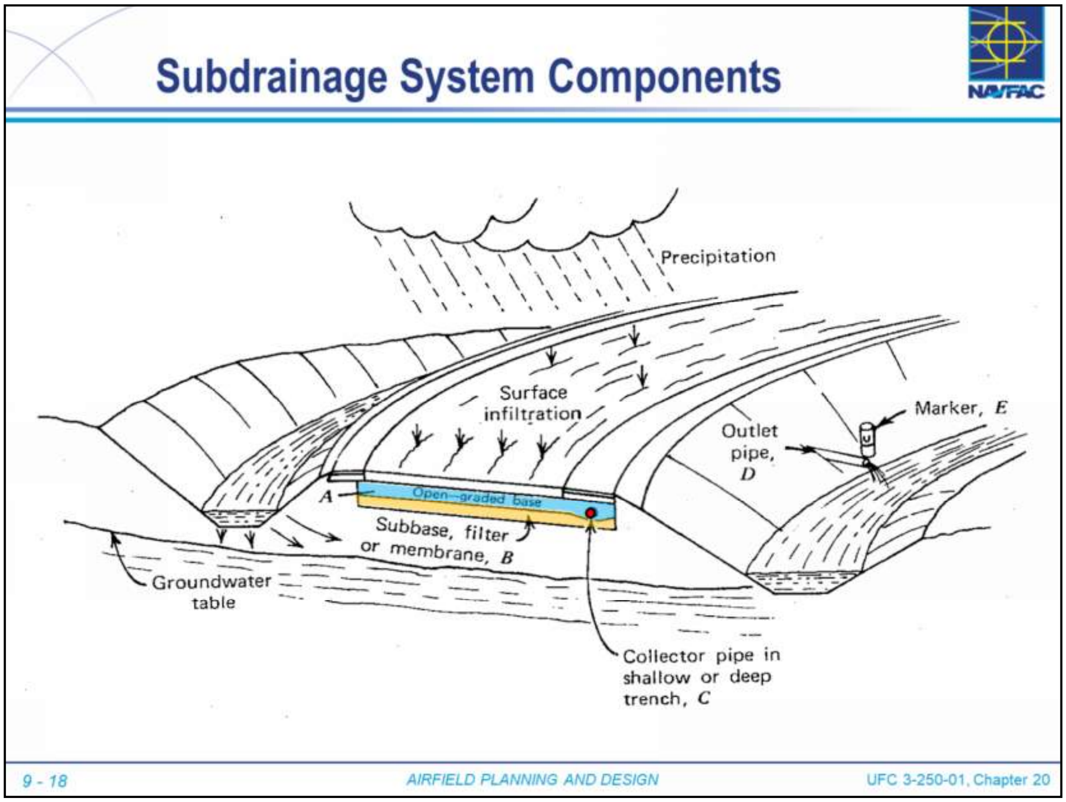


- Pumping
- On PCC pavements, it usually starts with a corner break
    - First on one slab
    - Then progressing to the adjacent corners
- With every aircraft movement, the broken piece moves a little
- When saturated, every wheel loading creates pressure on the base course
    - Starts jetting material around
- Eventually, staining is noted on the surface
    - Soil particles have washed to the surface of the pavement
    - Loss of slab support

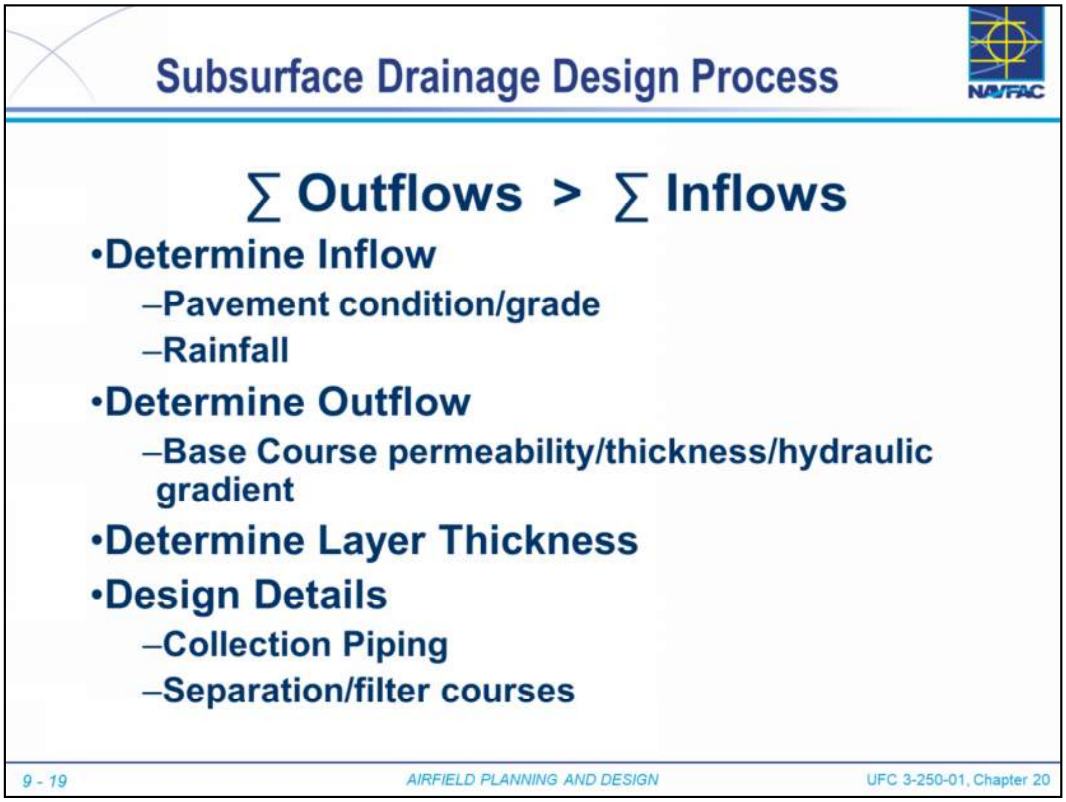


- Infiltration
  - Water going through the pavement surface into the base and subgrade

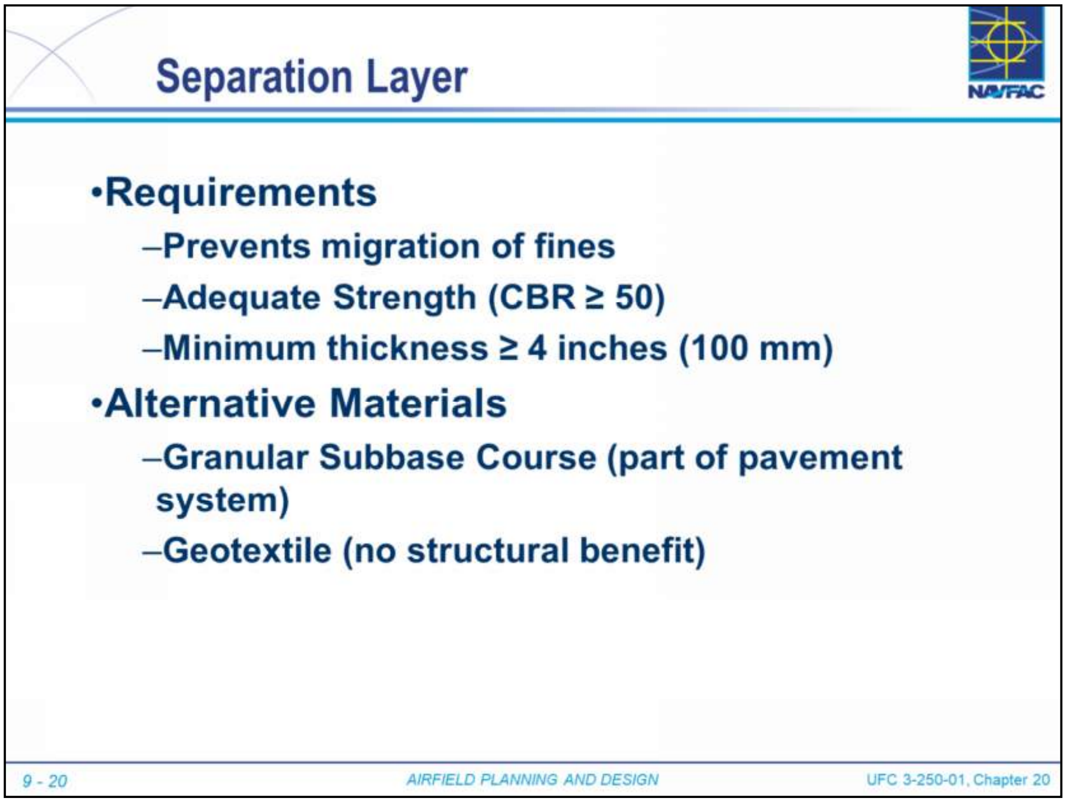
- Ground Water
  - High water table (ditches full of water)
  - Water flows up into base course under pavement



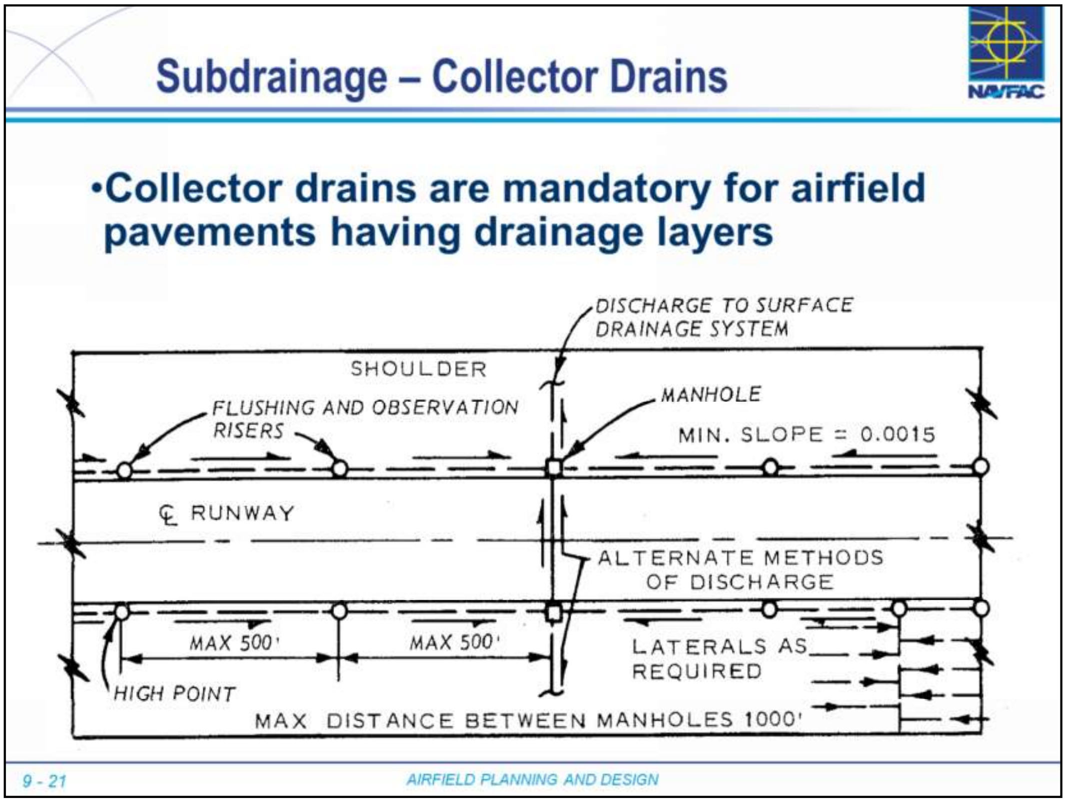
- System Components
  - Drainage Layer
  - Separation Layer
  - Collector Pipes
  - Outfall Pipe



- General Subsurface Drainage Procedures
    - Ensure outflow capacity exceeds inflow
    - Weather and Grades determine inflow
    - Drainage Layer porosity and Pipe Size effects outflow capacity
- Drainage Layer Thickness
    - Thickness related to storage capacity
    - Need 85% drainage in 24 hours on runways and taxiways
    - Need 85% drainage in 10 days on aprons

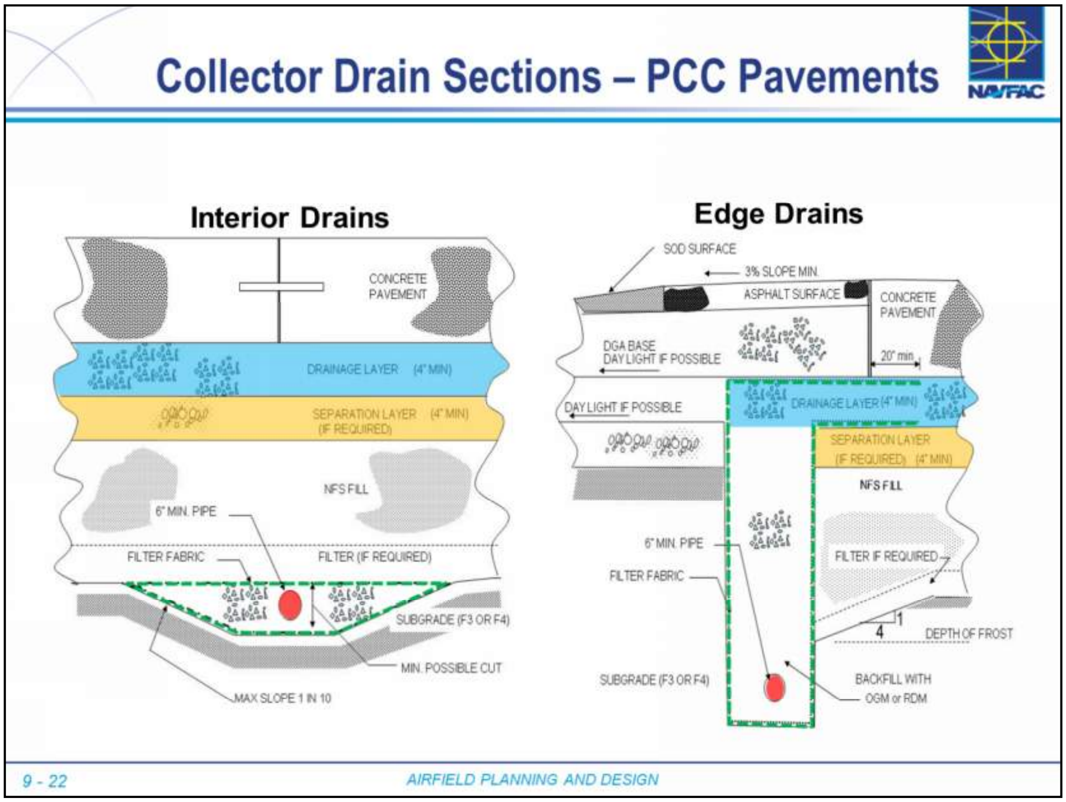


- Separation Layer Requirements
  - Positioned under Drainage Layer
  - Prevents migration of fines as water level goes up down
  - Must have adequate strength (CBR > 50)
  - Minimum 4” thickness
- Alternative materials
  - Granular subbase
  - Geotextile
    - Sometimes this is used to reduce amount of subgrade excavation

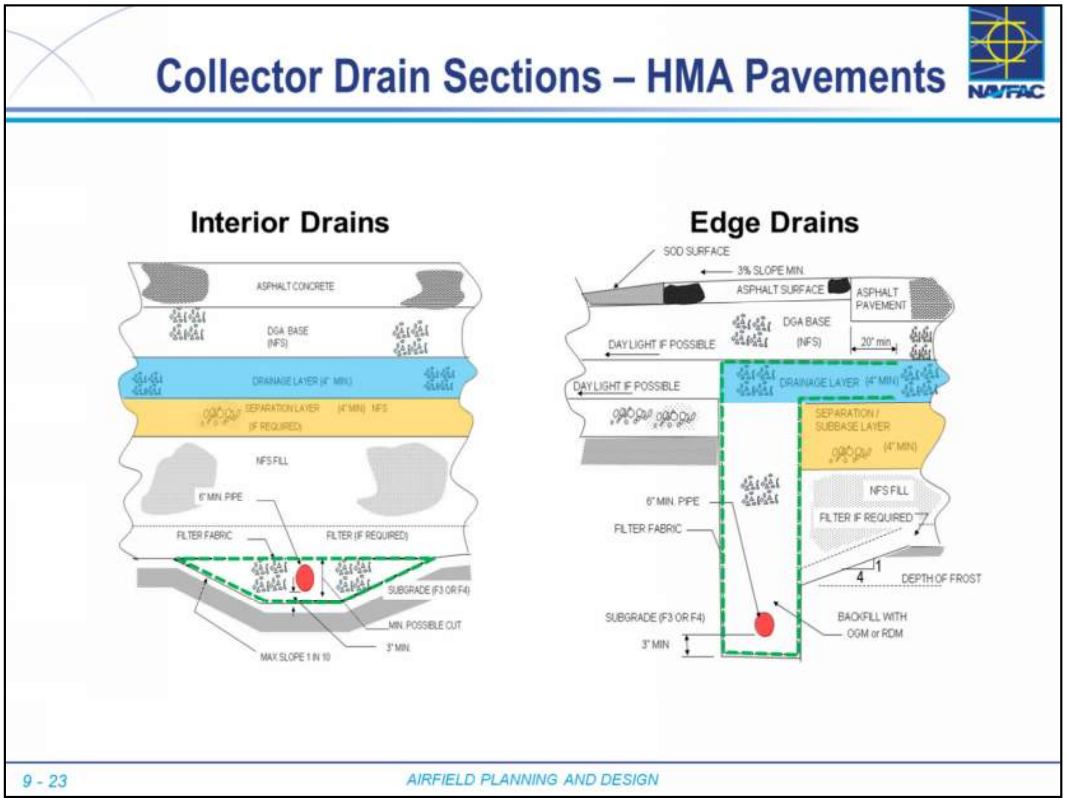


- Collector Drains mandatory for structures with drainage layers
    - Typically 6” diameter rigid PVC pipe
    - Larger pipe sizes possible when large networks collect into trunk pipes

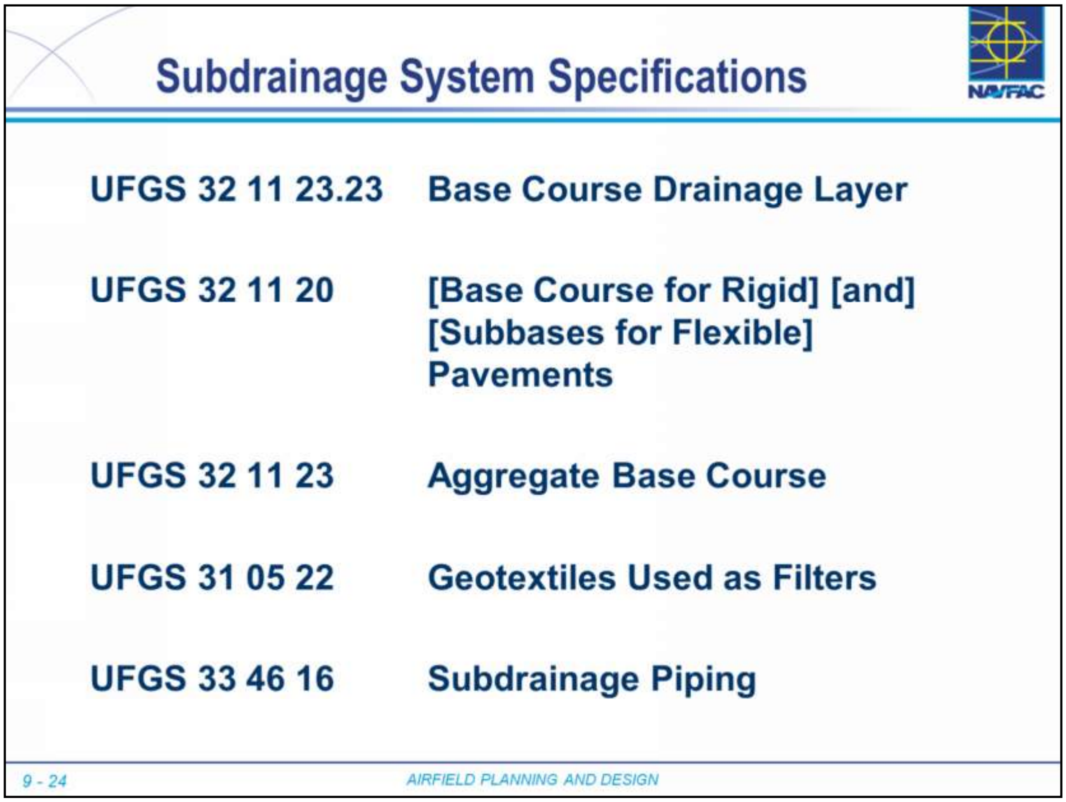
- Typical Drain Pipe network
- Pipe along each edge of runway or taxiway
- Lateral connectors
- Discharge to daylight or storm structure
- Cleanouts
    - Max 500’ between
- Collection Structures at multiple junction points can be useful access for cleaning.
- Configure cleanout fittings to allow for cleaning in an upstream direction. This is best way to remove a clogged area.
- Install subdrain as early as possible during construction
    - Allows subgrade to drain and dry out, become less susceptible to weather delays.
    - Always get installed prior to a Winter shutdown to improve conditions for a Spring start.



- Typical sections for subsurface drain pipes under PCC Pavement
- Drainage layer directly under PCC
- Interior
    - Used on Aprons
    - Trench wrapped in filter fabric
- Edge
    - Used along runways and taxiways
    - Trench wrapped in filter fabric
    - Connected to drainage layer
- UD pipe on airfields is solid-wall PVC with drilled holes or cut slots, not flexible corrugated with fabric sleeve, as commonly used on roadways

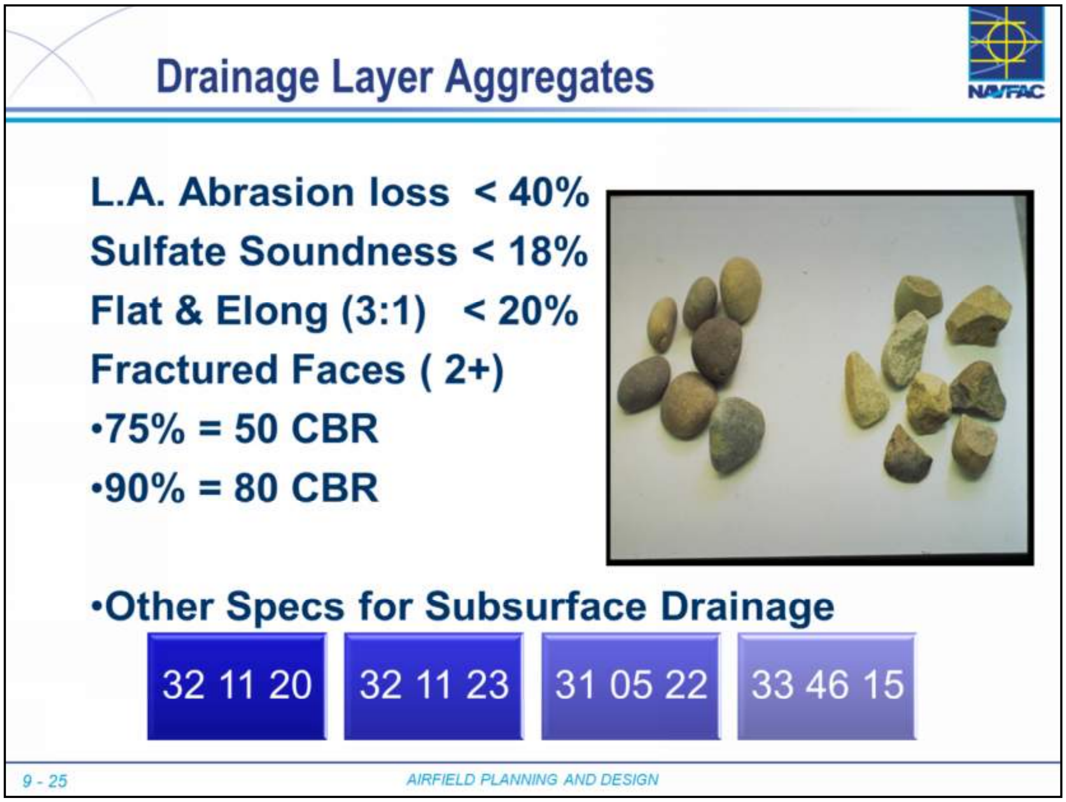


- Typical sections for subsurface drain pipes under HMA Pavement
- Drainage Layer under Dense Graded Aggregate Base Course
- Interior
    - Used on Aprons
    - Trench wrapped in filter fabric
- Edge
    - Used along runways and taxiways
    - Trench wrapped in filter fabric
    - Connected to drainage layer



- Several specs are used for Subsurface Drainage

- 32 11 23.23 Base Course Drainage Layer
    - Contains both RDM and OGM specs
- 32 11 20 Subbase Course for Pavements – typical aggregate Separation Layer
- 32 11 23 Aggregate Base Course – also used for Separation Layer
- 31 05 22 Geotextiles – used for fabric surrounding pipe trench and/or Separation
- 33 46 15 Subdrainage Piping – choose rigid, smooth PVC, not the other options (corrugated, steel, aluminum)
    - Includes paragraphs for filter fabric around pipe trench



Drainage Layer Aggregates (UFGS 32 11 23.23)

- Quality requirements are important to ensure stability and durability of the drainage layer
- OGM = Open Graded Material
    - permeability > 5000 ft per day
    - Needs cement or asphalt for stability
- RDM = Rapid Draining Material
    - permeability 1000 to 5000 ft per day
    - Can be stable within cement or asphalt

- Several other UFGS specs are used for Subsurface Drainage

- 32 11 20 Subbase Course for Pavements – typical aggregate Separation Layer
- 32 11 23 Aggregate Base Course – also used for Separation Layer
- 31 05 22 Geotextiles – used for fabric surrounding pipe trench and/or Separation
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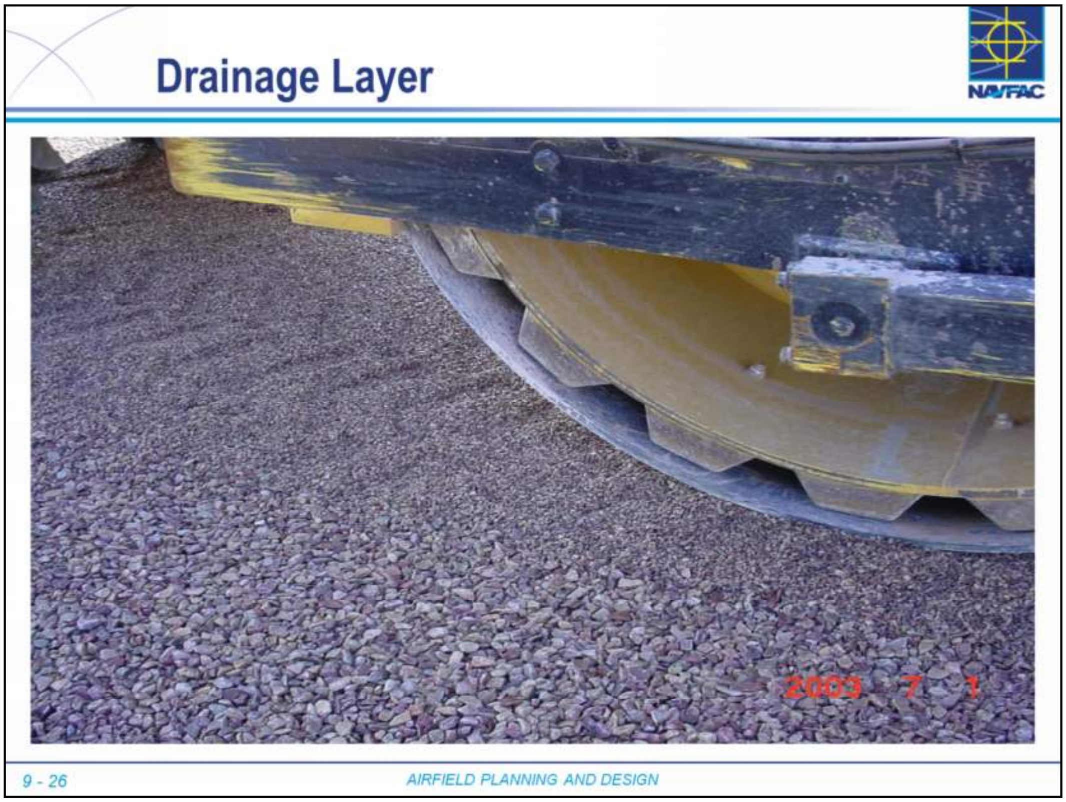

- Aggregate drainage layer
    - Note lack of fines
    - Note segregation – looks like a finer choke stone may have been applied
- Might be unstable under wheeled construction traffic

Drainage Layer – Asphalt Stabilized

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- Typical Asphalt Stabilized Drainage Layer

Drainage Layer

9 - 28 AIRFIELD PLANNING AND DESIGN

- Water poured on surface should rapidly flow through

Drainage Layer and Subsurface Drainage

- Construction Examples

- Next review some construction slides

- Asphalt Paver is best for placing drainage layer material.
- Helps to reduce segregation of the material
- Use material transfer vehicle to put asphalt in hopper.
- This eliminates dump truck and MTV traffic on drainage layer directly in front of paver.

- Paver & spreader box used to distribute drainage layer material and reduce segregation

- Rolling completed to seat the drainage layer material
- Density Testing not required

- TEST SECTION
    - Should always be completed
    - Used to determine the required number of passes to stabilize

Underdrain System

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- Cut UD trench early to facilitate subgrade drainage

- Starting Trench for UD installation
- If soils are soft, can be dug with small backhoe

Underdrain System

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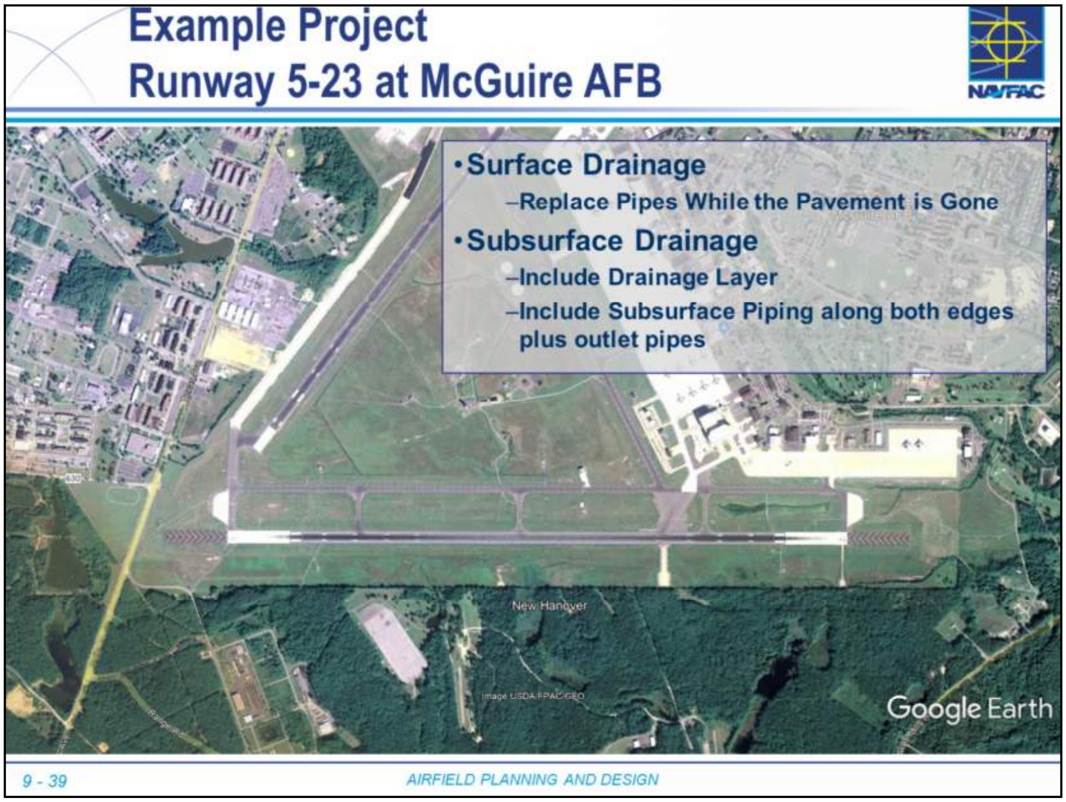
- Fabric wraps over top of UD pipe trench

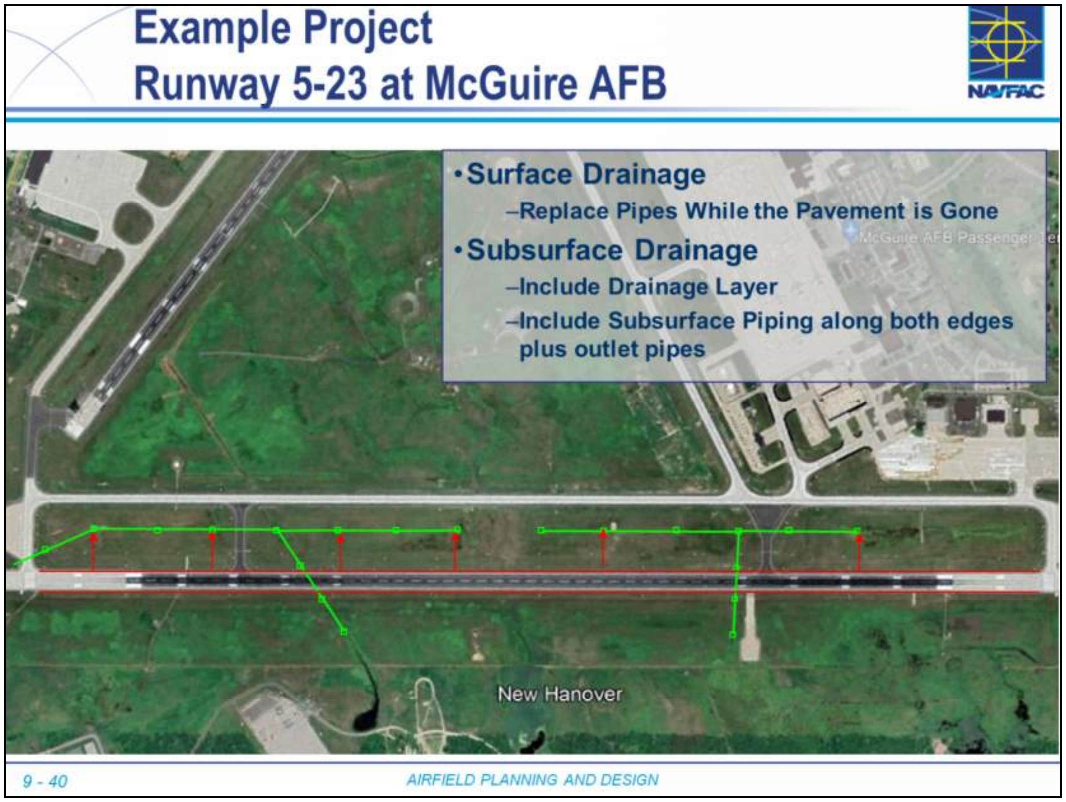
- Fabric in trench prior to pipe placement

- Cleanout risers stubbed up during base course/drainage layer prep
- Sometimes cleanouts end up within slabs

- Outfall pipe direct connection into existing drainage structure
- Note rubber collar around pipe and connection drilled through wall



- Surface Drainage
    - Identify and evaluate storm drainage in the project area and consider including in scope
    - Stipulate design requirements for new system
    - Identify difficult construction conditions (very high water table, high flow through pipes, etc.)
- Subsurface Drainage
    - Ensure drainage layer cost is included in programmed cost
    - Ensure perforated pipes along both edges plus outlet pipes are included in programmed cost



- Taxiways
    - Demolished two taxiways
    - Reconfigured wide taxiway into much smaller configuration

- Key Points of Section
  - Stormwater Drainage
    - Shed the water to infields
    - Keep standing water off paved surfaces
    - Avoid Stormwater Management Facilities (detention ponds) on airfields due to wildlife attraction
  - Utility Structures on Airfields
    - Design to support 100,000 lbs wheel load at 250 psi
  - Subsurface Drainage important for good pavement performance
    - Drainage Layers routes moisture out from under pavement
    - Perforated Underdrains collect water and route it to storm drainage systems

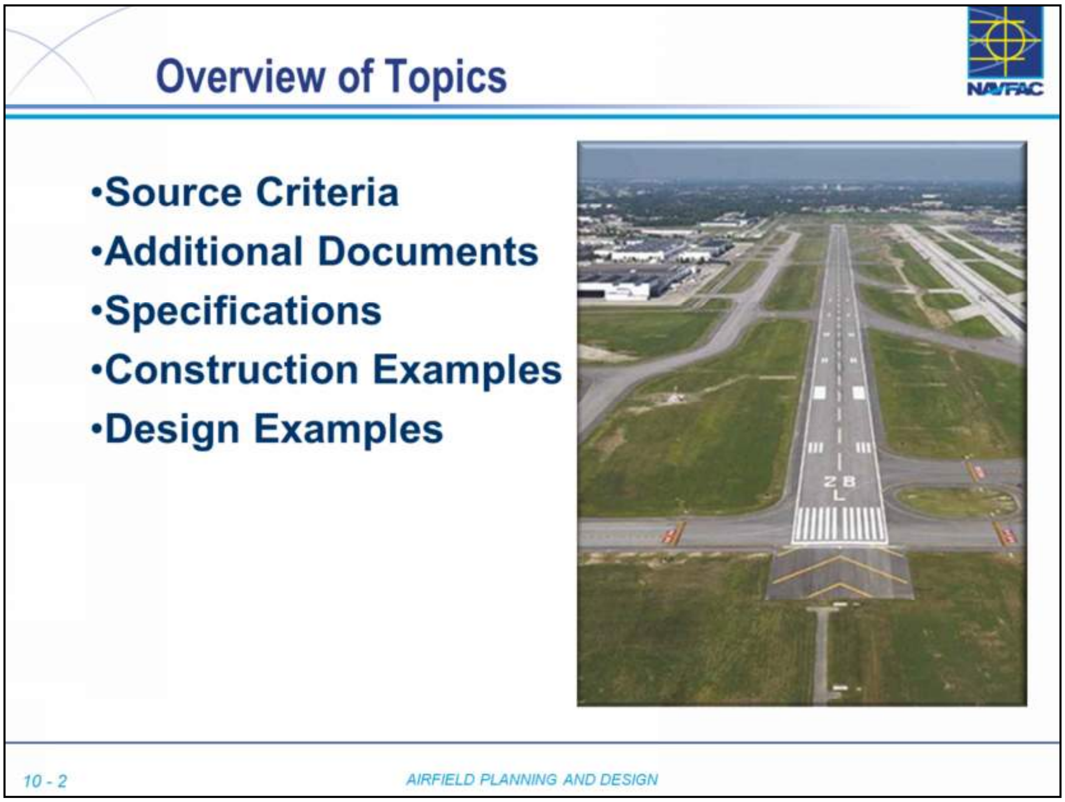
Name the Airfield

Naval Facilities Engineering Command

Section 10
Airfield Markings

AIRFIELD PLANNING AND DESIGN
CRITERIA TRAINING

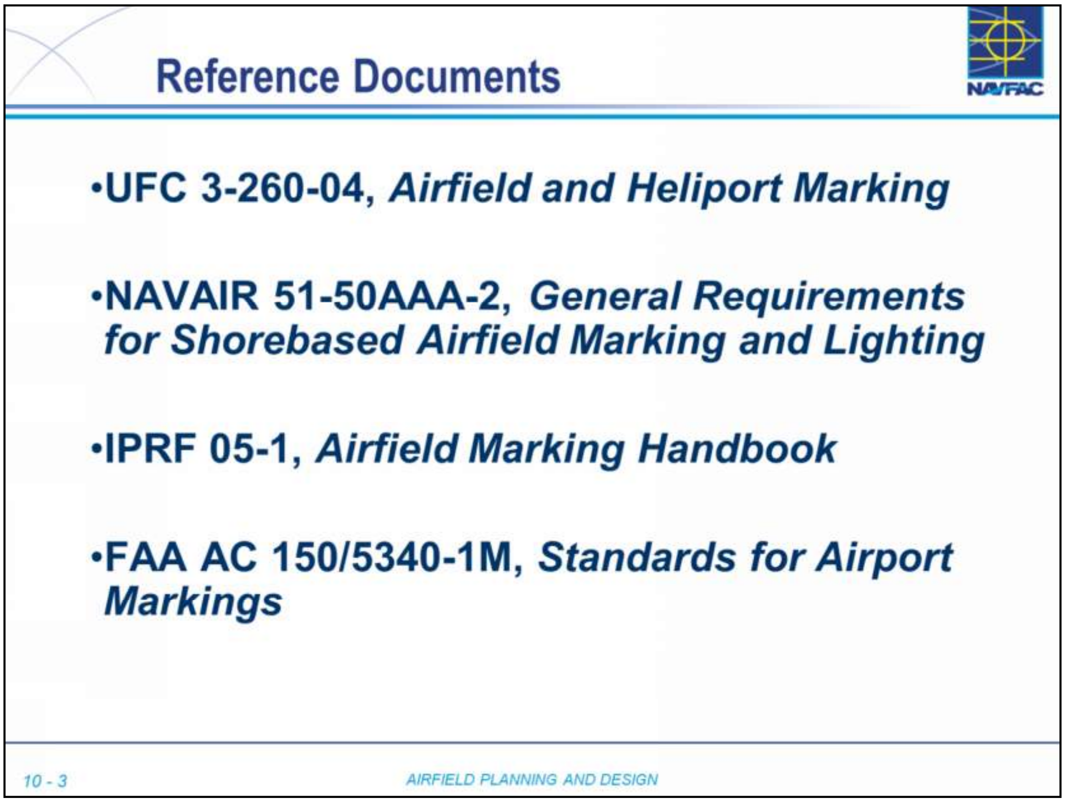
5/7/2023



Session is focused on airfield markings. List of Topics to be covered.

- Source Criteria
    - UFC 3-260-04
    - NAVAIR 51-50AAA-2
- Additional Documents – a few other non-DoD documents
- Specs – review details of the UFGS for markings
- Construction examples – equipment and tips
- Review some example plan sheets to identify some important features.

- **NOTE**: NAVAIR 51-50AAA-2 does not include any guidance on materials types, coating thickness or application procedures. For those items, follow the guidance in UFC 3-260-04 and the UFGS for pavement marking.



- UFC 3-260-04, *Airfield and Heliport Marking*
  - Published in May 2018
  - Replaced a variety of service-specific ETLs, UFCs and Technical Manuals
  - Applies to all DoD airports.
  - However, Para 1-4 states “US Navy and Marine Corps pavement marking details for shore-based installations are provided in NAVAIR 51-50AAA-2.
  - “Base the marking criteria used upon ownership of the facility or official agreements with the host nation or host aviation authority.”
  - Update non-compliant markings at the next painting cycle.

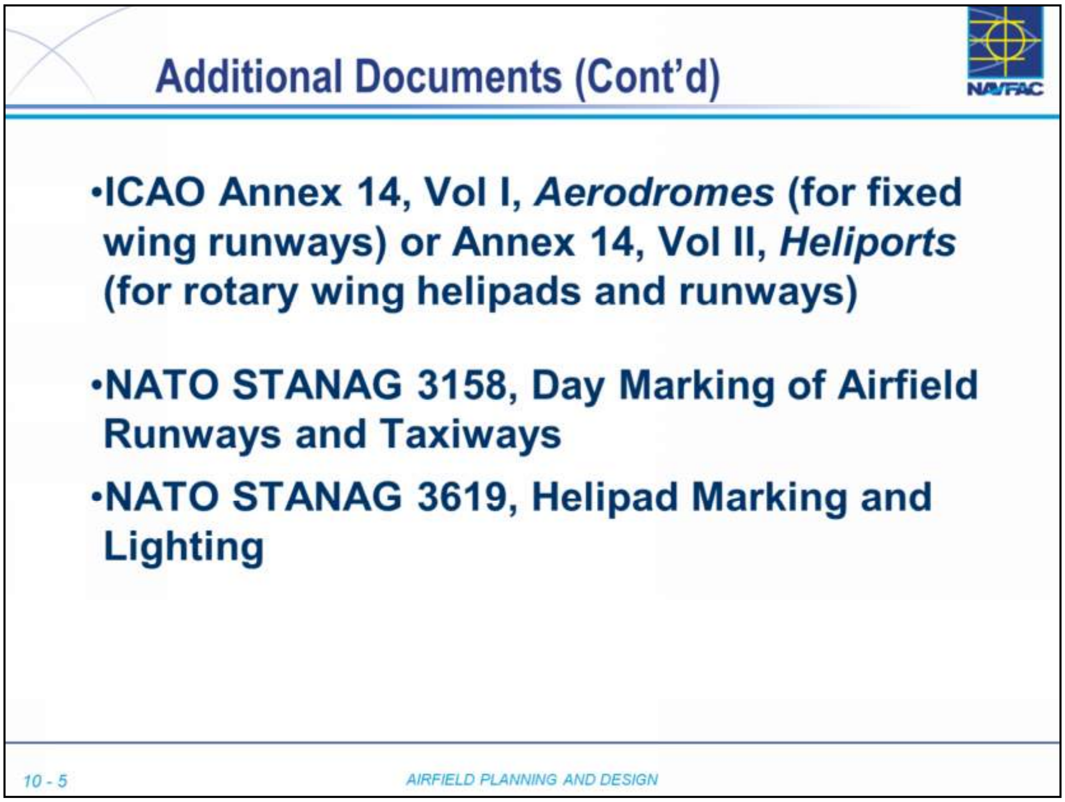
- NAVAIR 51-50AAA-2, *General Requirements for Shorebased Airfield Marking and Lighting*
  - Last change Nov 2017
  - Follow FAA whenever possible, unless specifically changed in 51-50AAA-2
  - Document is managed by **NAVAIR**, <u>not</u> **NAVFAC**.

- Innovative Pavement Research Foundation Report 05-1, *Airfield Marking Handbook*
  - Referenced as a good source for guidance in UFC 3-260-04, Appendix B, Best Practices

- FAA AC 150/5340-1M, *Standards for Airport Markings*
  - May 2019

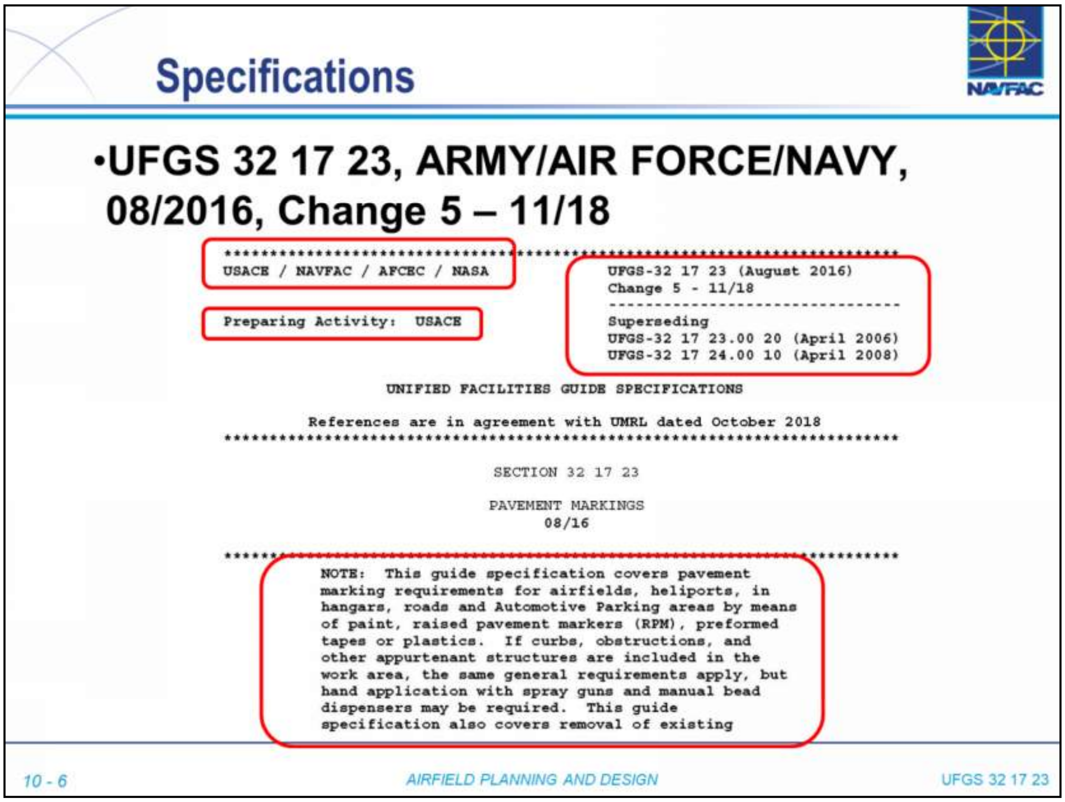
- NAVAIR 51-50AAA-2: Navy-specific marking guidance document,
  - Includes unique markings used at Navy facilities to mimick shipboard markings.

- Navy uses UFGS 32 17 23 *Pavement Marking*
  - Guide specification for all types of airfield markings
    - water-based
    - oil-based
    - Thermoplastic
    - Roads and airfields.
    - Need to edit carefully to make sure you get the right materials and application for airfields.
  - Check the tailoring options for Navy



- ICAO has their own set of standards for airport markings
  - Similar in color scheme (white on runways, yellow on taxiways)
  - Layout dimensions can be different

- NATO also has standards for airfield markings.
  - Reference these documents when working on a NATO facility project.
- The ASCC of NATO is how the US influences NATO standards
  - Army, Navy and Air Force Engineering have representation on this committee



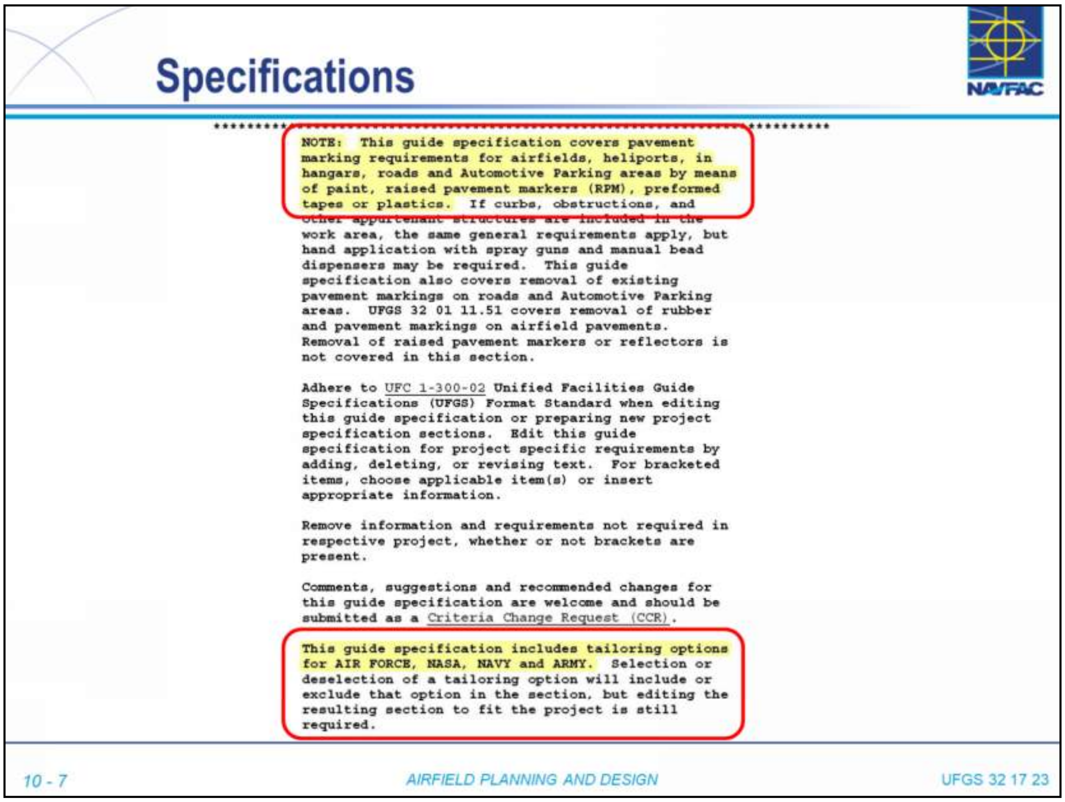
Specification

- Cover some details of the UFGS for markings
- Note – this is the only source of certain criteria for Navy, like material types and application rates. That aspect of markings is not covered in NAVAIR 51-50AAA-2

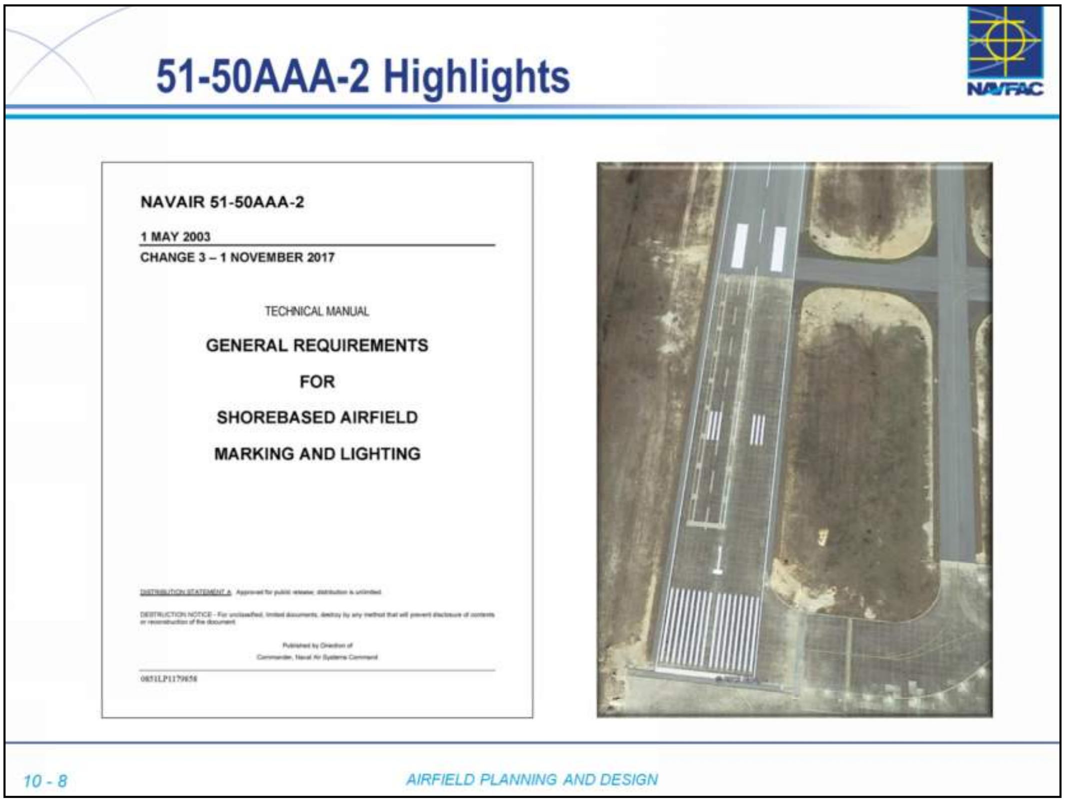
Pay attention to certain features in the title block

- 1. What agencies allow use of this spec.
- 2. Who prepared it – that is, who controls edits to the spec
- 3. What is the current date, and what was superseded – sometimes the numbers change
- 4. Designer Notes
    - Notes appear in the guidespecs to provide specific instructions to the designer
    - Should not be printed in the as-bid version of the spec

- This spec is used for all types of markings, including roads and parking lots. Need to read carefully and weed out the portions that don't apply to airfields, such as oil-based paints and tape strips.

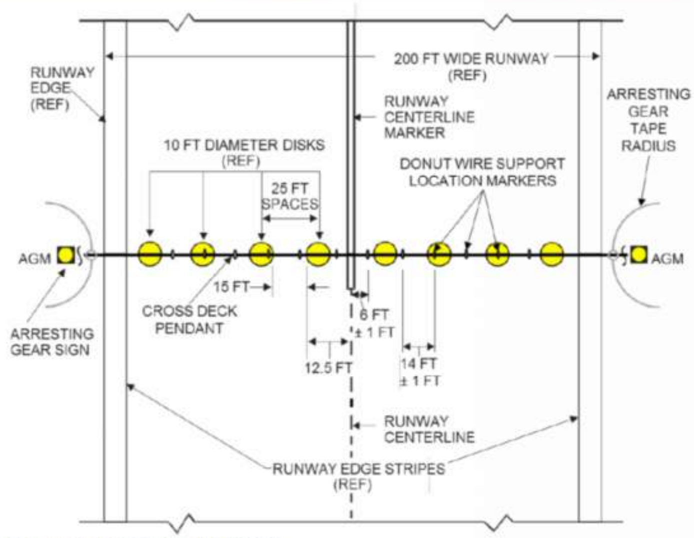


- Notes provide clues about the purpose of the spec.
    - Sometimes the titles are similar and hard to distinguish
    - Read the first couple sentences of the designer notes to determine whether you have selected the right spec.
- Many (but not all) specs include tailoring options
    - Specific to each services.
    - Use to quickly edit out the service-specific parts that don’t apply



- NAVAIR 51-50AAA-2 contains markings unique to Navy

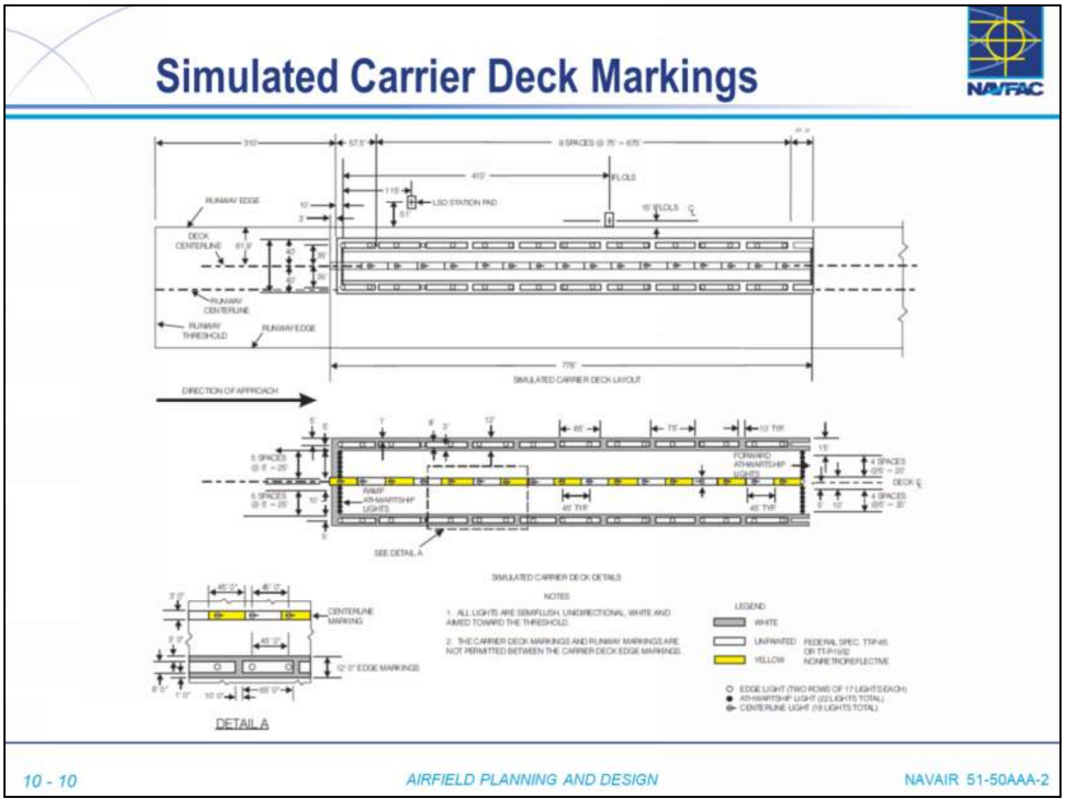
Arresting Gear Markers



COLOR OF DISKS IS RETROREFLECTIVE YELLOW

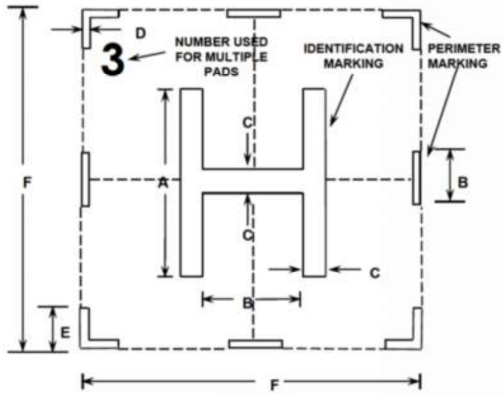
Figure 1. Configuration for pendant cable markings

- Arresting gear cable marking



- Simulated Carrier Deck Marking Layout

Helipad Markings



DIMENSIONS

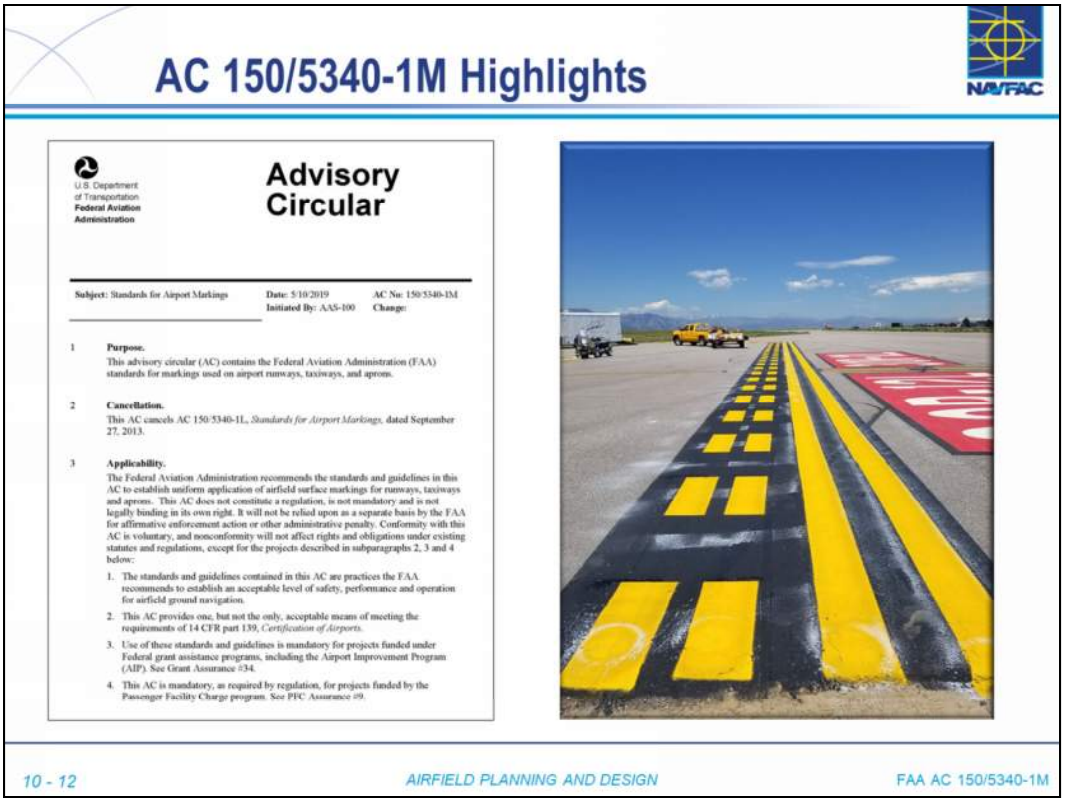
A = 0.6F BUT 60' MAX.
B = 0.5A

HELIPAD SIZE (F)	PATTERN LINE WIDTH (C)	PERIMETER EDGE WIDTH (D)	CORNER EDGE LENGTH (E)
80' - 99'	5'	24"	10' (TYP)
100' - 150'	6'	30"	12' (TYP)

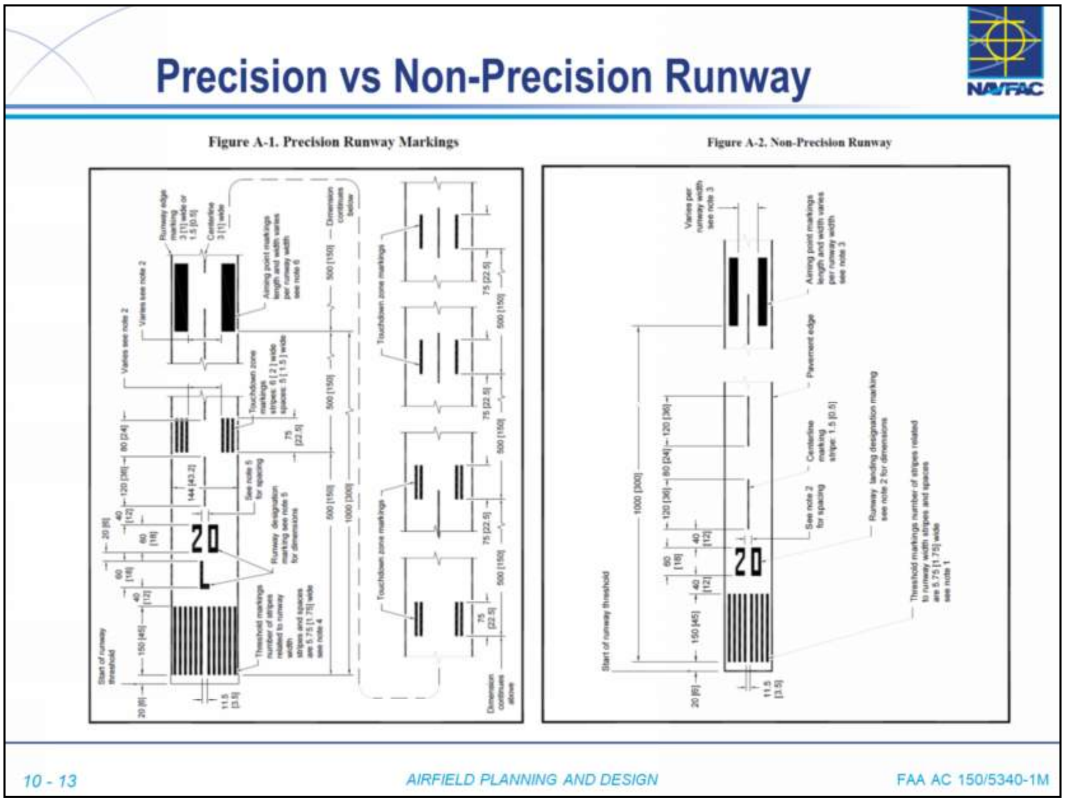
COLOR: RETROREFLECTIVE AVIATION SURFACE WHITE, EXCEPT HELIPADS FOR DAY OPERATIONS ONLY MAY BE NON-RETROREFLECTIVE WHITE

10 - 11 *AIRFIELD PLANNING AND DESIGN* NAVAIR 51-50AAA-2

NOTE: Applying the marking does not officially make it a helipad from a Basic Facilities Requirements (BFR) standpoint



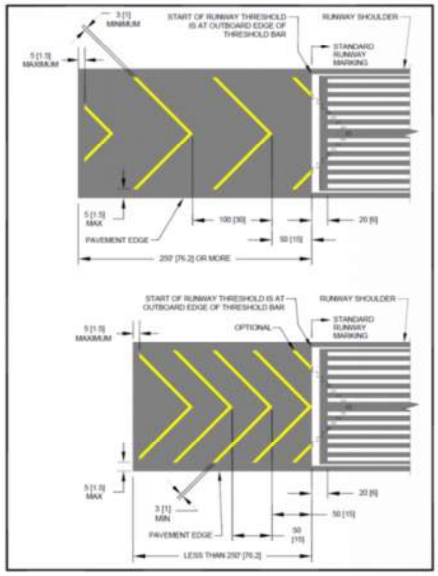
- FAA AC 150/5340-1M
  - Should be followed unless superseded by NAVAIR 51-50AAA-2.



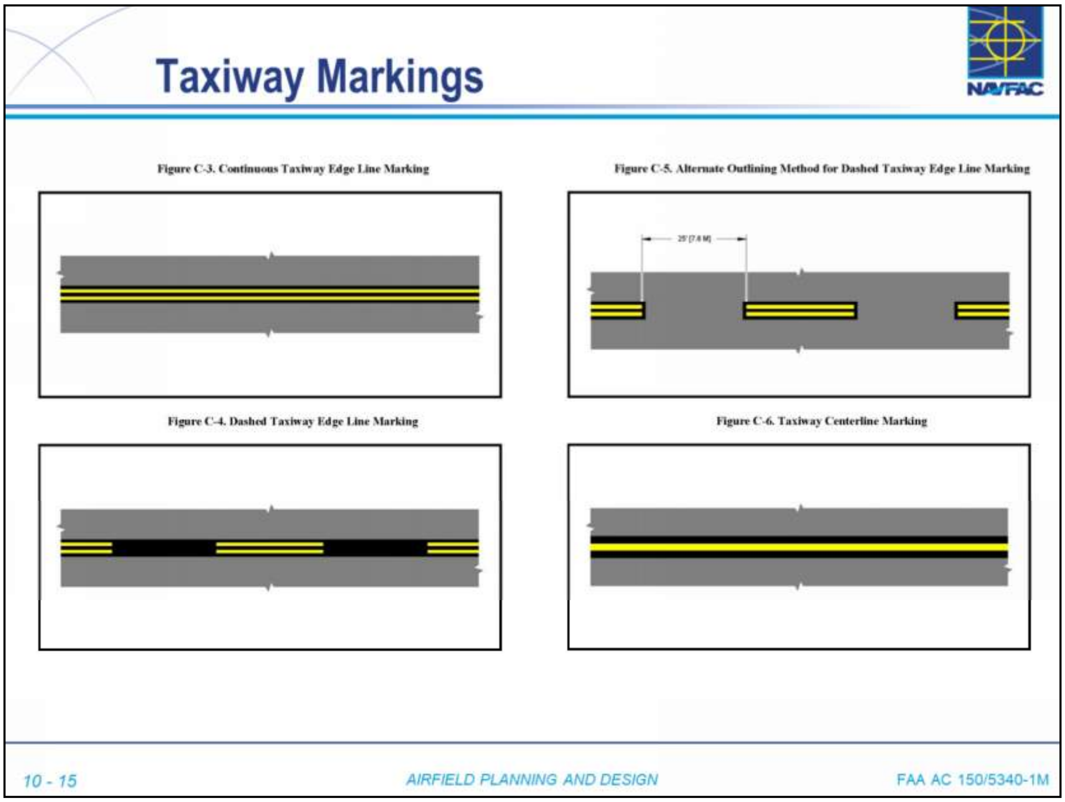
- Three different types of runways are distinguished by their markings. Need to know your runway type when you start design.
  - Precision Instrument – has the most markings
  - Non-precision Instrument – has threshold markings and aiming points
  - Visual – only designators, centerline and aiming points required

Blast Pads and Overruns

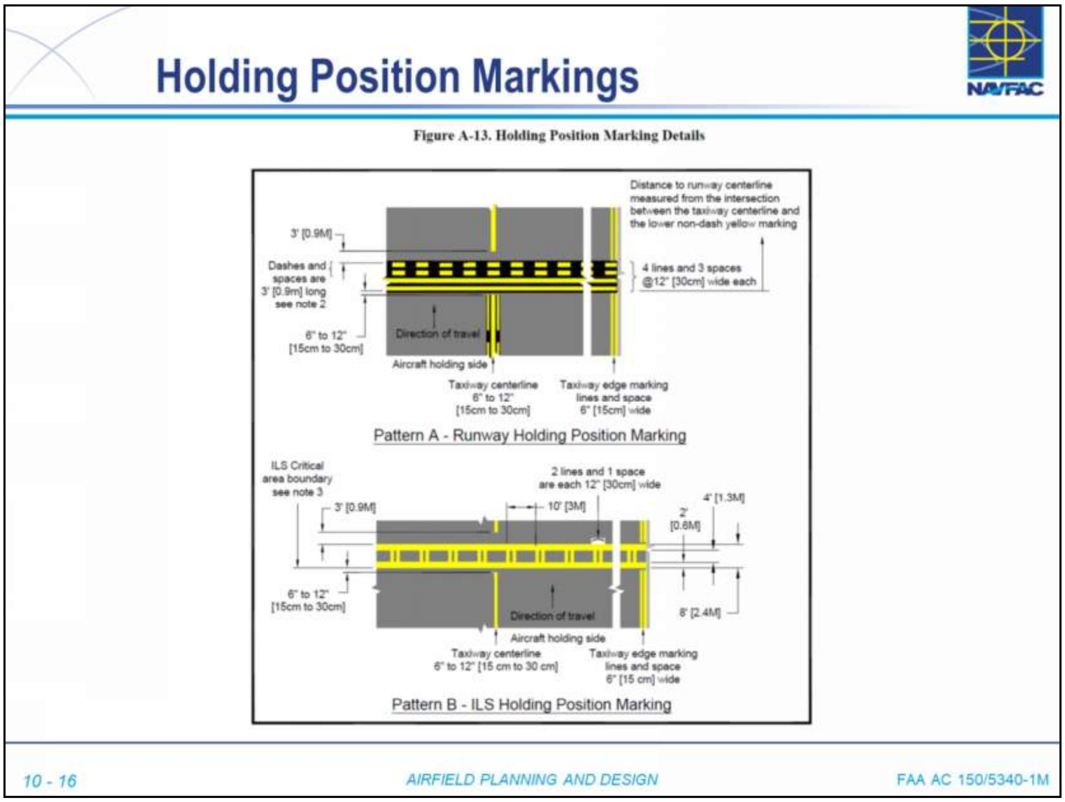
Figure A-9. Markings for Blast Pads and Stopways



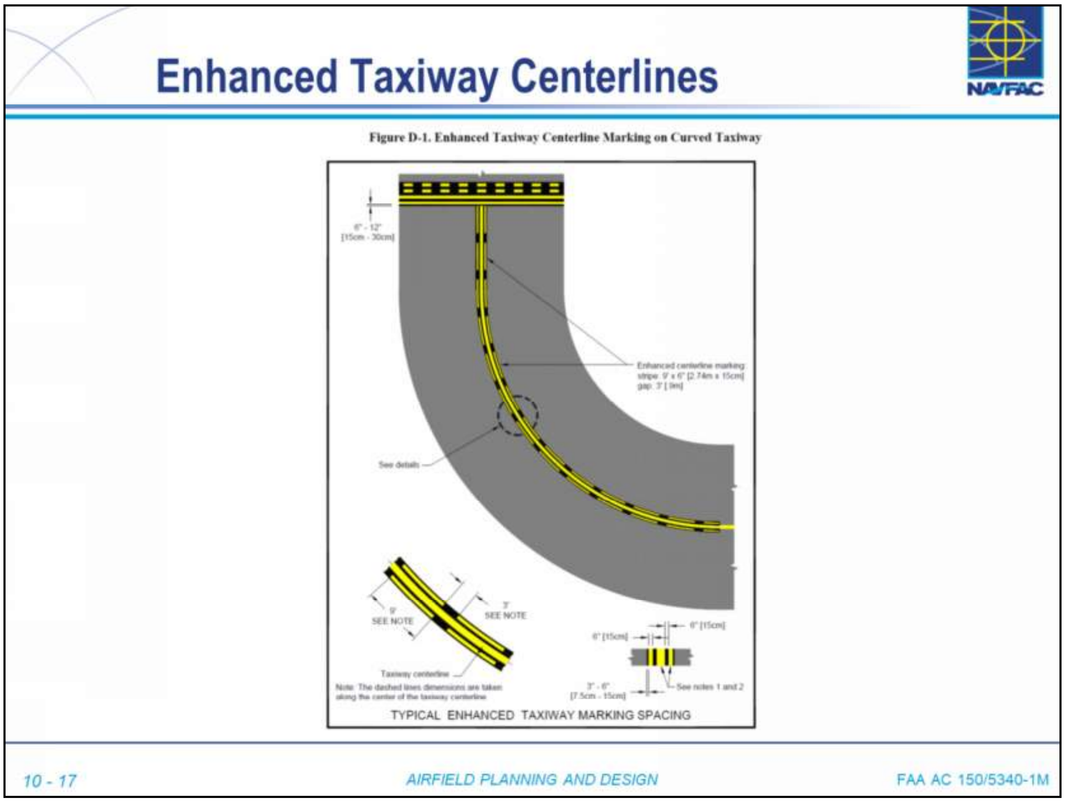
- Overruns require chevrons to distinguish from runway



- Taxiway markings include
    - Centerline
    - Edge
    - Dashed Edge



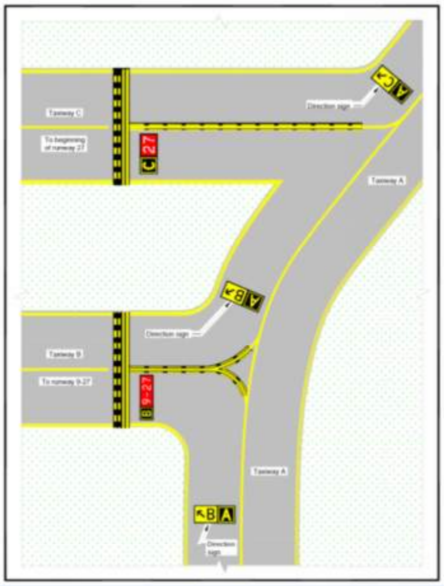
- Hold Position Markings are critical to safety.
- Read the notes and stick to the dimensions
    - Note the gaps between centerline and edge stripes and the hold line.



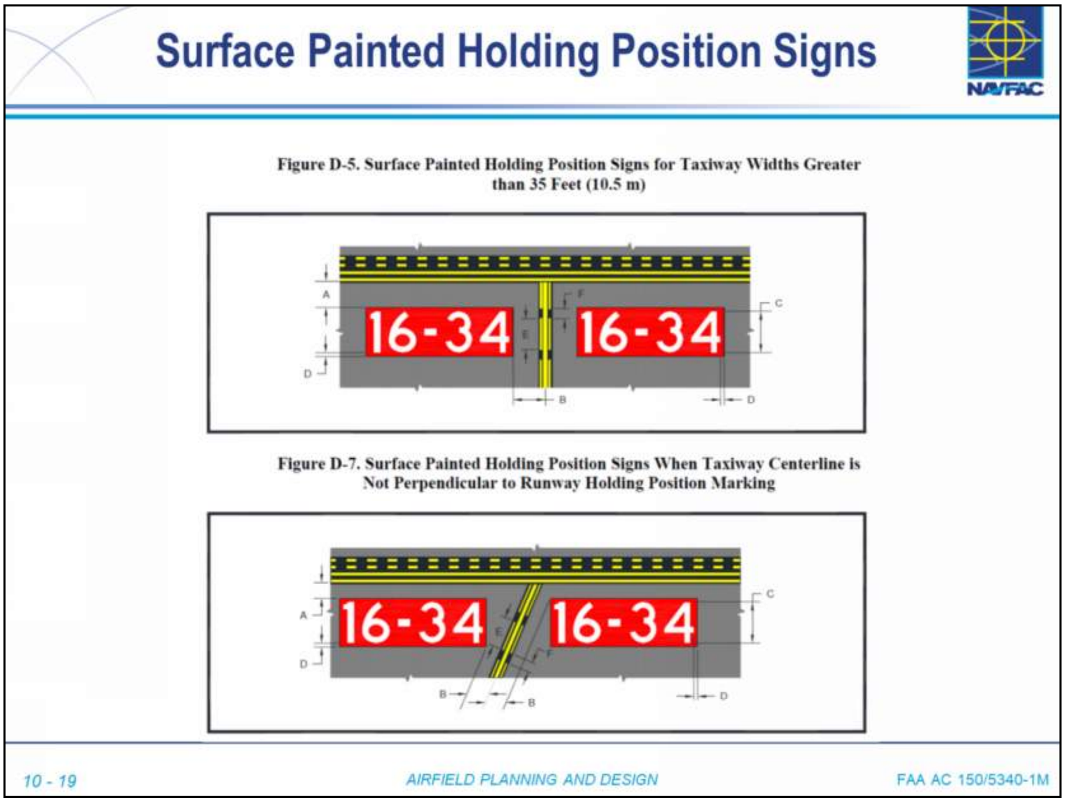
- Enhanced Taxiway Centerline Markings started with FAA about 10 years ago
- Now adopted by DoD

Surface Painted Hold or Direction Signs

Figure A-19. Surface Painted Direction Signs



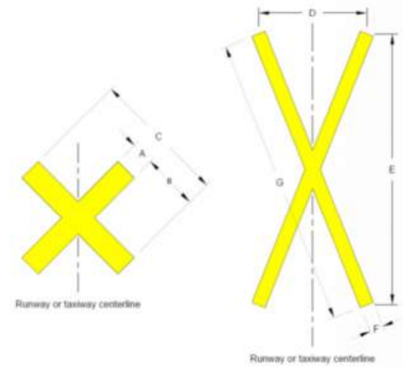
- Surface Painted Signs can be used to enhance awareness



- Surface Painted Hold Signs can alert ground vehicles not to enter runway

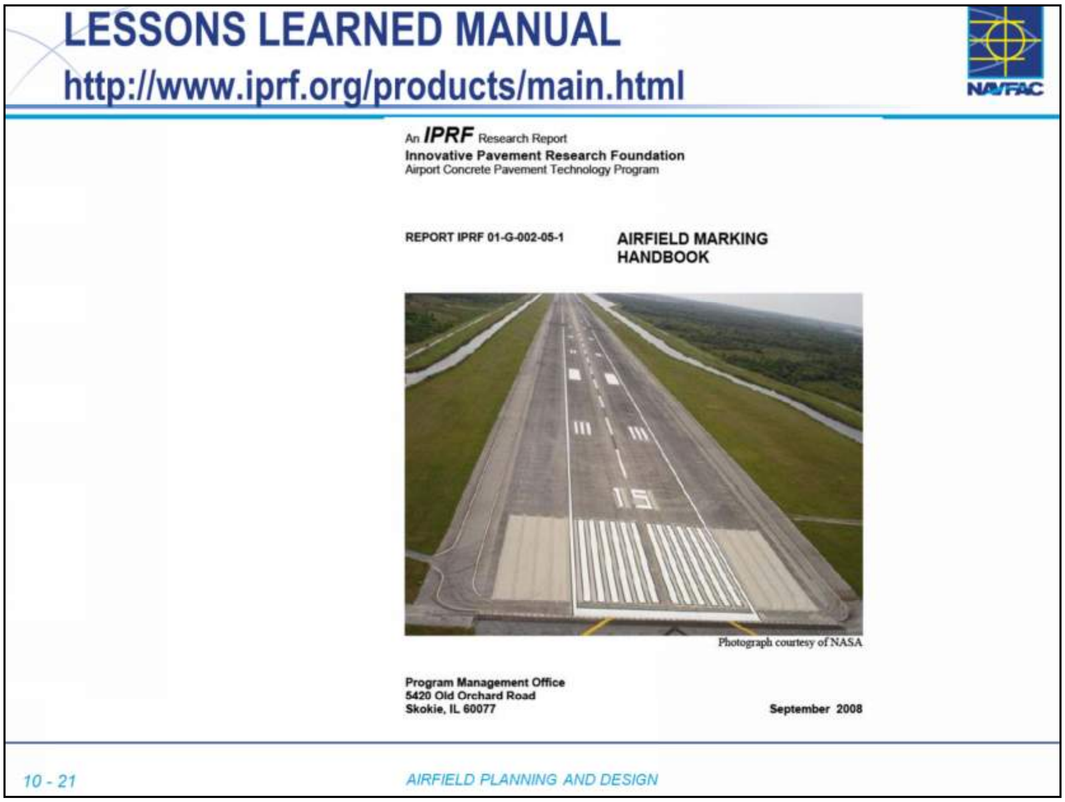
Closed Runway and Taxiway Markers

Figure A-27. Closed Runway and Taxiway Markings



Pattern	Dimension / Symbol type	A	B	C	D	E	F	G
A	Closed runway	10' [3M]*	25' [7.5M]	60' [18M]	-	-	-	-
B	Closed runway (alternate)	-	-	-	48 [14.4M]	120 [36M]	6 [1.8M]	129.25' [39M]
C	Closed taxiway	5' [1.5M]**	12.5' [3.8M]	30' 9M]	-	-	-	-
D	Closed taxiway (alternate)	-	-	-	24 [7.2M]	60 [18M]	3 [.09M]	64.6 [20M]

- AC also includes guidance for markings to close runways and taxiways



- Innovative Pavement Research Foundation sponsored the development of an Airfield Marking Handbook in 2008
- IPRF was part of the Airport Concrete Pavement Technology Program, funded by FAA.
- Lead author was an airfield pavement marking specialist contractor.
- Executive summary states "*The information presented here is a compendium of practices that, when used, result in longer performing pavement markings. Good markings are the result of quality materials installed by appropriate equipment that comply with basic application requirements. The quality of newly installed airfield markings is a direct reflection of both quality workmanship and materials*."
- Great reference for information on specifying markings, surface preparation, existing marking removals, and new marking applications.

- This document is referenced as a Best Practice in Appendix B, UFC 3-260-04.

- Surface preparation
  - Key to achieving good adhesion with the new paint.
  - Old pavement must be clean
  - New PCC pavement must have the curing compound removed.
- Example of a truck with equipment to clean pavement
  - can remove either curing compound or old paint.
- Old Paint Removal
  - Need to remove prior to re-painting whenever the existing paint is flaking and debonded.
  - See UFC 3-260-04, Para 4-3
  - "Each time surface is over-painted, the initial stress at the bond between the paint binder and the pavement increases. For this reason, **remove painted markings before they build up more than about 40 mils (1 millimeter) total thickness**. This occurs after about **five marking cycles with Type I or Type II** paints, and even more rapidly with the more heavily applied Type III (high-build) paints unless surface abrasion such as that caused by heavy accelerating, stopping, or turning traffic, or snow removal operations with plows and/or brooms, reduces the buildup by abrasion. **Over-painting** to excessive thickness also eventually **causes** the marking to **prematurely crack and peel**."

• Rotating heads of high pressure water.

- Pavement cleaning by waterblasting requires close monitoring to remove the paint but not damage the surface
- If too aggressive (too high pressure and/or too slow movement), the pavement surface can be damaged by cutting out all the surface paste on the PCC.

Marking Removal – FOD Risk

IPRF Figure 4-7. Many Layers of Paint on Asphalt

IPRF Figure 5-6. Heavy Paint Build Up on Concrete

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- Markings that build up too much can create risk of FOD
- Flakes can blast off or be ingested by engines (F-35B particularly susceptible)

- UFC 3-260-04, Para 4-3: Remove old markings to prevent paint thickness buildup greater than 40 mils (1 mm)

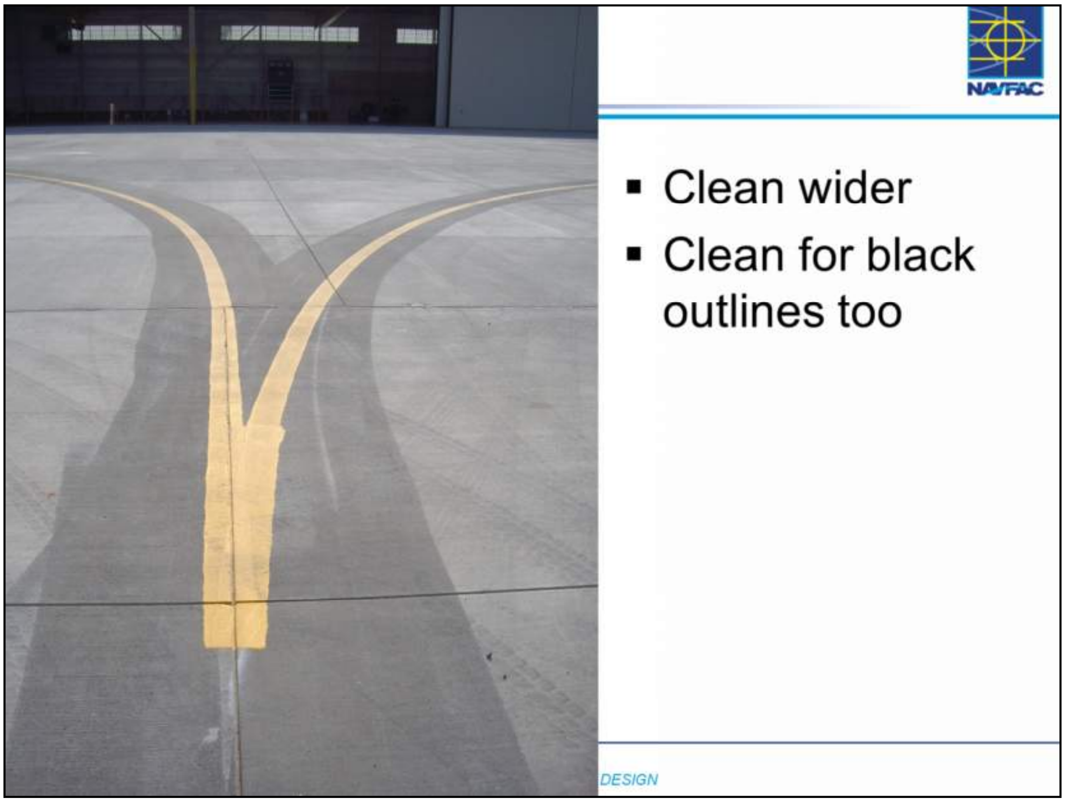
Marking Removal

IPRF Figure 4-1. Before Cleaning Loose and Poorly Bonded Paint

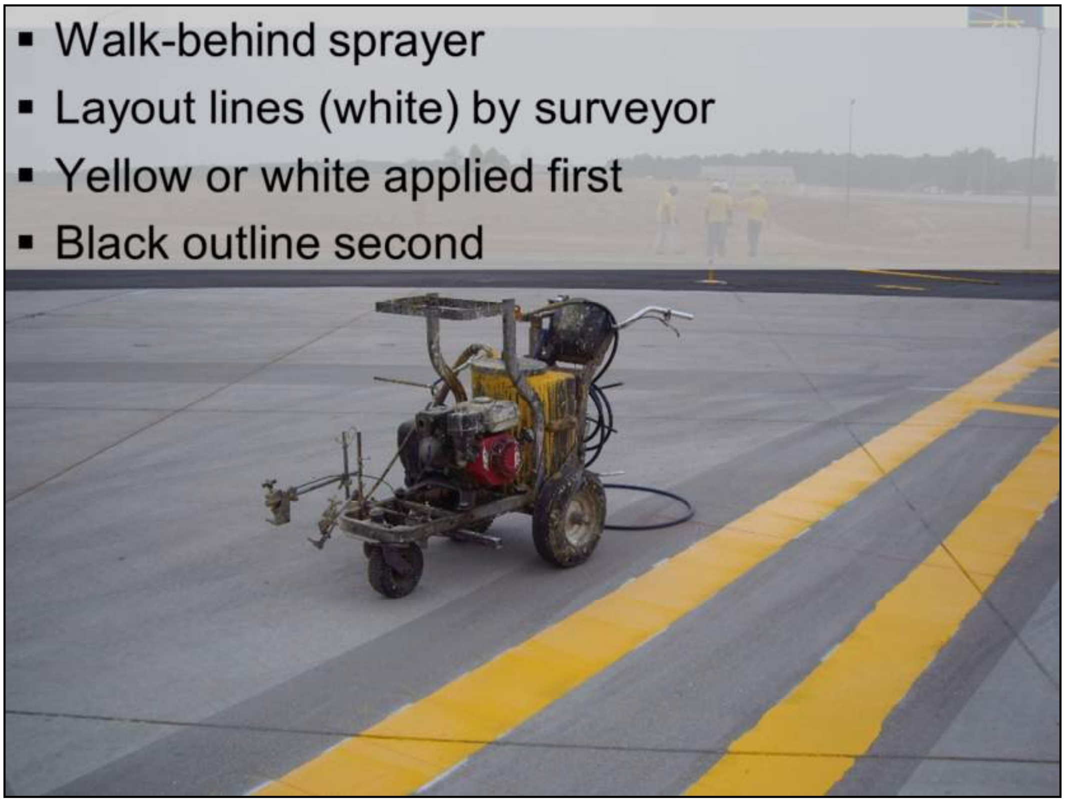
IPRF Figure 4-2. After Cleaning Loose and Poorly Bonded Paint by Waterblasting

- Pictures illustrate markings before and after removal.
- Complete removal of all paint is not essential.

- If too aggressive (too high pressure and/or too slow movement), the pavement surface can be damaged by cutting out all the surface paste on the PCC, as shown in this example.
- Need to specify degree of removal that is required
    - In most cases, 85% to 90% is adequate to remove excessive marking buildup prior to applying new paint.

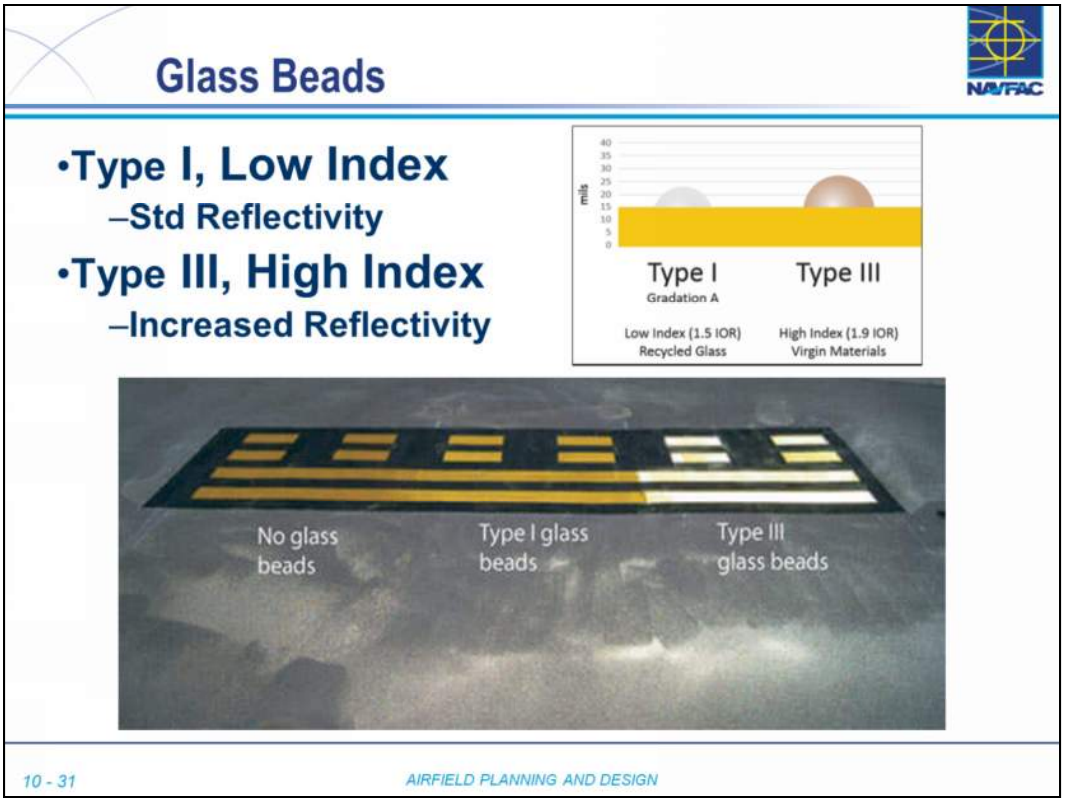


- Cleaning operations should be somewhat wider than the paint application.
- In this case, it appears black borders will still be added.



- Typical walk-behind paint sprayer.
- Layout markings (white lines)
  - Usually laid out by a surveyor by spraying over top of a stringline.
- Yellow stripes are applied (with reflective glass beads) first
- 6” black border
  - Clean up the edges
  - Enhance visibility.

- Glass beads
    - Sprayed onto the freshly sprayed paint
    - Use application machine to get even coverage



- Type I beads are low index (less perfectly round) resulting in more diffuse reflection.
- Type III beads are high index (more perfectly round) resulting in a better return of light to the source. These beads are more expensive than Type I.

Glass Beads

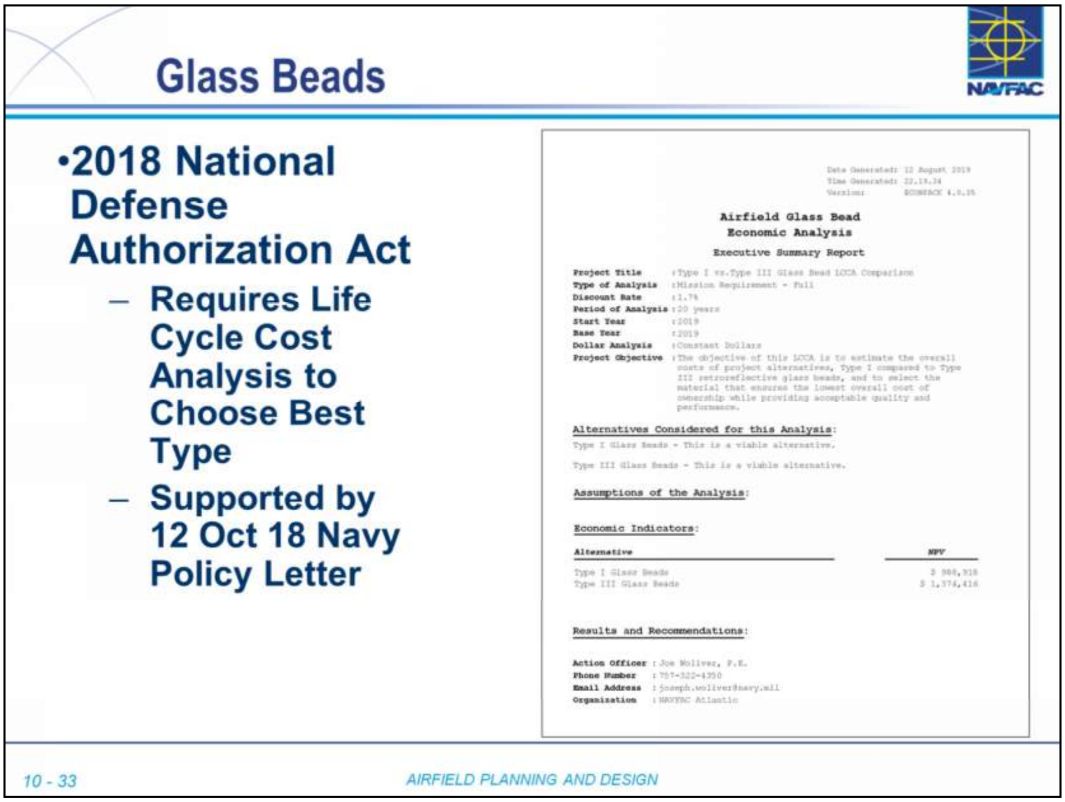
Type I Glass Bead

- Recycled glass
- Small
- Durable
- Index of Refraction of 1.5
- Inexpensive

Type III Glass Bead

- Virgin Glass
- Large
- Fragile
- Index of Refraction of 1.9
- Expensive

- Type I beads general properties
  - Recycled glass
  - Small
  - Durable
  - Index of Refraction = 1.5
  - Inexpensive
- Type III beads
  - New glass
  - Large
  - Fragile
  - Index of Refraction = 1.9
  - More Expensive



- 2018 National Defense Authorization Act requires DoD to complete a life-cycle cost analysis (LCCA) to determine most appropriate bead considering the local site conditions, life-cycle cost maintenance, environmental impact, operational requirements, and the safety of flight.
  - LCCA tool (ECONPAK) has been developed for Navy and is available from SMEs

- See INTERIM TECHNICAL GUIDANCE (ITG 2019-01) - SELECTION OF RETROREFLECTIVE BEADS FOR AIRFIELD PAVEMENT MARKINGS AND LIFE CYCLE COST ANALYSIS REQUIREMENTS, dated 12 Oct 18 for Navy implementation policy.

Glass Beads – Cost Comparison

NAVFAC

Complete Airfield	Unit	Type I			Type III		
		Unit Cost	QTY	Cost	Unit Cost	QTY	Cost
Airfield Marking Requirement	SF	N/A					
Materials (marking paint)							
Paint Coverage Rate	SF/gal	N/A					
Paint	$/gal	$26.75	1,887	$50,477	$26.75	1,887	$50,477
Beads	$/gal	$18.83	1,887	$35,537	$68.84	1,887	$129,905
Labor & Equipment							
Crew Production Rate	SF/day	N/A	3,500	N/A	N/A	3,500	N/A
Crew	$/day	$2,356	58	$136,648	$2,356	58	$136,648
Subtotal				$222,663			$317,030
Overhead & Profit	34.50%			$76,818.65			$109,375.39
Total Cost				$299,481			$426,405

Beads	Bead Raw Cost ($/50-lb. Bag)	Application Rate (bead weight/per gal paint)	Application Cost (bead cost/per gallon)
Type I	$134.52	7	$18.83
Type III	$344.21	10	$68.84

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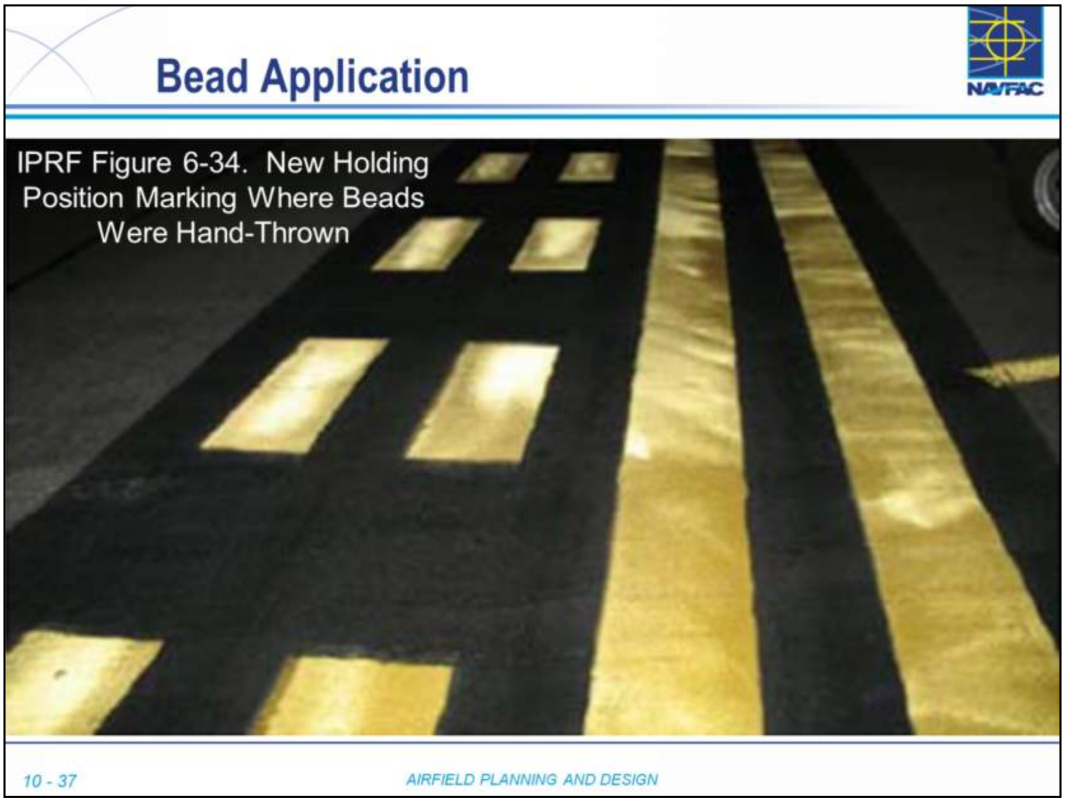
- Example Cost Comparison Developed by Navy
- Need a lifecycle cost analysis for every airfield striping project comparing the Type I and Type III beads
- Must use the least costly of the two
- Use ECONPAK if you can
- Guide for using ECONPAK for this process is on the WBDG, located here:
    - http://www.wbdg.org/ffc/dod/supplemental-technical-criteria/tspwg-m-3-260-04-18-01
- See below on WBDG for more information
    - TSPWG M 3-260-04.18-01 Life-Cycle Cost Analysis of Retroreflective Glass Beads
- Need to send a copy to LANT

…..not hand-tossed onto the new paint.

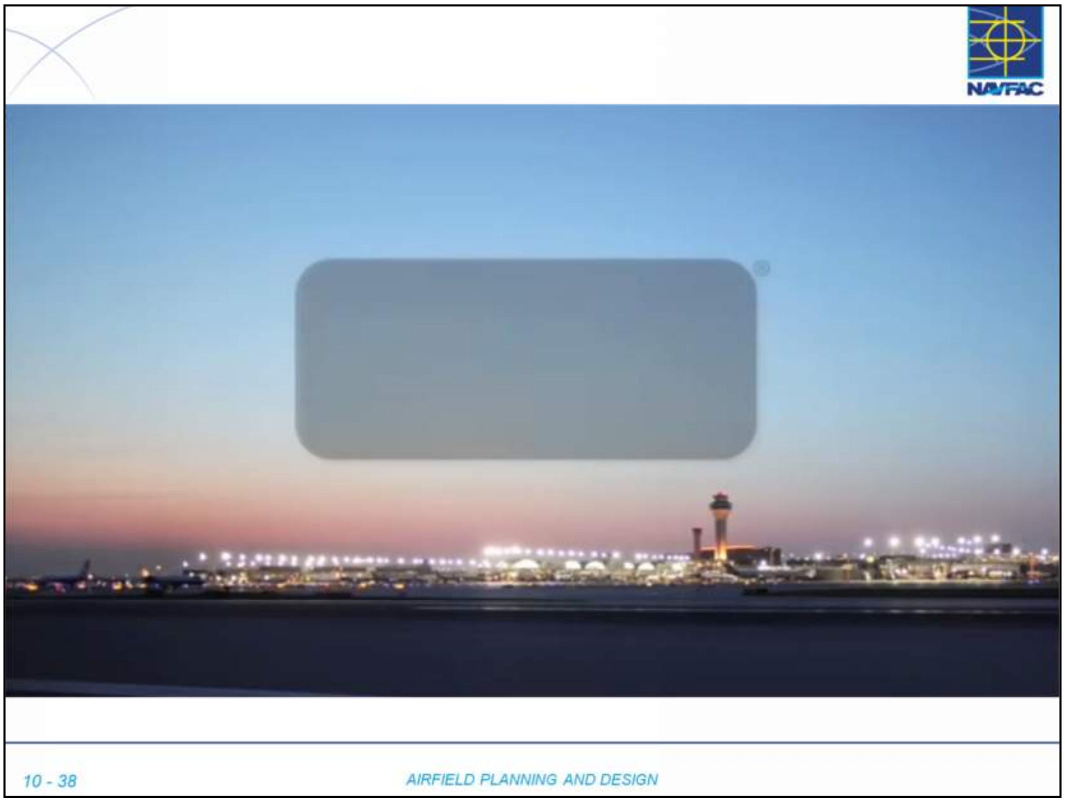
Bead Application

IPRF Figure 6-31. Pressurized Bead Application in Foreground, Gravity Drop in Background

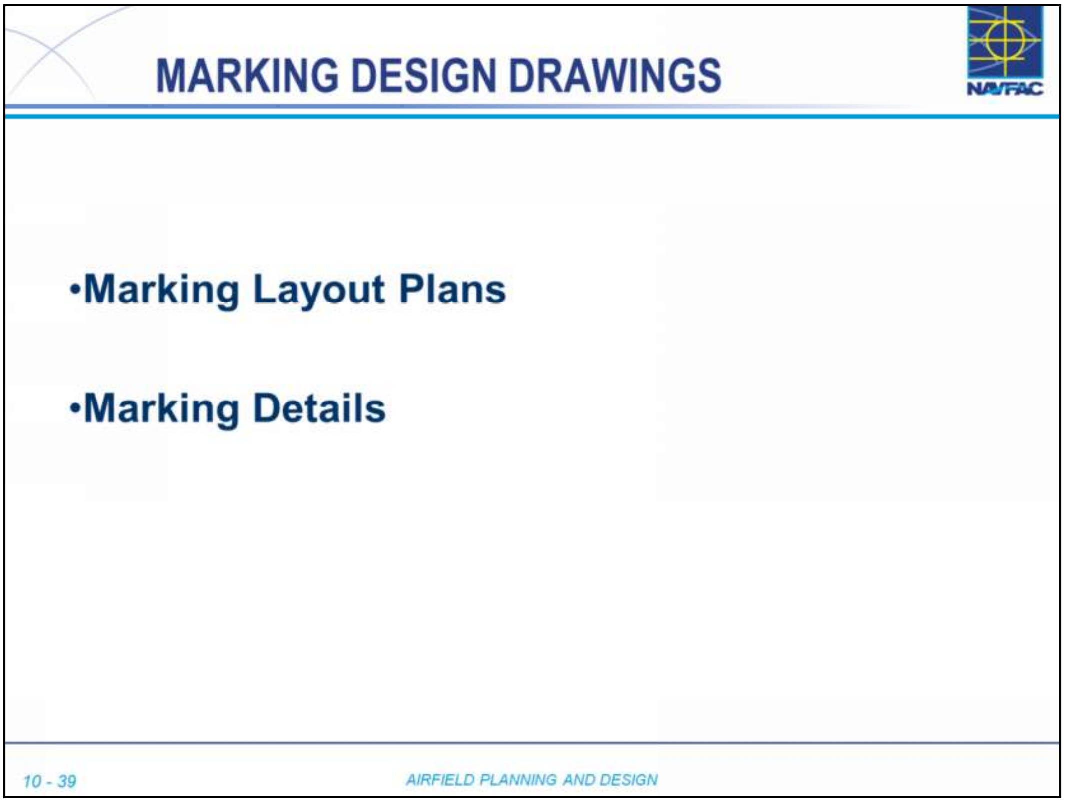
- Reflectivity of spray applied beads much more consistent than gravity drop with stripes



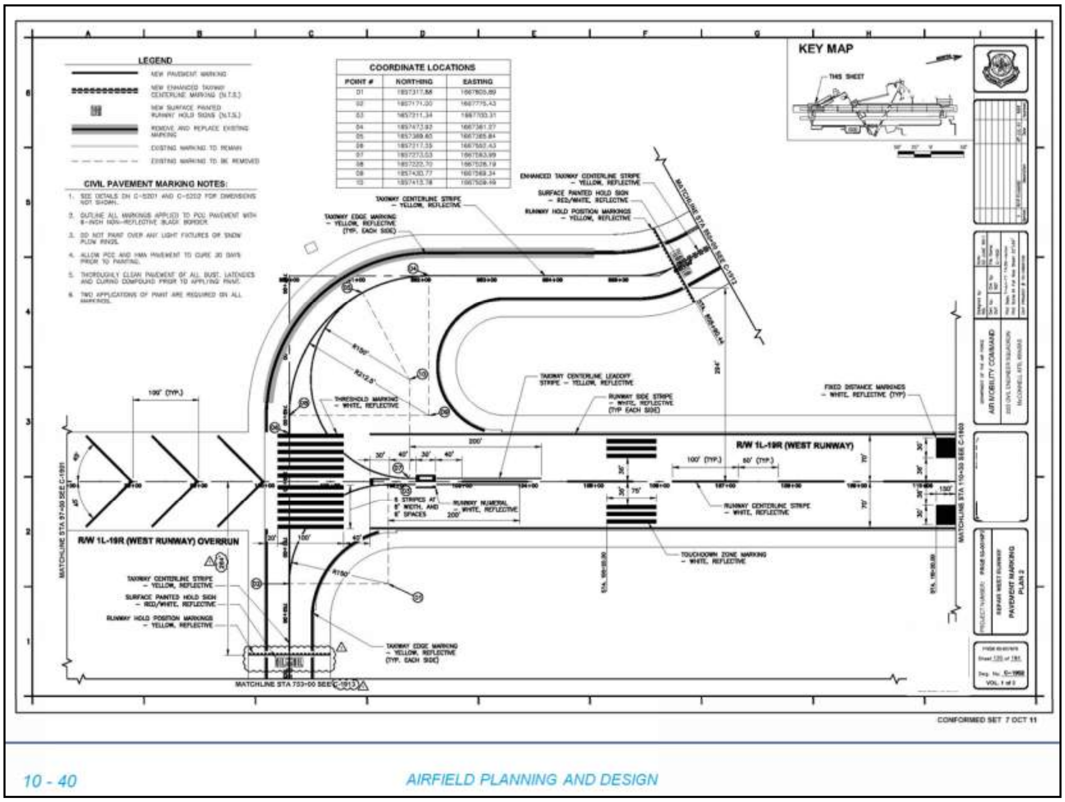
- Hand application of beads leads to very inconsistent reflectivity



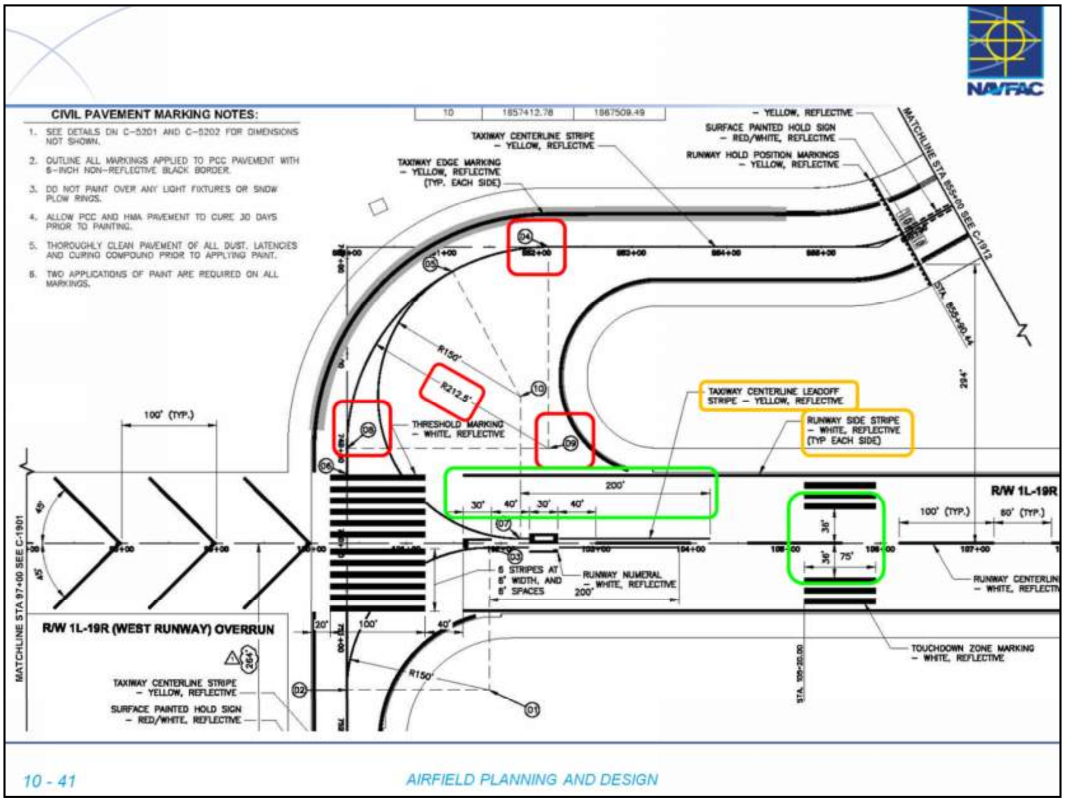
Video: Pavement Marking Application Video from Hi-Lite



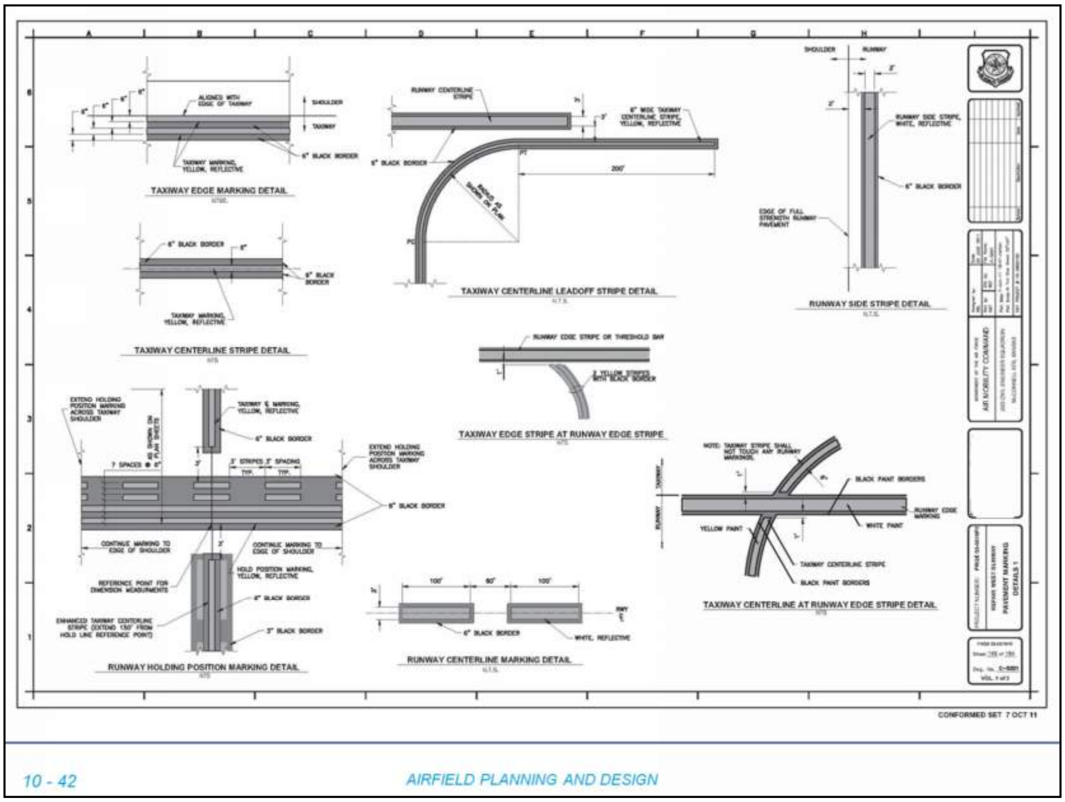
- Examples of typical marking plans and details
- Key features that should be included in your plans.



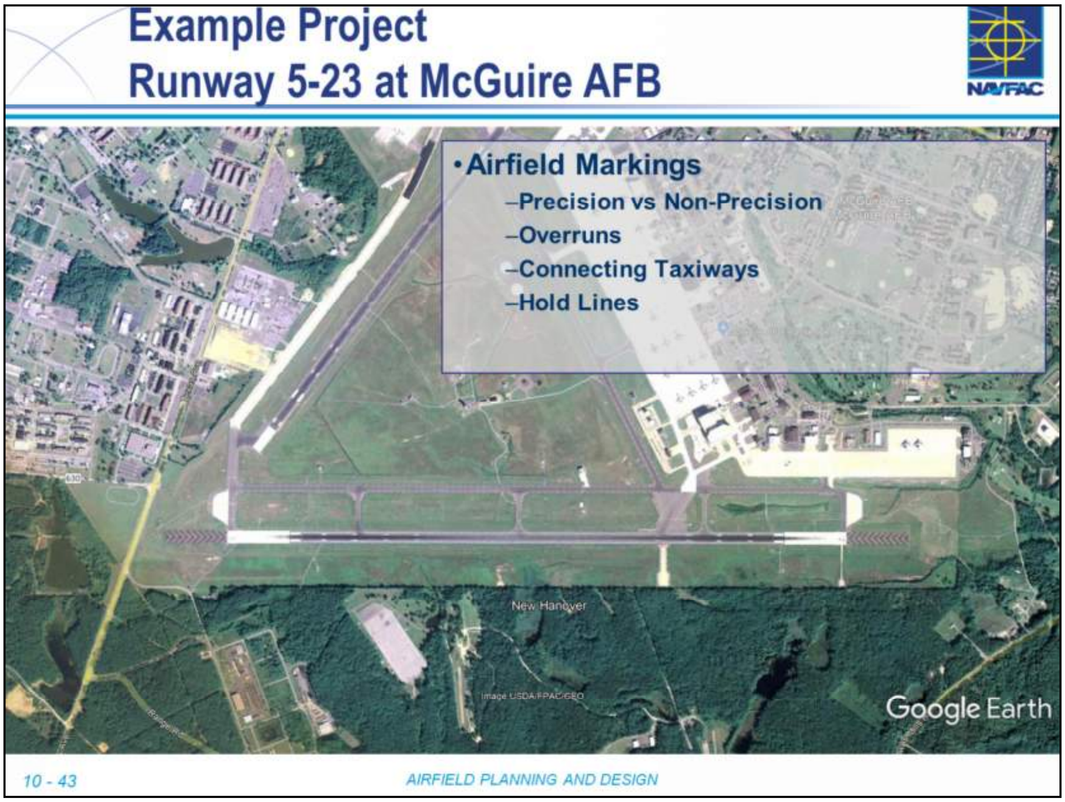
- Layouts
    - REMEMBER - surveyor needs to layout out all the various markings
    - Need to provide enough information to complete layout



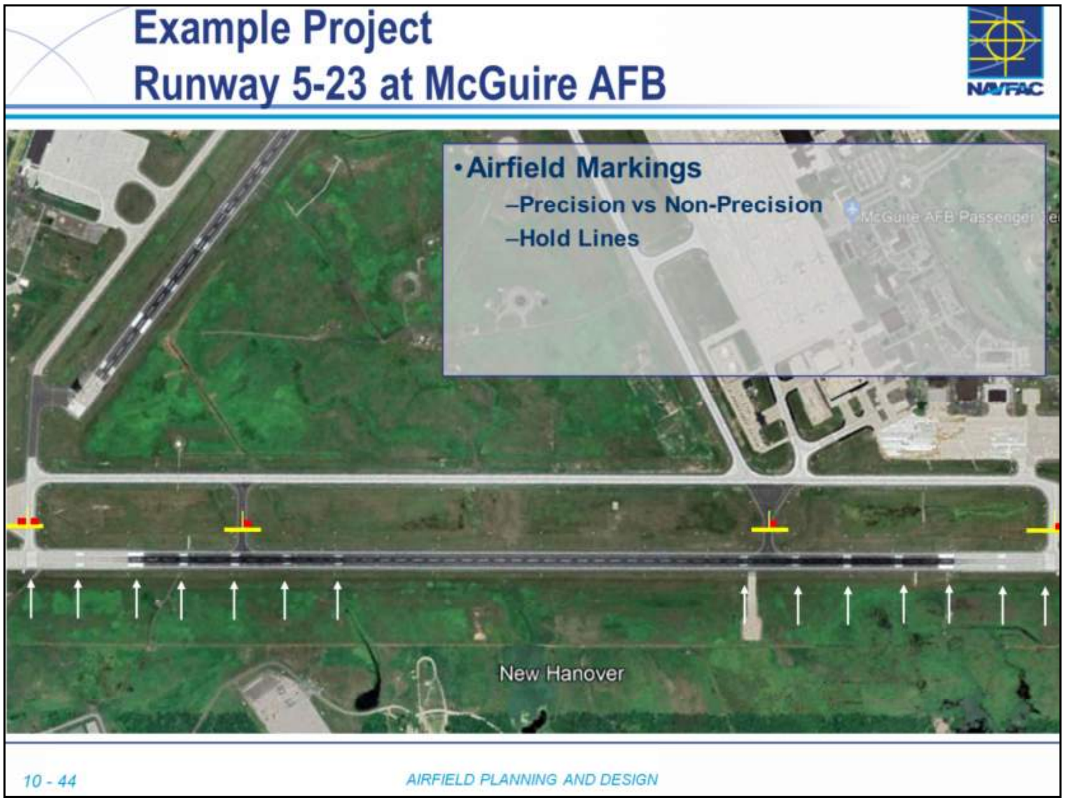
- Include start and end points for curves, with curve center points and radii.
- Provide spacing dimensions wherever possible
- Call out line colors
- Provide references to details through the legend or bubble callouts.



- Details should be fully dimensioned.
- Use shades of gray to show black background as well as the yellow or white markings
- Detail the marking position relative to edge of pavement or other markings



- Airfield Markings
    - Be sure to include in programming documents
    - Cost is low but not insignificant
        - Runways
        - Overruns
        - Hold Lines
    - Temporary Markings such as Temp Displaced Threshold requirement placement <u>and</u> removal



- Airfield Markings
    - Precision Markings required a large area of marking
    - Hold Lines are wide. Include surface painted hold signs and enhanced taxiway centerlines.
    - The markings add up.

- Key Points of Section
  - UFC 3-260-04 passes through to NAVAIR 51-50AAA-2 is primary guidance for Navy.
    - Supplemented by FAA AC 150/5340-1M
  - UFGS 32 17 23 contains information about application rates, preparation, marking removal, etc.
  - Waterborne paint most commonly used on airfields
  - Beads critical to retro-reflectivity
    - Type I vs Type III
  - Good construction techniques critical
    - IPRF Airfield Marking Handbook is good reference

Name the Airfield

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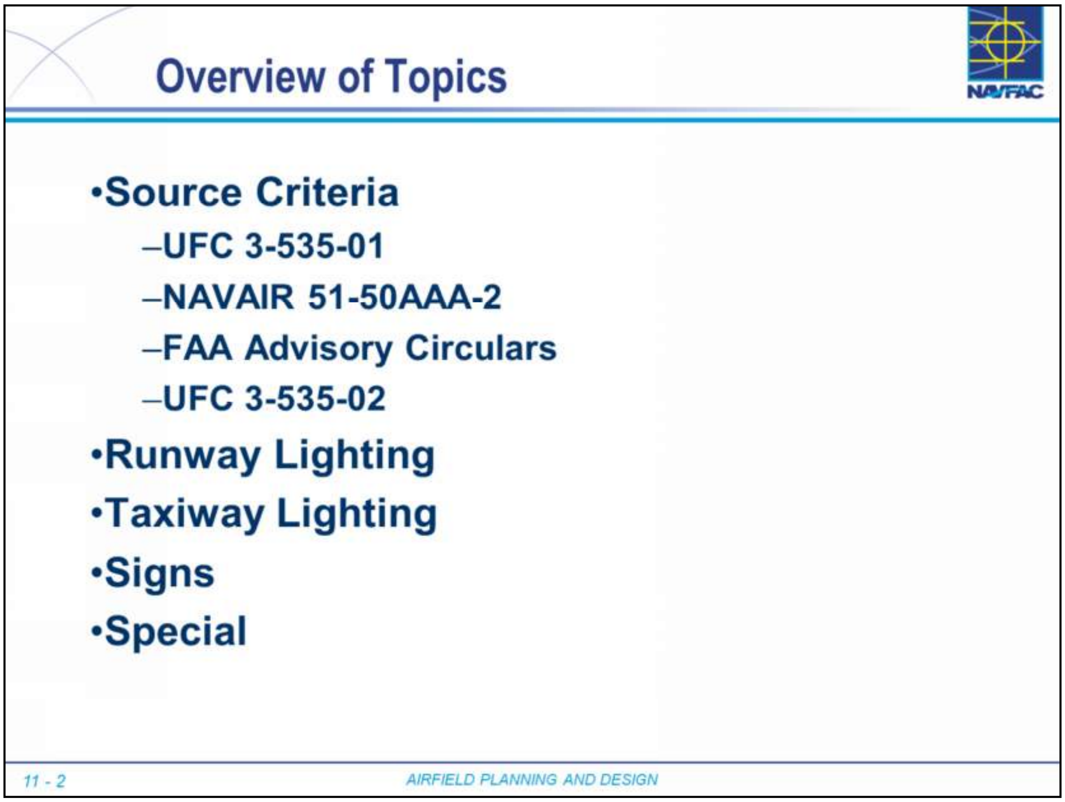
- Glacial Ice Runway
- Deep Snow Skiway
- Fuel Tanks
- Aircraft Parking

NAVFAC
Naval Facilities Engineering Command

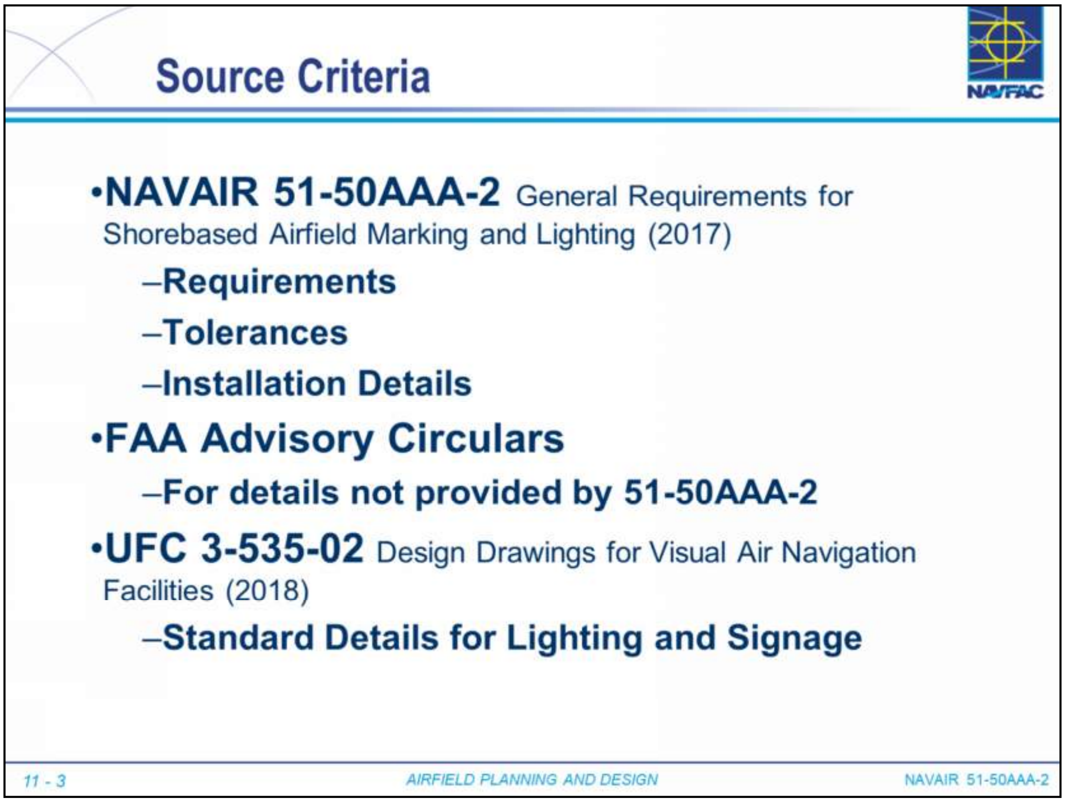
Section 11 Airfield Lighting and NAVAIDs

AIRFIELD PLANNING AND DESIGN CRITERIA TRAINING

5/7/2023



- UFC 3-535-01 is initial source for DoD
    - Para 1-6 Stipulates NAVAIR 51-50AAA-2 takes precedence over the UFC
    - Includes a list of features where Navy guidance differs from Tri-Service guidance



- NAVAIR 51-50AAA-2
    - Primary guidance for Navy
    - Includes lighting layout, configurations
    - Some installation details
- FAA Advisory Circulars
    - Supplements 51-50AAA-2
    - Many different ACs for different topics like
        - Lighting (Runway, Taxiway, Approach, centerline, etc.)
        - PAPIs
        - Equipment Specs
        - Signs

- UFC 3-535-02 – example typical details
    - Special Navy Details in Chapters 9 & 10
        - Chapter 9: Wave-off and Wheels-Up Lighting Systems
        - Chapter 10: Simulated Carrier Deck Lighting Systems

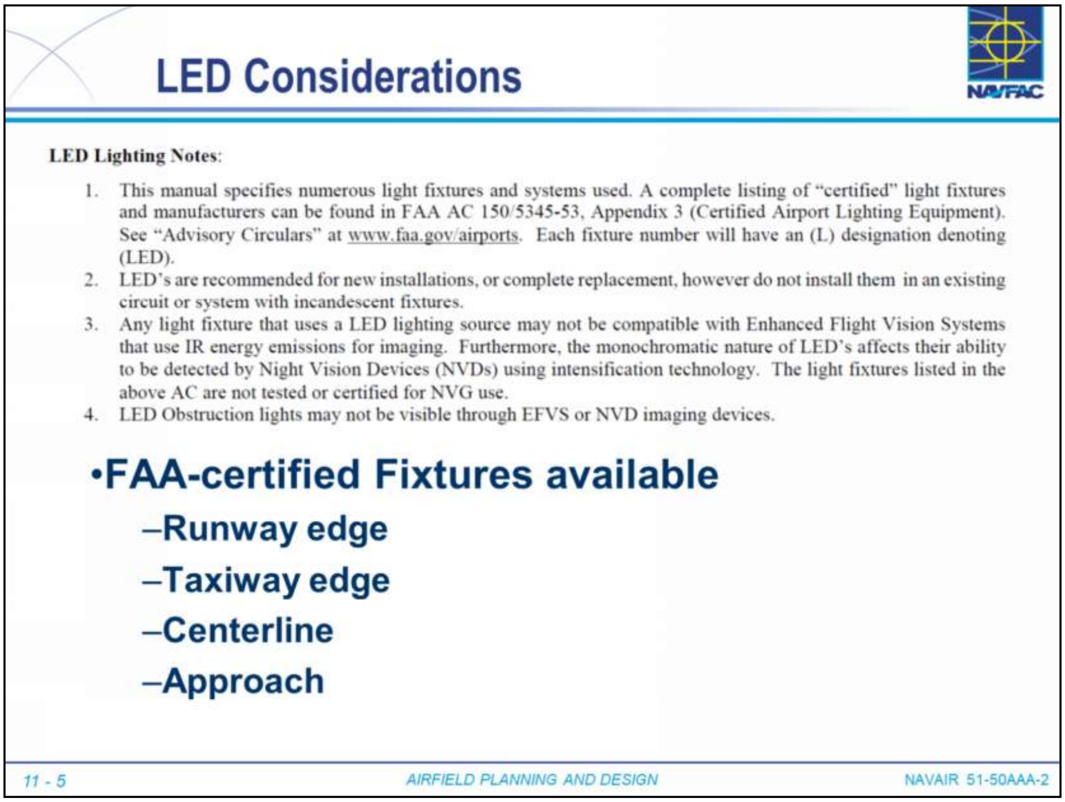
Runway Lighting Systems
Approach Visual Aids

TABLE 1. APPROACH VISUAL AIDS REQUIREMENTS

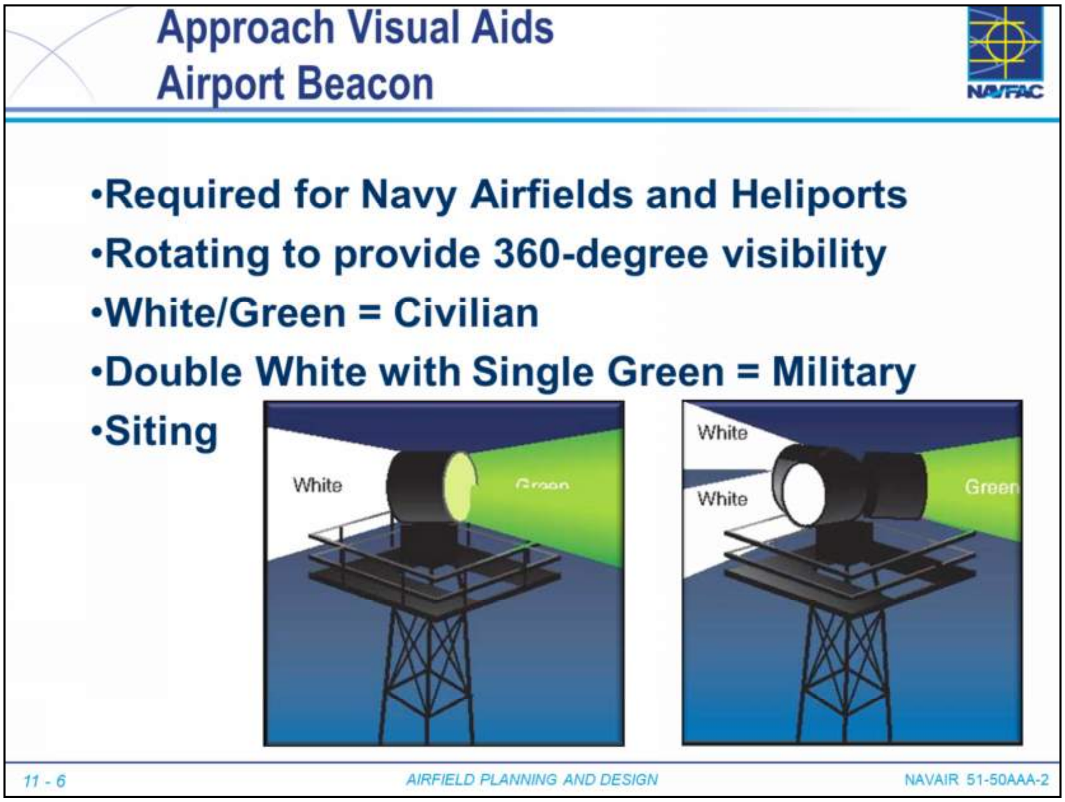
Visual Aids System	Authorized Operations						
		IFR Category					
	VFR	Non-Prec	I	II	IIIA	IIIB	IIIC
Identification Marking (WP003 01)	C	C	NR	NR	NR	NR	NR
Airport Beacons (WP003 02)	R	R	-	-	-	-	-
Wind Indicators (WP003 03)	OPT	OPT	-	-	-	-	-
Circling Guidance Lights (WP003 04)	RS	RS	NR	NR	NR	NR	NR
REIL (WP003 05)	C	C	-	NR	NR	NR	NR
ALSF-1 (WP003 06) *(see note)*	NR	NR	NR	NR	NR	NR	NR
ALSF -2 (WP003 07)	NR	RS	NR	R	R	R	R
SALS (WP003 08)	NR	RS	NR	NR	NR	NR	NR
Obstruction Markings (WP003 09)	R	R	-	-	-	-	-
Obstruction Lights (WP003 10)	R	R	R	R	-	-	-
PAPI (WP003 12)	RS	RS	RS	-	-	-	-
Optical Landing Aid (OLA) (WP003 13)	RS	RS	RS	-	-	-	-
MALSR (WP003 14) *(see note)*	RS	RS	R	-	-	-	-

C - Recommended
R - Required (These visual aids are required for operating in the IFR Category, but other factors may negate approval for installation. See Justification for Installation, WP002 00.)
RS - Required under special conditions. *An example: Only if high-speed exit is installed.
OPT - Option as recommended by air station commander and approved by NAVAIR.
\- - No entries are made where requirements have not been determined or where the system would have limited usefulness under the particular category.
NR - Not Required.

NOTE For CAT I approach systems use MALSR. See WP002 00 paragraph 20.b(3).



- LED allowed in certain situations, if equipment certified by FAA
    - NOTE: Army has allowed for new installations, with waiver.
    - NOTE: Air Force still do not allow on runway
- No partial LED systems – all or none

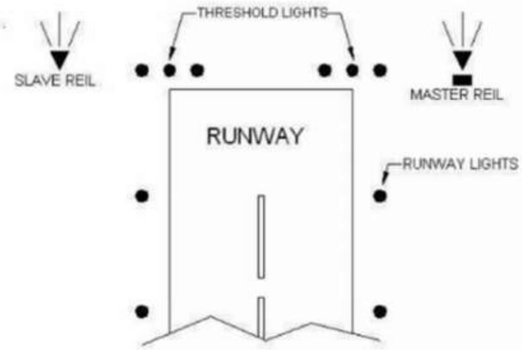


- High intensity flashing lights that provide a visual signal to pilots to assist in locating and identifying the airfield at night or in restricted visibility.
- Rotating or fixed but provide signal through 360 degrees of azimuth
- Required for all Navy airfields
    - If two airfields within one mile of each other, one beacon can serve both
- Required for heliports if not located at an airfield
- Double-peaked white beam (military) and a single peaked green beam (lighted airfield)
- Siting
    - 360 visibility
    - Less than 1000 ft from centerline
    - Not in line of sight from tower to approach zone
    - 750 ft or more from control tower
    - Should be 20-ft higher than ATCT cab floor

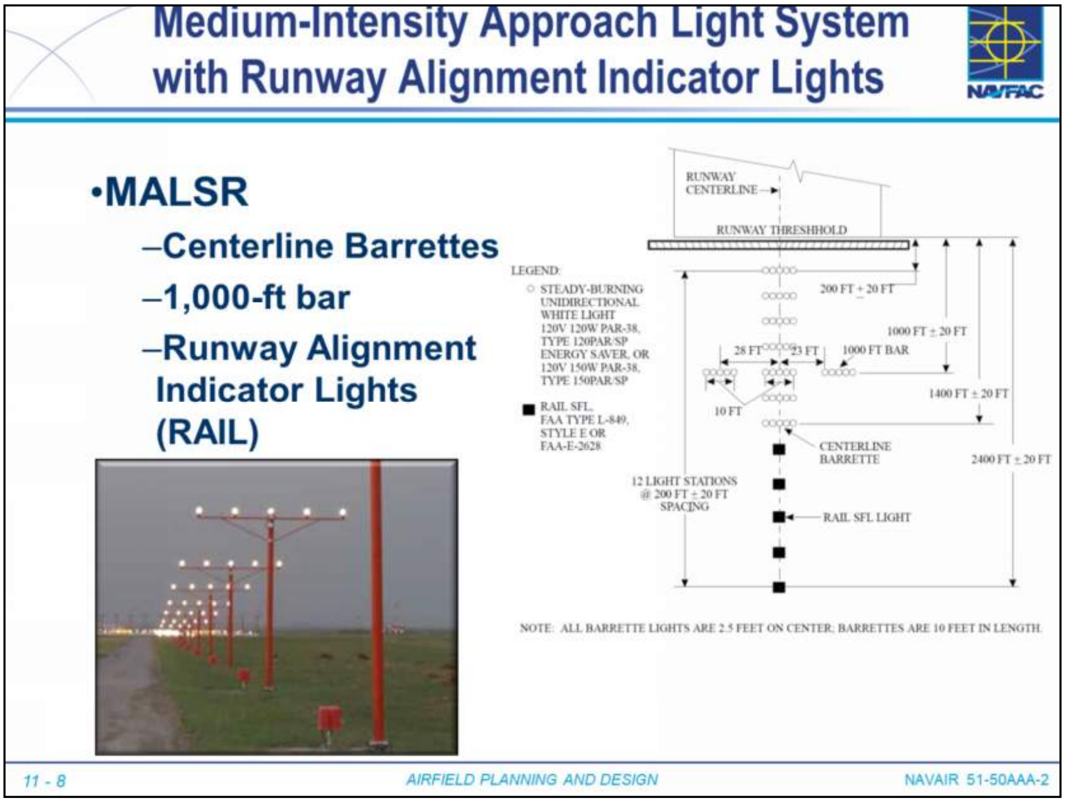
Approach Visual Aids
Runway End Identification Lights

- **REILs**
  - **Two simultaneous strobes**
  - **At Threshold**

TYPICAL REIL INSTALLATION



- Two simultaneously flashing lights, one on each side of runway at the threshold
- Provides rapid and positive identification of the runway threshold during an approach
- Unidirectional
- Intensity keyed to runway edge light intensity
- Primary and Secondary



- If runway has ILS, MLS or PAR, runway should qualify for MALSR – CAT I operations
- System of Light Bars and Barrettes in the approach zone immediately ahead of the runway threshold
    - 12 Centerline light barrettes, 2,400-ft length, 200-ft spacing
    - 1,000 ft crossbar
    - RAIL – 5 Sequence Flashing Lights
    - Threshold lights

Medium-Intensity Approach Light System with Runway Alignment Indicator Lights

- **MALSR**
  - **Semi-flush lights in paved overruns**
  - **Frangible towers**
    - 23 ft above rail
    - 17 ft above interstates
    - 15 ft above roads
    - 10 ft above controlled roads
  - **Powered from vault or independent**
  - **Controlled by Tower**

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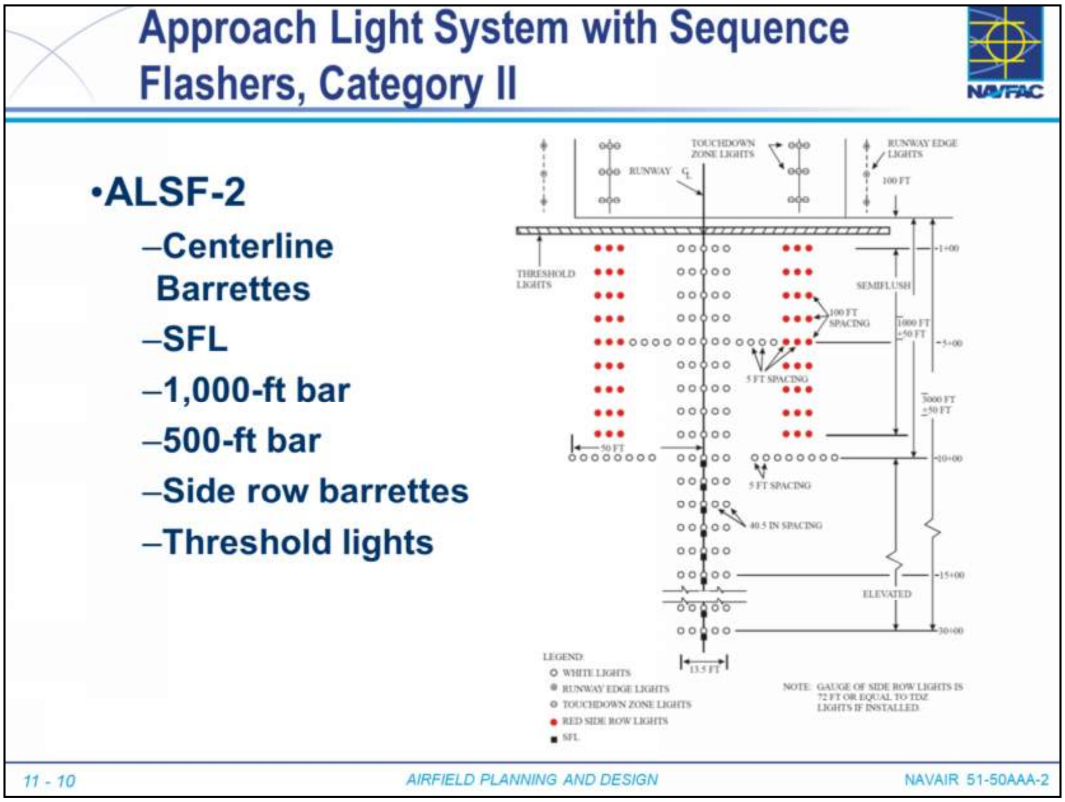
- MALSR in paved overrun



- System of Light Bars and Barrettes in the approach zone immediately ahead of the runway threshold
    - 30 Centerline light barrettes. 3,000 ft at 100-ft spacing
    - Sequenced flashing lights (rabbit)
    - 1,000 ft crossbar
    - 500-ft crossbar
    - Side row barrettes
    - Threshold lights
- 3,000-ft standard length, can be shortened to 2,400 ft

Approach Light System with Sequence Flashers, Category II

- **ALSF-2**
  - **Semi-flush lights in paved overruns**
  - **Frangible towers to elevate over roads, rails, waterways**
  - **Approach threshold lights in line with runway threshold lights**
  - **4 circuits from vault**

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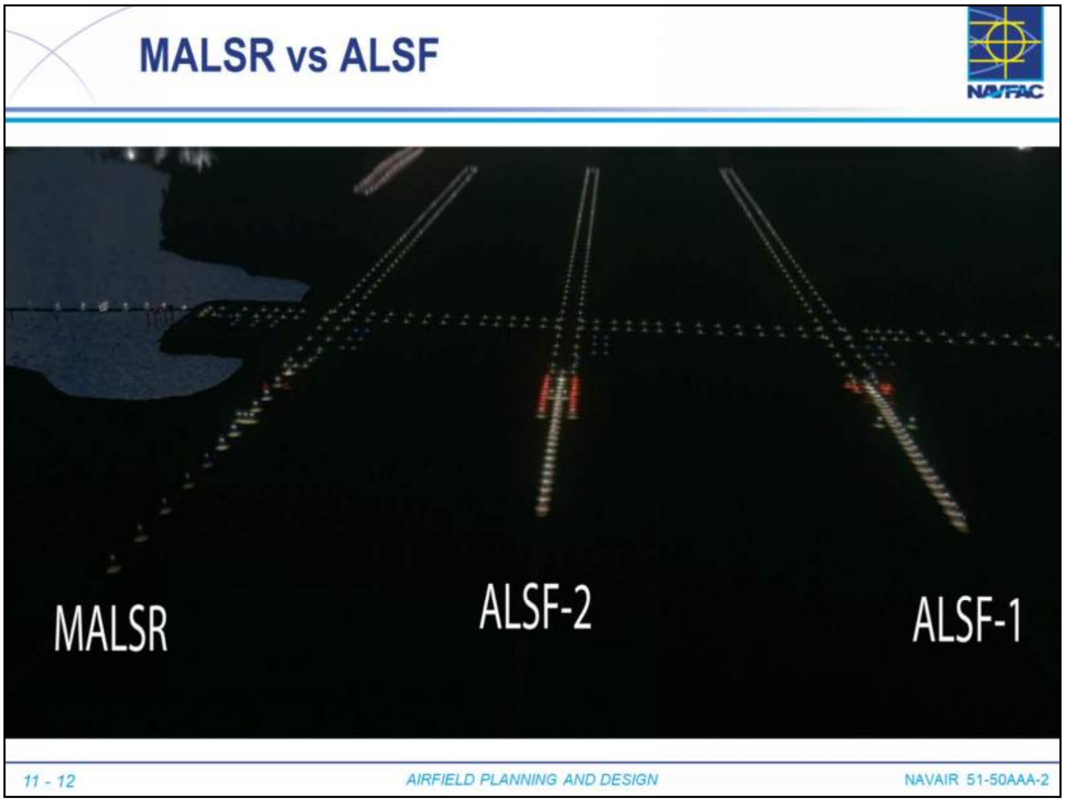
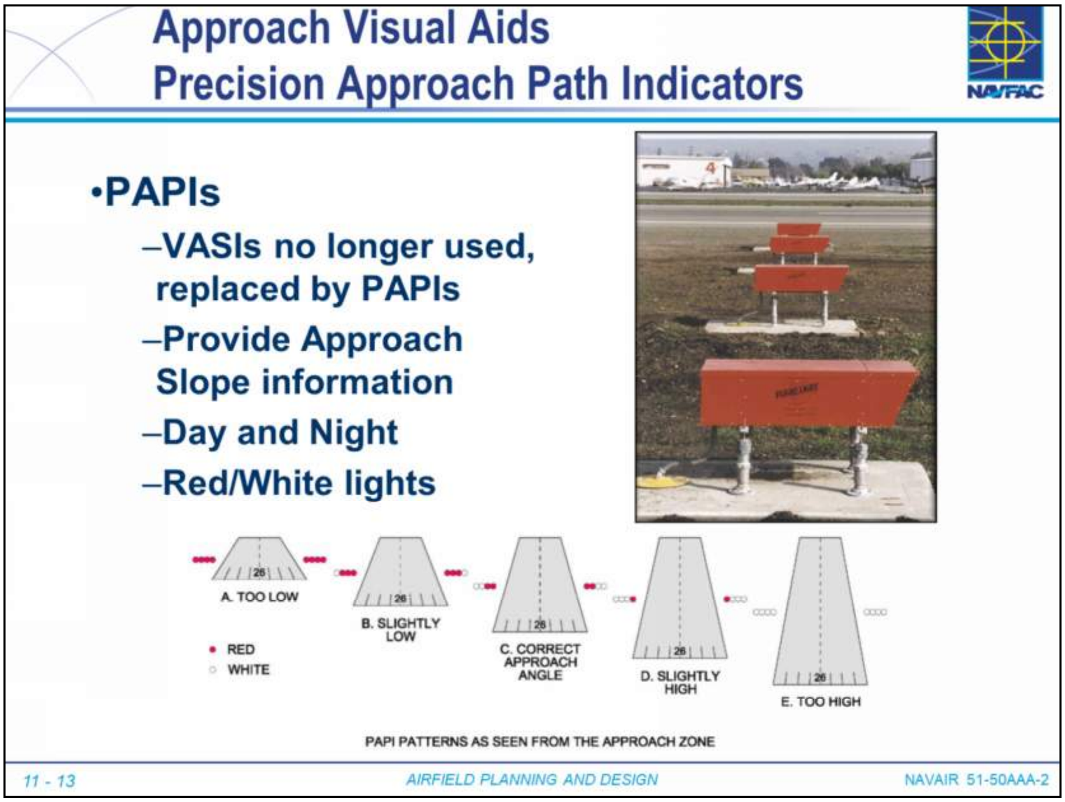
- System of Light Bars and Barrettes in the approach zone immediately ahead of the runway threshold
  - Centerline light barrettes
  - Sequenced flashing lights (rabbit)
  - 1,000 ft crossbar
  - 500-ft crossbar
  - Side row barrettes
  - Threshold lights
- 3,000-ft standard length, can be shortened to 2,400 ft

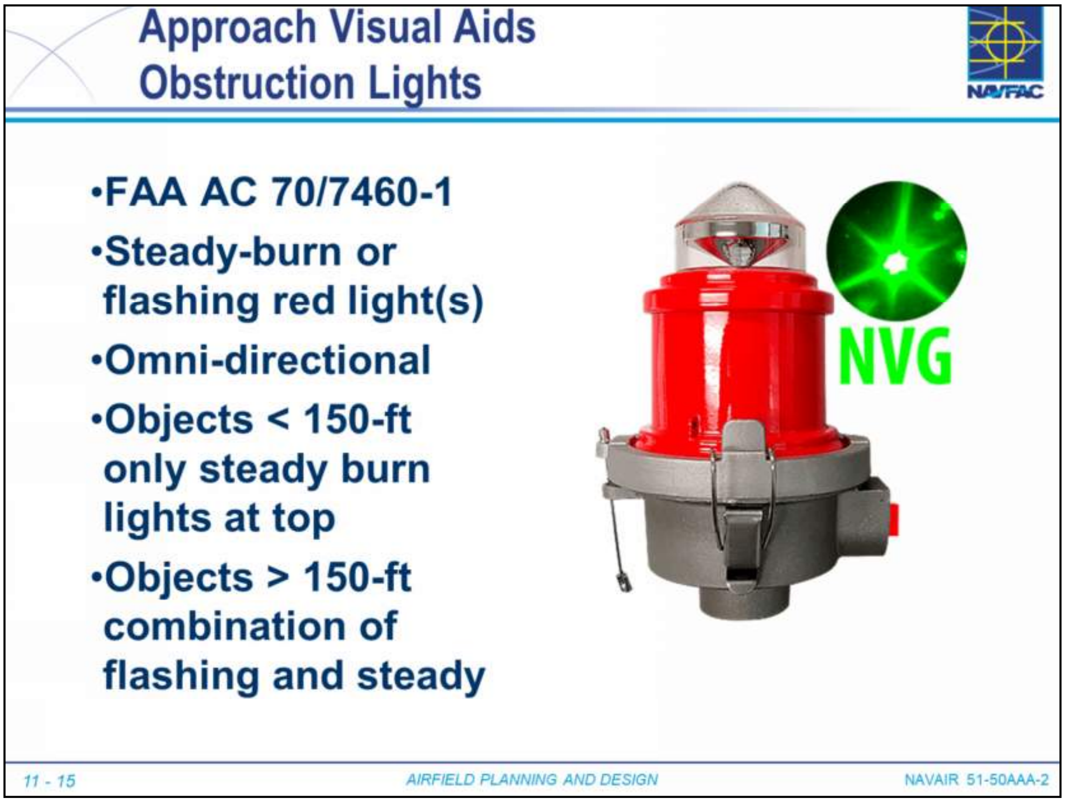


- Quick comparison of the lights in 3 different systems
    - Sequenced Flashers are not visible

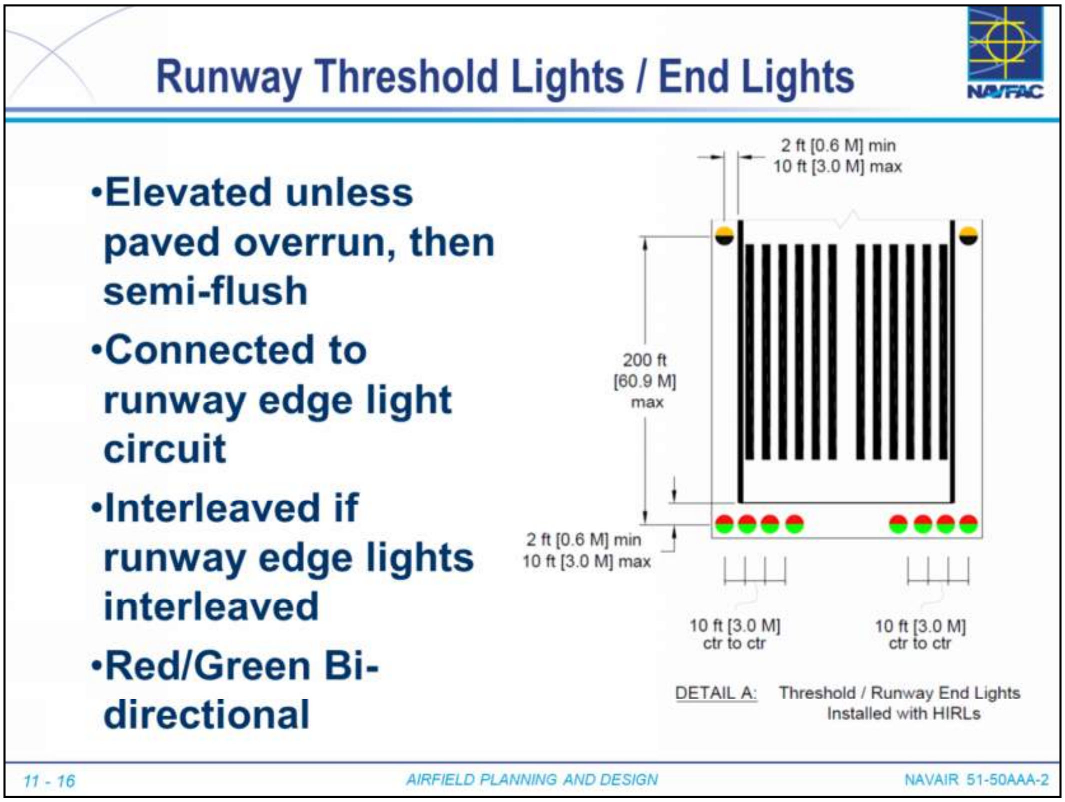


- VASIs have been replaced by PAPIs
- Provides the pilot approaching for a landing with approach slope angle information and assists him with intercepting and maintaining the correct approach slope angle.
- Visible day and night
- Guides pilot to proper touchdown location
- 4 lights arranged in a wing bar near the runway edge in the touchdown area
- 1, 2 3, or 4 Red or White lights visible, depending on position relative to proper position
- FAA AC 150/5345-28 for equipment and siting

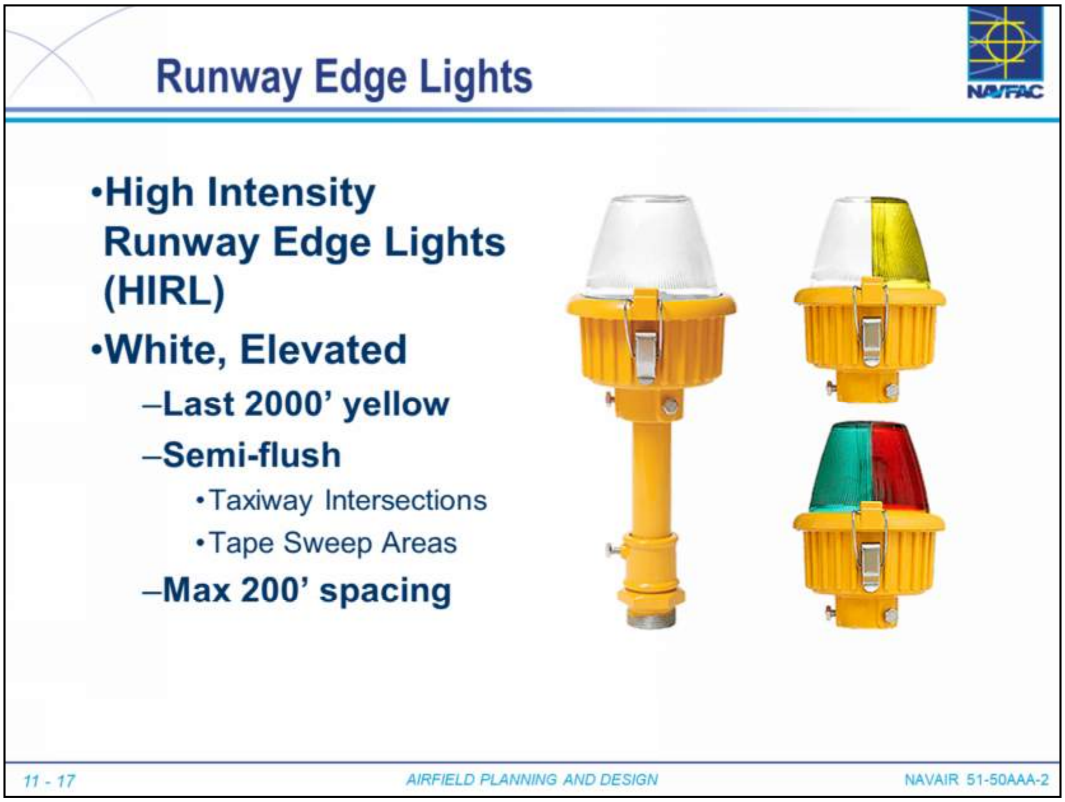
- OLA purpose is to provide the pilot approaching for landing with a visual signal to assist in intercepting and maintaining the correct approach glide slope.
- Runway landing areas with simulated carrier deck shall have OLA equipment.
- Most OLA are portable.
- Does not provide longitudinal alignment information.
- Source Lights – Yellow “meatball”, turns red when too low
- Datum Lights – horizontal bar of green lights
- Wave-off lights – flashing red lights along each side of source lights. Activated only to inform pilot to execute a missed approach.
- Cut lights – flashing green lights above the source lights activated to instruct pilot of prop aircraft to cut engine power.
- Controlled by Landing Signal Officer (LSO)
- Picture: Improved Fresnel Lens Optical Landing System (IFLOLS)



- Obstruction Lights are used to warn aircraft of above ground objects in vicinity of airfield
- OB Lights must be NVG compatible (visible when wearing NVG equipment). Some manufacturers are now making LED OB lights that are NVG compatible (IR strobe added).
    - FAA AC 150/5345-43J, *Specification for Obstruction Lighting Equipment.*
    - FAA Engineering Brief #98*, Infrared Specifications for Aviation Obstruction Light Compatibility with Night Vision Goggles (NVGs)*
    - NAVAIR 51-50AAA-2 states to follow FAA requirements and specifications for equipment



- Threshold lights define the beginning of the runway for approaching aircraft
- Straight line of lights at each end of the runway.
- Perpendicular to runway centerline
- Symmetrical about the runway centerline
- Required for any runway that is equipped with edge lights
- Green for approaching aircraft, red for runway end lights.



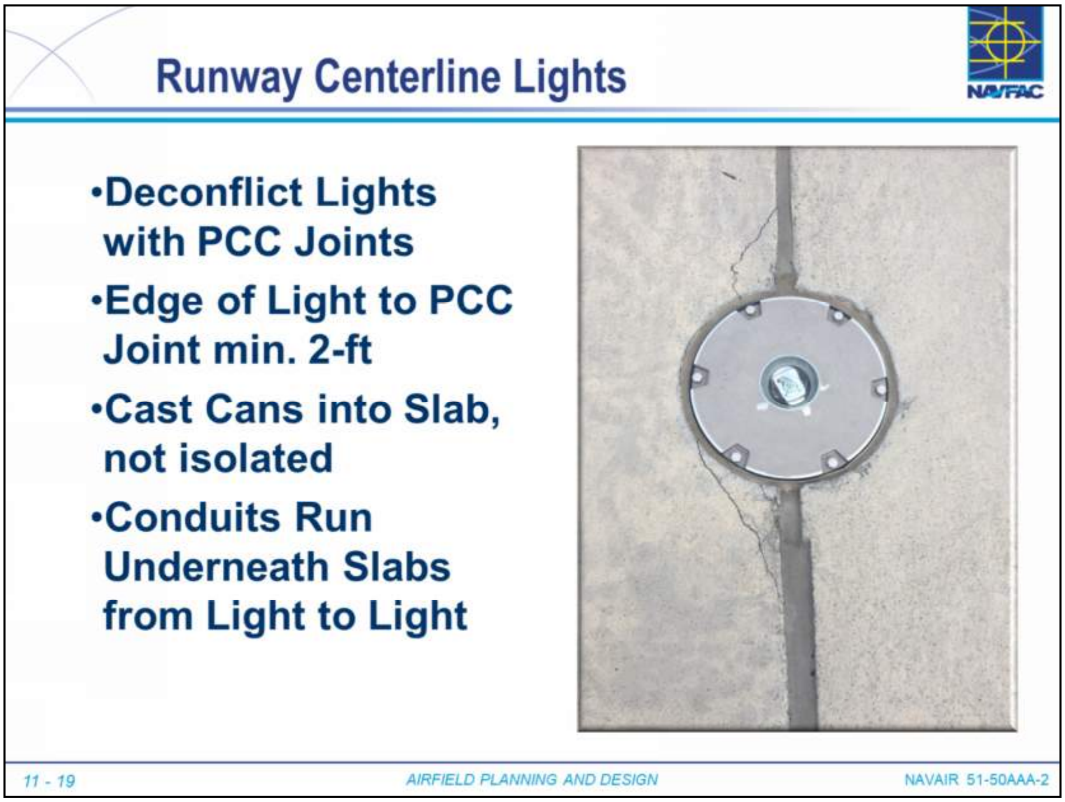
- HIRL define the lateral limits of the usable runway surface for landings and takeoffs
- Required for all runways used at night or in IFR conditions
- Two straight lines of high-intensity lights on each edge of runway.
- White, but last 2,000' bi-directional yellow/white (yellow facing takeoff aircraft).
- Elevated lights, except semi-flush at taxiway intersections or tape sweep areas

Runway Centerline Lights

NAVFAC

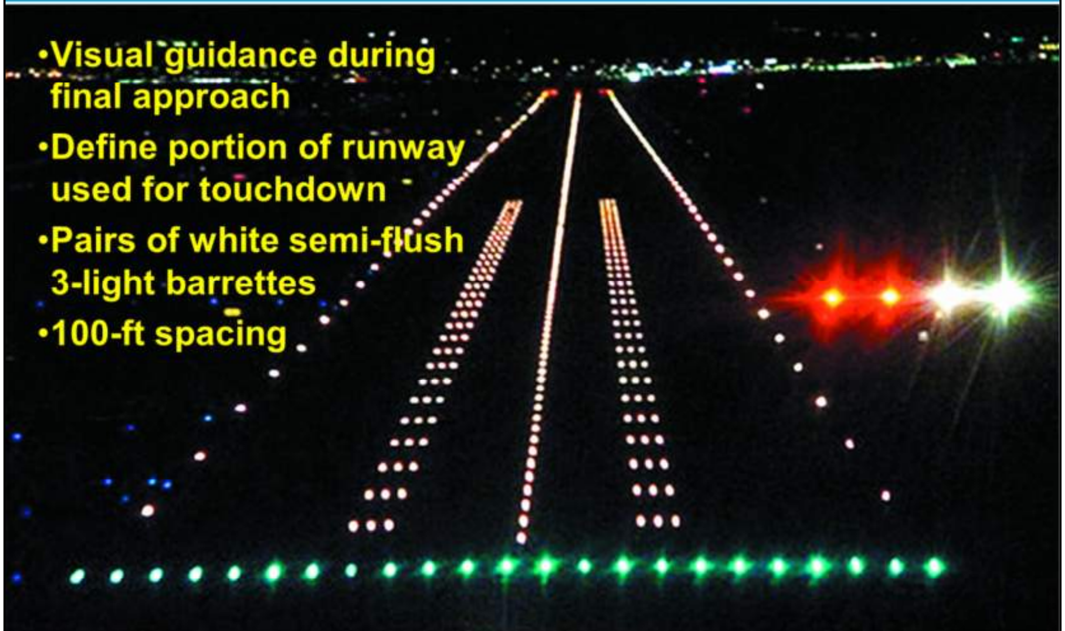
- Single semi-flush bi-directional lights
- Threshold to threshold
- 100’ spacing
- White until last 3000’
- Red/White 3000’ to 1000’ remaining
- Red last 1000’

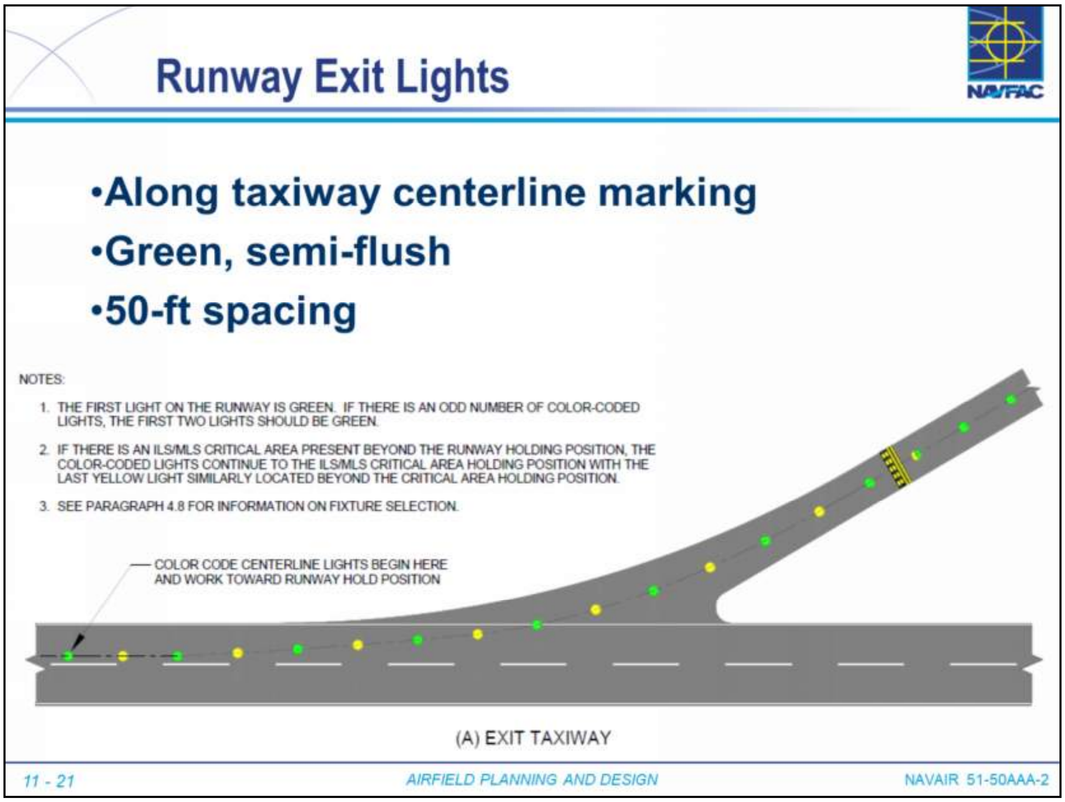
- Centerline lights improve runway acquisition and alignment



- In PCC pavements, lights must be offset 2.5’ from centerline to avoid conflict with PCC joint.
    - Essential for good pavement performance
    - All in-pavement lights in PCC must be deconflicted with joints
    - Light base cans should be cast into the pavement slab, not isolated
    - Conduit is underneath the slab

Touchdown Zone Lights





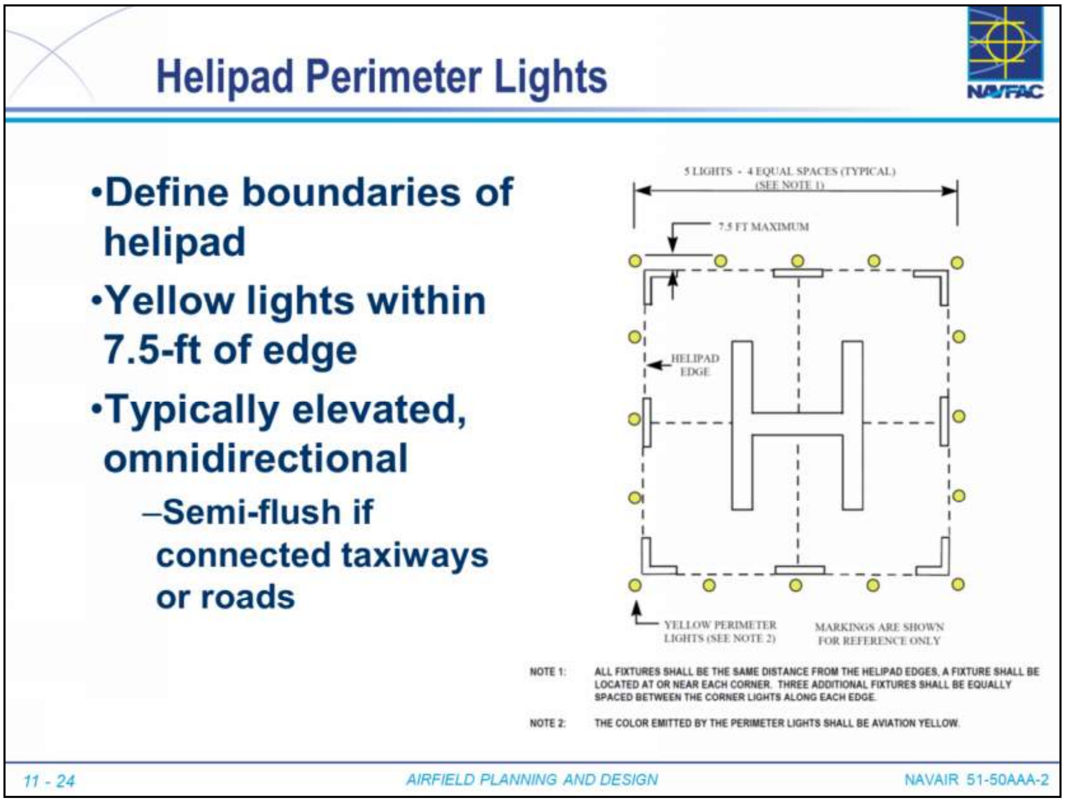
- Exit lights provide visual clues to pilot for departing a runway at high-speed exits before complete deceleration and at low speed exits with visibility problems
    - Special case of a taxiway centerline light
- Green semi-flush lights along the taxiway exit marking
- 50-ft spacing
- Uni-directional
- Aimed such that axis of light points at four lights ahead
- Figure A-45 from AC 150/5340-30J

Taxiway Edge Lights

- Outline routes for taxiing to and from runways and parking aprons
- Blue, omni-directional elevated fixtures
- Situational spacing rules for straight and curved segments per AC 150/5340-30H

Taxiway Centerline Lights

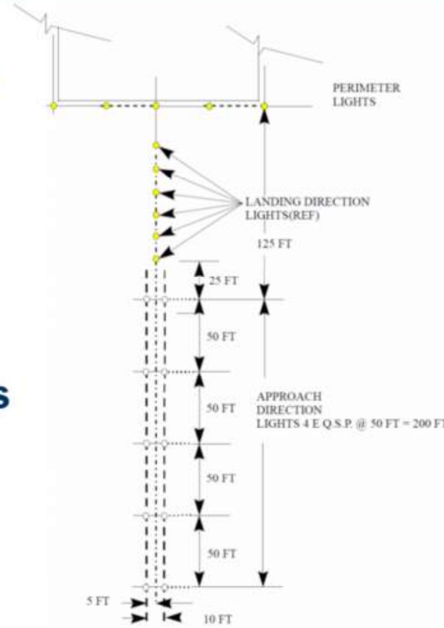
- Semi-flush green bi-directional lights
- Situational spacing rules for Cat II/III and others for straight and curved segments
- Not commonly used on military airfields



- Define boundaries of helipad
- Omni-directional yellow
- If vehicles access the helipad from all directions, then use semi-flush lights instead of elevated
- FAA Engineering Brief 87 defines L-860HR and L-860HS (elevated and semi-flush)
    - Elevated appear readily available
    - Semi-flush L-860 not available

Helipad Approach Lights

- Show preferred approach direction to the helipad
- Omnidirectional elevated lights
- Landing Direction Lights
  - 6 yellow lights
- Approach Direction Lights
  - Five pairs of white lights extending from landing direction lights



Signs

Runway Distance Markers

NAVFAC

- RDM Signs
  - 1,000-ft spacing
  - White numeral on black background
  - 50 to 75 ft from runway edge
  - Move up to 100’ to deconflict with intersections

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- Indicates to aircraft pilots the distance remaining to the end of the runway during takeoff or landing.
- Required for runways where fixed wing jet operations are conducted.
- Row of signs along each side of the runway spaced at 1,000 ft longitudinally
- Number indicates the distance remaining in 1,000’s of feet
- White numeral on black background
- Positioned 50 to 75 ft from runway edge
- Move up to 100’ to deconflict, if not then skip

Arresting Gear Markers

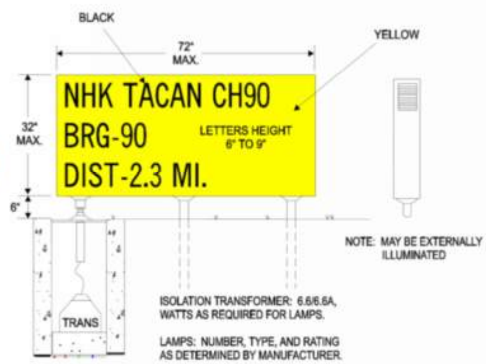
- Arresting Gear Marker Signs
  - Aligned with pendant cable
  - Two signs, each side of runway
  - Min 60-ft from runway edge
  - Yellow circle on black backround

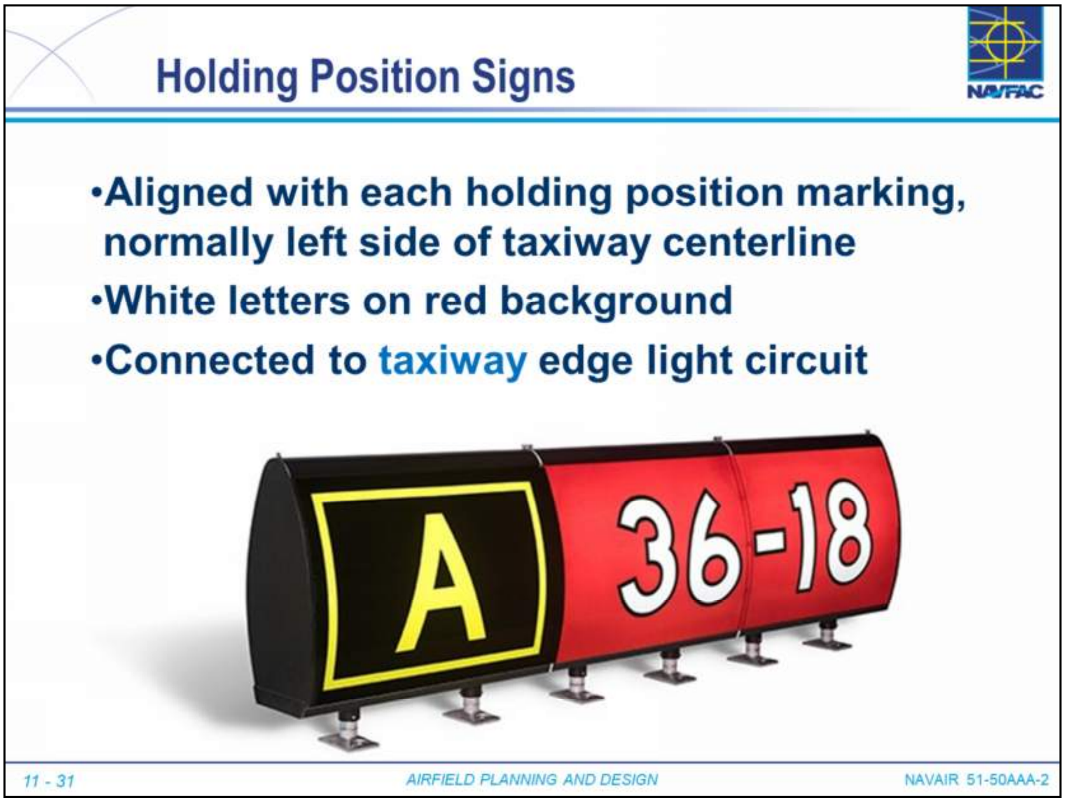
Taxiway Guidance Signs

- •Assist pilot in following desired routes
- •Direction or Destination (black on yellow background
- •Location (yellow on black background
- •Mandatory (white on red background)

Special Taxiway Signs

- Provide pilots information for checking operation of the aircraft navigational equipment
- TACAN Checkpoint most common near runway end hold position
  - Black on yellow background





- Circuit connection is point of contention – Air Force and Army require hold sign on same circuit as runway edge lights or on separate circuit, to ensure it is one whenever the runway lights are on, even if taxiway lights are off.

Electrical Power and Control

- Airfield Lighting Vault
- Series Circuits
  - Constant Current Regulators – allows intensity adjustment
  - Multiple circuits for flexible control
- Insulated cables in conduits
- Grounding and Counterpoise

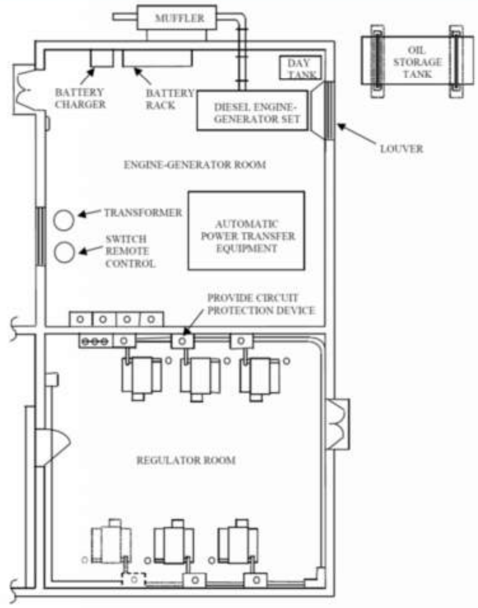
Electrical Power and Control

- **Airfield Lighting Control System**
  - **Located in Air Traffic Control Tower**

- Airfield Lighting Control System (AFLCS)
  - Provide switches for remotely controlling airfield lighting systems.
  - Directly connected to circuits in airfield lighting vault.
  - Accessed through the Navy's Visual Information Display System (VIDS).
  - Located in Air Traffic Control Tower with connections to other VIDS terminals, such as flight planning.
- If a Landing Safety Officer (LSO) Tower exists, control panels may be very different to match onboard ship controls.

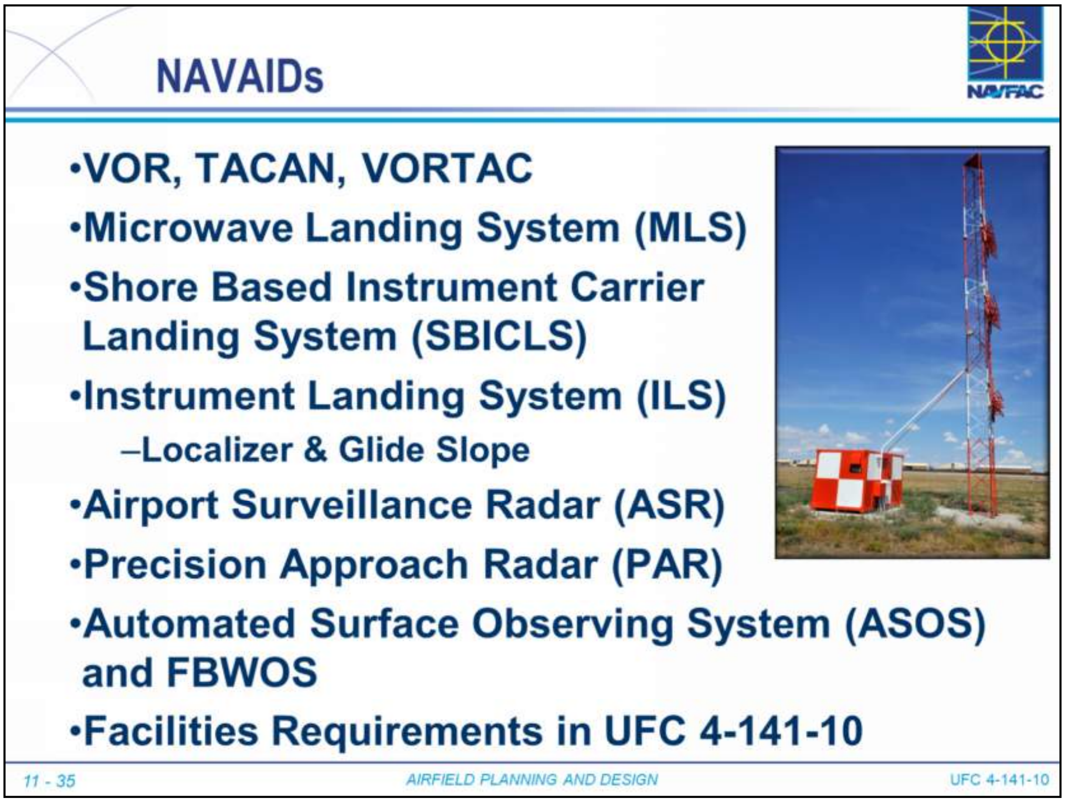
Electrical Power and Control

- **Backup Power**
  - **Generator**
  - **Automatic Transfer Switch**
    - Max. 15 sec transfer time
    - Cat II = 1 sec transfer
  - **Engine Start and accept more than 75% of rated load within 12 seconds**

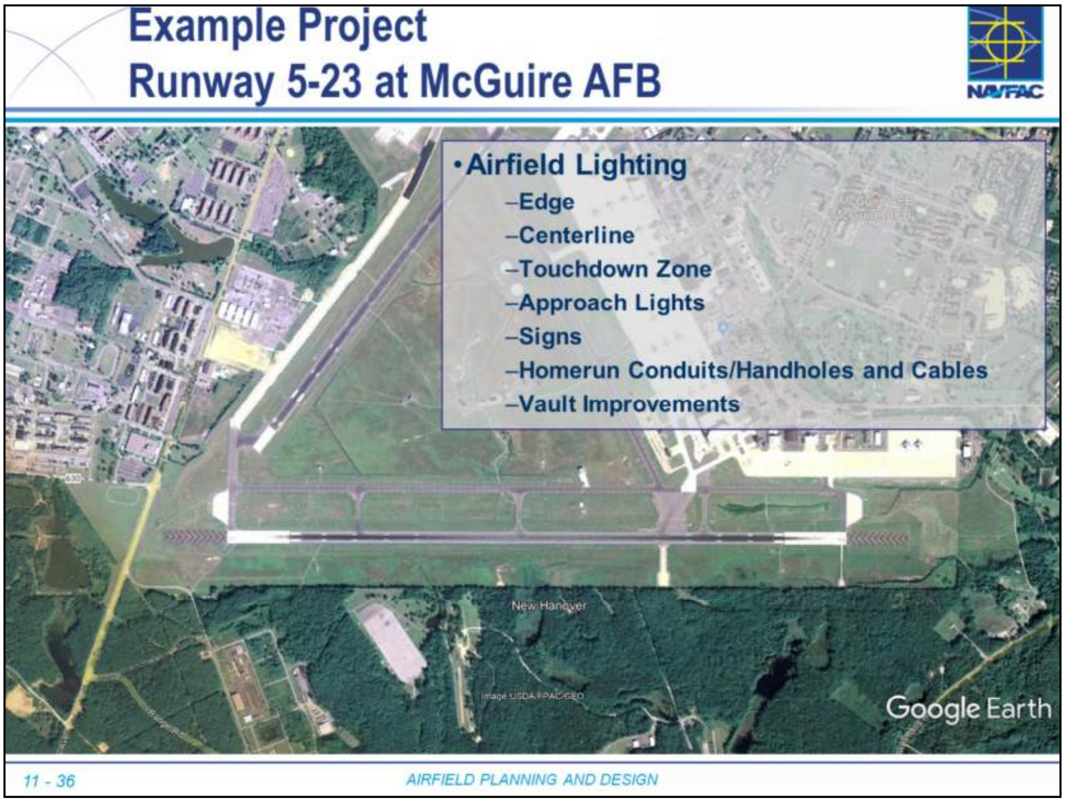


11 - 34 AIRFIELD PLANNING AND DESIGN NAVAIR 51-50AAA-2

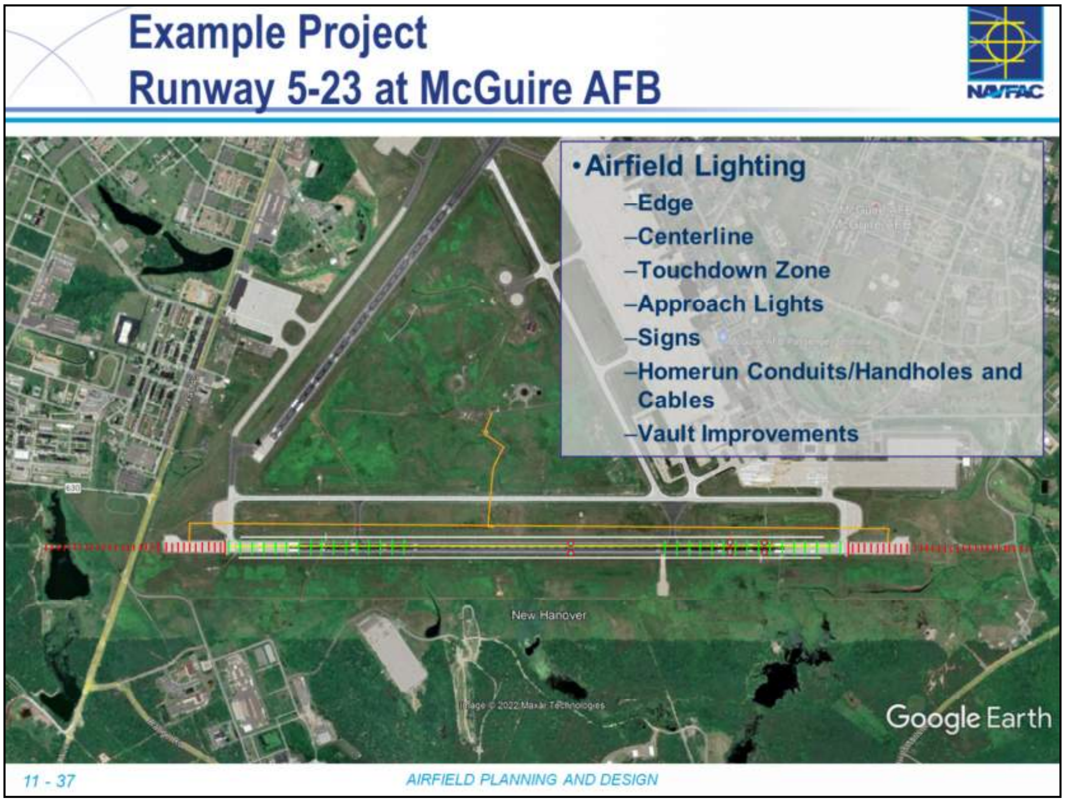
- Backup power required for airfield lighting
- 15-second transfer time basic requirement
  - In CAT-II conditions, 1-second transfer required
    - Generally requires having the generator running before the power goes out
- Generator sized for Actual Load + 20% expansion
- Fuel Storage for 72 hours operation, but outside generator room – only day tank inside.
- Ventilation required for generator intake and exhaust, battery rack.
- Regulator room sometimes air conditioned – switchgear-style regulators are more sensitive and need cleaner environment



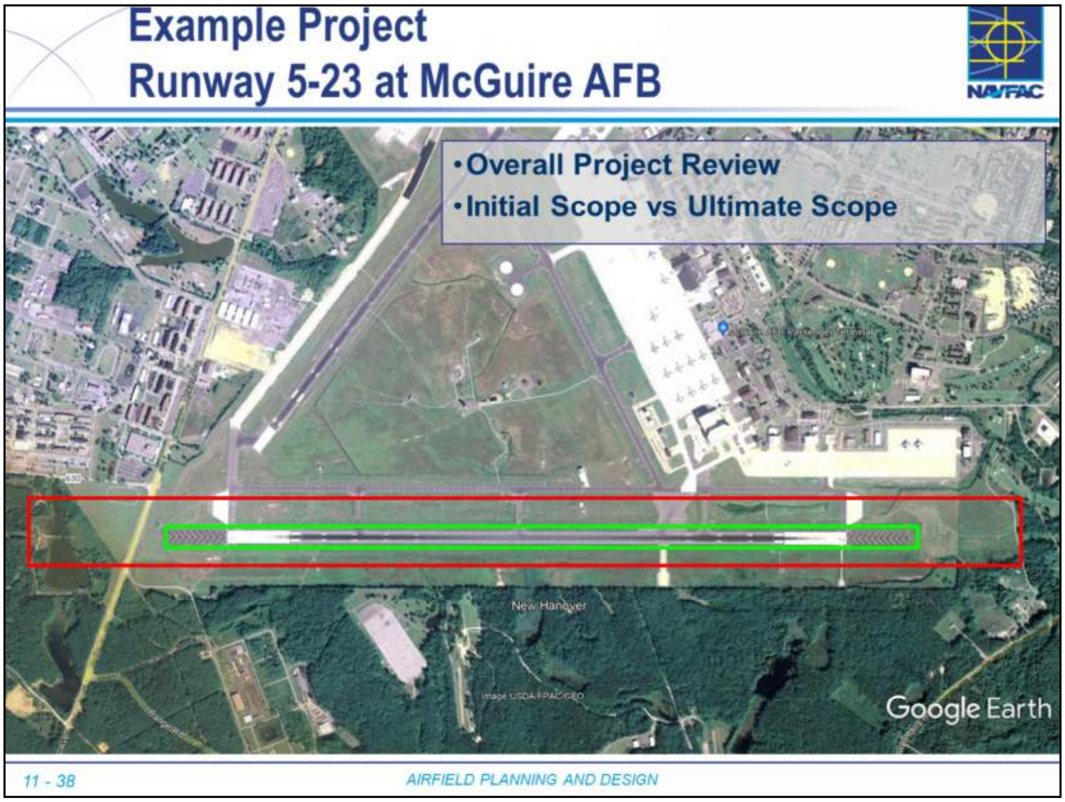
- NAVAIDS
  - Several different system components
  - Permitted within the Primary Surface because “fixed by function”
  - Frangible where appropriate
  - Shelters/Backup Generators outside primary surface if feasible
- Facility Requirements for electronic NAVAIDS included in UFC 4-141-10



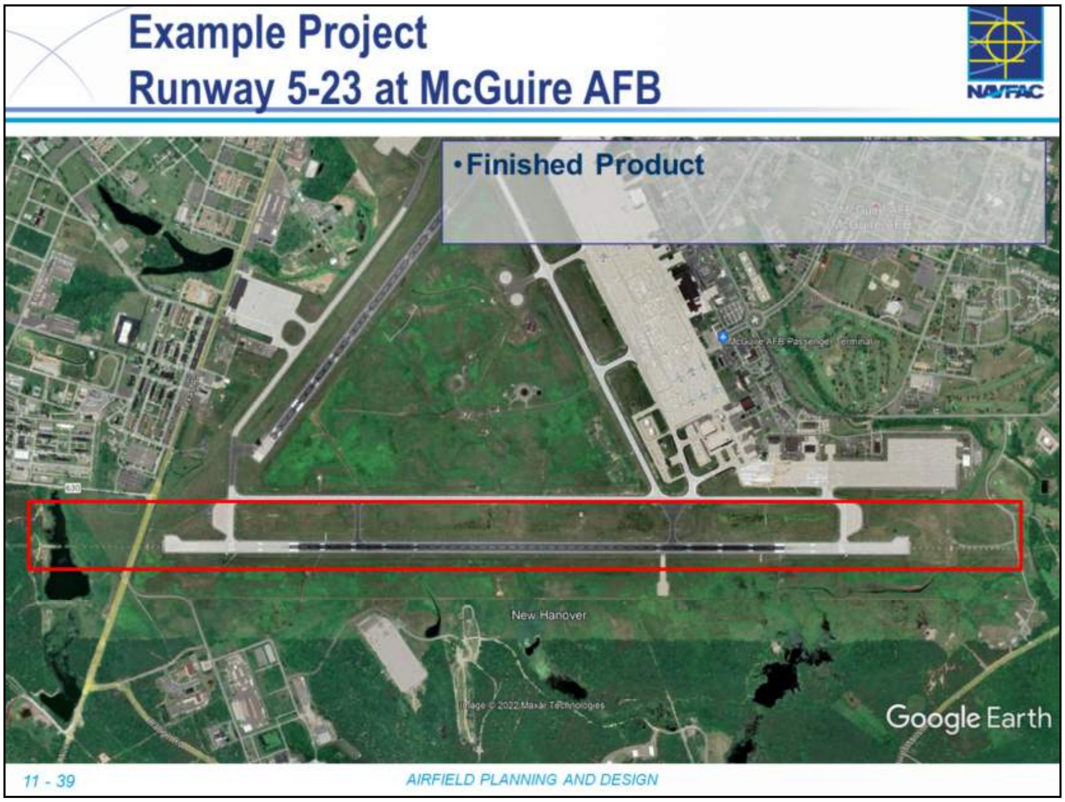
- Airfield Lighting
    - Be sure to include in programming documents
    - Determine requirements for future missions as part of the programming process
    - Numerous Lighting Systems and Options
    - Field Investigation needed to determine existing circuiting and condition of systems.



- Runway and Taxiway Edge Lighting
- Centerline Lights
- Touchdown Zone Lights
- Superimposed LZ Lights (overt and covert)
- ALSF-2 Approach Lights
- RDR Signs
- Hold Signs
- Directional Signs supporting new configuration
- Home Run Duct Bank and Cables
- Regulator Replacements in Vault



- Overall Project Review
    - Initial design and program scope basically just included the runway
    - During design, it was recognized that if the runway was going to be completely shut down for 2 construction seasons, then might as well do at least the hold lines, and then decided to expand connectors work to the parallel taxiway.
    - Protected habitat
    - Wetlands
    - High Ground Water Table
    - Temporary Fence to put the runway “outside the fence”.



- Connector Taxiways
- Demolished Taxiways
- Reconfigured Intersection
- Strengthened Overruns
- Asphalt vs Concrete Middle Section
- Relocated Localizer
- Relocated Roadway

- Key Points of Section
    - UFC 3-535-01 passes through to NAVAIR 51-50AAA-2 for primary lighting criteria
    - Many different types of lighting systems
    - LED systems allowed, but can’t be mixed
    - Good detailing required for lights in pavements for good pavement performance
    - Airfield Lighting Vaults
        - Unique facility on airfield to power and control all lighting systems
        - Connected to Air Traffic Control Tower
        - Backup power required

Name the Airfield

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