

# PROJECT MANUAL

For

## SUSTAIN AIRFIELD MARKINGS & RUBBER REMOVAL SPECIFICATIONS

**08 Apr 2023**

USAFR ZQEL 23-0001

For

910<sup>th</sup> Airlift Wing  
Youngstown Air Reserve Station  
3976 King Graves Road  
Vienna, OH 44473-0910



Prepared By

DEPARTMENT OF THE AIR FORCE  
910<sup>th</sup> BASE CIVIL ENGINEERING OFFICE  
3976 KING GRAVES ROAD, BUILDING 510  
VIENNA, OHIO 44473-5931

LIST OF DRAWINGS

Sheet	DWG No:	Title Sheet	Date of Issue
-------	------------	-------------	------------------

TITLE

1 of 5	G1	Title Sheet & Specifications	08 Apr 2023
2 of 5	G2	Overall Site Plan – Landing Zone	08 Apr 2023
3 of 5	G3	CL Sta 0+00 to CL Sta 12+00 & Quantities	08 Apr 2023
4 of 5	G4	CL Sta 12+00 to CL Sta 34+50	08 Apr 2023
5 of 5	G5	CL Sta 34+50 to CL Sta 41+00	08 Apr 2023

END OF LIST OF DRAWINGS

SECTION 00 00 10 – PROJECT TITLE SHEET

SECTION 00 01 00 – TABLE OF CONTENTS

SECTION 00 01 50 – LIST OF DRAWINGS

DIVISION 01 – GENERAL REQUIREMENTS

Section 01 00 00 - General Requirements

Section 01 33 00 - Submittal Procedures AF Forms 66, 3000, 3064 and 3065

Section 01 35 43 – Environmental Procedures

Section 32 01 11.51 = Rubber and Paint Removal from Airfield Pavements

Section 32 17 23 – Pavement Markings

ATTACHMENTS – ADDITIONAL SPECIFICATIONS

A. Unified Facilities Criteria (UFC) Airfield and Heliport Markings

UFC 3-20-04, 16 May 2018

B. TT-P-1952E, Federal Specifications – Paint Traffic and Airfield Markings,  
Waterborne

C. TT-B-1952D, Beads (Glass Spheres) Retro-Reflective

END OF SECTION 00 00 01

## SECTION 01 00 00 - GENERAL REQUIREMENTS

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. The Contractor shall furnish all supervision, labor, materials, tools, equipment, apparatus, and transportation required to complete the construction in conformity with the Contract Documents.
- B. The Project is for the removal of aircraft rubber removal form the Assault Runway Landing Zone (LZ), and for the restriping of the Landing Zone. All work is located on the controlled portion of the airfield and on Youngstown Air Reserve Station, Vienna OH.
- C. The Work consists of – but is not limited to – the following: Air Force Statement of Work:

- 1.3 SUMMARY OF WORK: The Contractor shall furnish and install/perform all material, equipment, components, parts, tools, labor, transportation, hauling, disposal/recycling, cleaning, inspection, testing, commissioning, training, reporting, etc., necessary to perform this project as described in the contract-delivery order, including this Statement of Work and any/all applicable federal, state and local law, regulation, standards, and codes. Unless otherwise stated, any/all work items includes requirement for contractor to remove and properly dispose of/recycle off base, and to furnish and install/incorporate any/all new materials, equipment, components needed to properly complete the work item; any Government furnished property and/or reinstallation of existing materials/equipment/components shall be as stated/specified herein. Contractor shall submit materials/methods for approval prior to ordering and/or incorporation into the work; as a minimum, submittals shall include product literature, MSDS, standard color, texture and style samples/swatches/boards, and place of origin/manufacture. Demolished materials, waste/debris is property of the contractor, unless otherwise stated herein; contractor is responsible for proper disposal/recycling of such materials off base; such material shall be promptly removed from the installation and shall not be stored/stockpiled unless submitted and approved for such. Contractor is responsible for verification of all details, measurements, etc. prior to ordering materials and execution of work. The work includes, but is not limited to, the following principal elements:

## 2.0 SCOPE.

**2.1. DESCRIPTION OF WORK.** The work specified herein consists of furnishing all labor, equipment, tools, appliances, transportation, and materials required to remove 95% of the rubber buildup from 100% of designated area on the Youngstown ARS Assault (asphalt covered) Runway. The rubber removal is to be completed without damage to the pavement surface, joints, and joint and crack seals, or any other government property. Destruction of any runway or other pavement markings as a result of the rubber removal process will be restored, repainted as necessary. All LZ Markings, Controlled Apron and Non-Controlled Apron Markings shall be repainted as per specifications and as shown on plans **dated 08 Apr 2023.**

**2.2. DETERMINATION OF COMPLIANCE.** The determination of compliance of the 95% removal shall be accomplished by test as described in Section Eight (8), Compliance Testing.

**2.3. PAVEMENT DAMAGE SURVEY:** Base Engineering, Contracting Officer Representative and Contractor shall jointly inspect the work area prior to commencement of work. Any existing damage to pavement systems shall be documented at that time. The Contractor shall repair damage incurred during the contracted operations in accordance with paragraph 12.1.

## 3.0 **METHODS AND WORK AREAS:**

**3.1. RUBBER REMOVAL:** Rubber buildup shall be removed from the designated rubber-covered area in accordance with paragraph 7.2. The rubber-covered area in each runway touchdown zone is an imaginary rectangle with sides parallel to the centerline and ends transverse to the centerline. Within the rectangle, the rubber deposits overlap and the exposed pavement texture comprises no less than 80% of the total area. The rubber-covered area does not include the portion of pavement outside the central rubber buildup zone where the rubber marks are intermittent and more than 80% of the pavement texture is exposed. Rubber deposits are not to be removed outside the designated rubber-covered area. Any runway/pavement markings destroyed as a result of the rubber removal process will be repainted, restored as necessary.

**3.2. DESIGNATED WORK AREA:** The Assault Landing Strip is defined as having three (3) designated areas. Area's 1 & 2, which measure 60' x 300' and Area 3, the actual landing Zone, (LZ) which measures 60' x 3500'. The work areas for rubber removal on the Youngstown ARS Assault Runway are as follows:

The first is located at the Southeast touchdown area and consists of a rectangle area 40 feet wide by 650 feet in length (26,000 SF). This is referenced as Area A.

The second is located at the Northwest end touchdown area, and is a rectangular area 40 feet wide by 600 feet in length (24,000 SF). This is

referenced as Area B. Refer to Sheet G2.

**3.2.a.** Refer to attached plans G2 for areas of rubber removal;

Area A is a 650 linear foot by 40 feet wide portion, measured 20 feet from centerline on either side of the LZ starting at CL Sta 2+50 to CL Sta 9+00. This area is located within Area 1 and Area 3. This area for rubber removal is 26,000 sqft.

Area B is a 600 linear foot by 40 feet wide portion, measured 20 feet from centerline on either side of the LZ starting at CL Sta 32+50 to CL Sta 38+50. This area is located within Area 2 and Area 3. This area for rubber removal is 24,000 sqft.

The entire LZ will be re-stripped per plan, refer to sheets; C1, C2, and C3.

**3.3** RESTORATION OF AIRFIELD MARKINGS: Airfield markings damaged or destroyed by the contractor during rubber removal operations will be repaired at Contractors expense. All rubber removal will be completed prior to accomplishing airfield stripping.

**4.0 EQUIPMENT**

**4.1. MACHINERY.** The equipment used in the removal process shall be mounted on pneumatic tires and shall be capable of removing deposits of rubber without causing damage to pavement surfaces, joints, or joint and crack seal material.

**4.2. STORAGE.** The Contractor shall store equipment and materials only in areas designated/approved by the Contracting Officer.

**5.0 GOVERNMENT FURNISHED MATERIALS AND EQUIPMENT.**

**5.1. COMMUNICATIONS EQUIPMENT.** The Government shall furnish a radio to the Contractor for communication with the Control Tower during each work day. The Contractor will assume responsibility for the radio while it is in his possession, and shall reimburse the Government for repair or replacement of the radio if it is lost, damaged, or destroyed.

**5.2. WATER.** Water shall be furnished at no cost to the Contractor. The water supply shall be a fire hydrant designated by the CO and located within a reasonable proximity to the work area. The Contractor will install a gate valve and a back-flow prevention device on the fire hydrant tap. The Contractor shall furnish all equipment, material, and labor required to obtain and deliver water from the designated fire hydrant to the work areas.

**6. OPERATIONS ON THE AIRFIELD.**

**6.1. AIRFIELD ACCESS.** Work shall be performed in the controlled zones of the base and airfield. All access to or through the base shall be coordinated with the CO,

or authorized representative. All access to or through the airfield shall be coordinated with the Chief of Airfield Management.

**6.2.** Within the radio controlled zone of the airfield, the Contractor shall maintain continuous verbal and visual contact with the control tower. The Contractor shall verbally inform the control tower and the Chief of Airfield Management when the work has been completed and all equipment, personnel, and materials have been removed from the airfield.

**6.3. DEBRIS REMOVAL:** The Contractor shall clear debris from the runway surface as the work progresses.

**6.4. WORK SCHEDULE:** The Contractor shall adhere to the pre-approved schedule for execution of work, weather permitting, runway closures shall be coordinated in advance. If the Contractor's schedule is delayed by weather conditions or mechanical equipment breakdown, the Contractor shall notify the CO and a new work schedule shall be established.

**6.5. ENVIRONMENTAL LIMITATIONS.** Rubber removal methods that use water or chemicals shall not be permitted when the temperature is at 40 degrees F and falling, or the pavement surface temperature is at 35 degrees F or less and falling.

**6.6. WORK ZONES.** The Contractor shall provide all temporary markings and traffic controls necessary to establish a safe and adequate work zone and to minimize (airfield (and) traffic) interruptions.

**6.7. ACCESS OF CONTROL ZONES.** The Contractor shall perform all contracted work within the controlled zones of the base or the airfield. Coordinate access through the base with the CO. Coordinate access to or through the radio controlled zone of the airfield with the Chief of Airfield Management. When within the radio controlled zone of the airfield, the Contractor shall maintain continuous verbal and visual contact with the control tower. The Contractor shall verbally inform the control tower and the Chief of Airfield Management when the work has been completed and all equipment, personnel, and materials have been removed from the airfield.

**6.8. Runway Operations.** Work may be interrupted to provide a runway for aircraft in an emergency or when a special or unscheduled mission is assigned. If the runway is needed for aircraft operations, the Contractor shall remove all equipment from the operational surfaces of the airfield and beyond the hold line within 15 minutes of notification to clear the runway. A scheduled landing or departure that has been identified to the Contractor prior to the start of the Contractor's work shift shall not be considered an interruption.

## **7.0 METHOD OF OPERATION:**

**7.1 ESTABLISHMENT OF WORK ZONES:** The Contractor shall provide all cones, barriers, lights, signs, placards, flags, and flagging personnel necessary to establish an adequate work zone. The Contractor shall establish and maintain work zones as necessary throughout the period of the contract, prominently identifying potential hazards and dangers to personnel and traffic in or near the work area.

wastes in strict compliance with all applicable local, state, and Federal environmental statutes and regulations.

## **8.0 SPECIAL CONSIDERATIONS:**

**8.1.** The Contractor shall submit a Waste Identification and Disposal Plan describing his proposed actions regarding waste collection, control, identification, and disposal. The plan will address disposal methods and requirements for hazardous and non-hazardous wastes.

**8.2.** The Contractor shall draft any written notification required by local, state, or Federal laws, regulations, or guidelines, and shall submit such notification to the CO for approval. After approval from the CO, the Contractor shall submit the written notifications and/or permits to the appropriate regulating authority. Proof of regulatory (local, state, and Federal) approved submittals must be presented to the CO prior to the start of any work.

**8.3.** The Contractor shall protect all areas of pavement adjacent to the work area from splatter, splash, spills, and drips. Any disfigurement will be removed by the Contractor at the Contractor's expense. The Contractor shall remove completely all improperly placed or improperly applied markings and disfigurements without damage to the pavement, joints, and joint and crack seals.

**8.4.** Obliterating the markings with paint will not be allowed unless the removal process leaves marking patterns that could mislead or confuse pilots or motorists. The Contractor and the CO or authorized representative shall jointly inspect the work area before marking operations commence. During this inspection, proper layout of new markings shall be verified and existing damage to the pavement systems, joints, and joint and crack seals shall be documented.

## **9.0 DEFINITIONS**

- A. Any and all references in the Specifications and/or on the Drawings to – and/or requirements for – “notifications” shall be taken to mean written notification to the Contracting Officer.



- B. Any and all references in the Specifications and/or on the Drawings to – and/or requirements for – “submittals” shall be taken to mean submittals in accordance with both of the following:
  - 1. Section 01 30 01 – Submittal Descriptions.
  - 2. Section 01 33 00 – Submittal Procedures.
- C. Any and all references to – and/or requirements for materials and work to be in – compliance with the Manufacturer’s recommendations shall be taken to mean – and/or includes the requirement that:

“Work shall be accomplished in accordance with the Manufacturer’s recommendations. In the event of a conflict between the Manufacturer’s recommendations and the Specifications, the Manufacturer’s recommendations shall take precedence. However, if the Specifications require work and/or materials above/beyond the Manufacturer’s recommendations without conflict with the manufacturer’s recommendations, such additional work and/or materials shall be provided – in addition to that provided pursuant to the Manufacturer’s recommendations.”

## **10.0 DOCUMENTS**

- A. The Contractor shall be responsible for reviewing the complete set of Contract Documents for:
  - 1. Procedures.
  - 2. Space requirements.
  - 3. Materials.
  - 4. Installation sequence.
  - 5. Similar items.
- B. The Contractor shall coordinate efforts with all others working on the Project.

## **11.0 CONTRACTOR USE OF THE PREMISES**

- A. Confine construction activities to areas defined for the Work in the Specifications and on the Drawings – or specifically assigned for that use by the Contracting Officer. Do not use any other areas on Government premises without written consent of the Contracting Officer.
- B. Do not unreasonably encumber the Site with materials or equipment.
- C. Assume full responsibility for protection and safekeeping of products stored at the Site.

## **12.0 SITE ADMINISTRATION**

- A. The Prime Contractor shall assume responsibility for the general charge of the construction and the Site until the Project is turned over to the Government.

## **13.0 LAYOUT**

- A. Immediately locate all reference points, layout the Work, and be responsible for all measurements and other work to be executed by the Contractor under the Contract. Exercise precaution to confirm the figures shown on the Drawings before laying out the Work. Note: The Contractor shall be responsible for any errors resulting from a failure to do so.
- B. Verify all dimensions of existing and new work. Be responsible for their accuracy. Submit differences found to the Contracting Officer for consideration before proceeding with the Work. No extra compensation will be permitted because of differences between the actual dimensions and the measurements indicated on the Drawings.

## **14.0 TEMPORARY FACILITIES AND CONTROLS**

- A. Streets, Drives, and Walks:
  - 1. Keep streets and drives clear of equipment, tools, and machinery.
  - 2. If during the execution of this Contract it becomes necessary to obstruct any street, make necessary arrangements with the Contracting Officer's Representative – and the Security Police – at least 48 hours in advance.
    - a. Keep streets and walks clear of mud and debris caused by construction operations.
    - b. Provide all drive and sidewalk barriers required and necessary, complete with lights for night use.
- B. Provide adequate sanitary toilet facilities for all workers employed on the Project. Maintain toilet facilities used by construction employees in a clean and sanitary condition and furnish necessary supplies.
- C. Only store materials within the area of the Contract Limits. Do not store materials in a manner creating a nuisance or a fire or traffic hazard. Store flammable and combustible materials separately. Inside storage will not be available to the Contractor.
- D. The Contractor shall ensure that all materials and equipment are protected prior to installation and until final acceptance. Storage shall be dry, clean, and safe. Materials or

equipment that become damaged, deteriorated, rusted, or defaced due to improper storage shall be fully repaired, refinished, or replaced as directed by the Contracting Officer. Materials or equipment lost through theft or mishandling shall be replaced by the Contractor without additional cost to the Government.

- E. Temporary Fire Protection: Observe all provisions of the Government safety regulations relative to fire prevention throughout the construction period. Ensure that applicable permits are visible and kept current.
- F. Provide temporary safety equipment in accordance with the requirements of the Government's safety regulations.
- G. Utilities:
  - 1. Notwithstanding the provisions of other clauses of the Contract, all reasonably required amounts of water, gas, electricity, and the like, essential to the performance of the Contract, will be made available at no cost to the Contractor from existing systems, outlets, and supplies.
  - 2. Tying into Electrical Utilities: For this entire Project, tie-ins within Government-owned components will be at no cost to the Contractor.
  - 3. Any arrangements with the utility company – or any fees involved in tying into the distribution system owned by the utility company – are the responsibility of the Contractor. The Government will not be held responsible for interruption of utility service and will not be liable for the Contractor's delays, damages, or increased costs occasioned by such an interruption of service.
  - 4. Temporary connections or lines shall be installed, maintained, and removed by the Contractor at no additional expense to the Government and in a manner acceptable to the Contracting Officer.
  - 5. No water may be obtained from the fire hydrants on the Base without permission from both the Contracting Officer and the Base Fire Department.
    - a. Temporary water lines connected by the Contractor to hydrants on the Base shall be equipped with reduced pressure backflow preventers.

## **15.0 PROJECT CLOSE-OUT**

- A. When the Contractor determines that the Work is complete, submit to the Contracting Officer a request (in writing) for final inspection in accordance with the terms of the Contract.

## **16.0 CLEANING**

- A. Conduct cleaning and disposal operations to comply with Federal, State EPA, and local land, air, and water laws.

- B. Be responsible for seeing that the Site is kept clean at all times and that a daily cleaning is conducted. Storage shall only take place in designated areas.
- C. Unless noted otherwise, all materials removed as a result of the Contractor's operations under the Contract shall become the property of the Contractor and shall be properly disposed of, reused, or recycled – away from the Base – at the expense of the Contractor.
- D. Be responsible for final cleaning. See that the building and the Site are in a clean condition when they are turned over to the Government. At completion of the Work, the Contractor shall remove the Contractor's remaining tools, scaffolding, and surplus materials from the Site.
- E. Prior to any demolition/excavation, submit a waste disposal plan for the recycling and disposal of construction waste materials and demolition debris resulting from the Work of this Contract, including:
  - 1. A description of the waste materials and debris to be reused or recycled.
  - 2. The proposed method of collection and transport.
  - 3. The location of proposed disposal and recycling facilities.
  - 4. The name, address, and telephone number for each facility and transporter.
    - a. If, for any applicable materials listed in Paragraph H below, recycling facilities are not available within a 100-mile radius of the Base, state that in the plan.
- F. Provide all containers required to collect solid wastes collected during the performance of the Contract. At no time shall the Contractor use dumpsters or other waste receptacle maintained by the Base for the disposal of any solid wastes. Small quantities of recyclable materials, such as cardboard, metals, and wood pallets, may be placed in the recycling containers maintained by the Base. Coordinate this exception with the Base Environmental Engineer's Office.
  - 1. The dumpsters maintained by the Base are periodically checked. If it is determined that the Contractor has placed construction and/or demolition debris (other than the recyclable materials listed above) – or any other waste – in a dumpster or other solid-waste collection unit maintained by the Base, the Contractor will immediately remove said waste and dispose of it – or recycle it – properly, away from the Base.
  - 2. If any waste is dumped in an unauthorized area, immediately remove the material and restore the area to its pre-existing condition.
- G. Track the amount of construction/demolition debris and other solid waste that is disposed of under this Contract. It is preferred that the waste be tracked by weight – but tracking

the waste by volume (that is, cubic yards) will also be accepted. Submit the amount of waste disposed of – and all associated weight tickets – to the Contracting Officer monthly using AF Form 3000.

- H. Transport as much of the recyclable construction waste materials and demolition debris as practicable to a valid recycling facility. The recyclable materials can include:
  - 1. Cardboard.
  - 2. Rubble (asphalt and concrete).
  - 3. Recycled cementitious materials (in concrete mix).
  - 4. Brick.
  - 5. Metals.
  - 6. Wood.
  - 7. Plastic.
  - 8. Insulation.
  - 9. Roofing.
  - 10. Glass.
  - 11. Acoustical ceiling panels.
  - 12. Carpet.
  - 13. Polyvinyl chloride piping.
  - 14. R-22 refrigerant.
  - 15. Ballasts.
  - 16. Other materials applicable to the Project that can be reused or recycled.
- I. Submit the amount of materials recycled – and all associated weight tickets – to the Contracting Officer monthly using AF Form 3000.

## **17.0 RECORD DOCUMENTS**

- A. Maintain at the Site one copy of the Drawings with redline changes.
- B. At completion of the Work, deliver Record Documents to the Contracting Officer.
  - 1. Be responsible for the preparation and furnishing of marked-up Contract Drawings including all of the Work of this Contract. Record, using colored pencil, in a neat, workmanlike manner, all cases where actual field construction differs from the Work as indicated by the Contract Documents – as well as changes in location and in elevation. Dimension concealed work and utility locations.
  - 2. These marked-up Contract Drawings will not be acceptable as Shop Drawings.
  - 3. Maintain these marked-up Contract Drawings at the Site as an up-to-date set of Contract Drawings. At completion of the Work, turn this set of marked-up Contract Drawings over to the Contracting Officer for the updating of Record Drawings.

## **18.0 PHOTOGRAPHY PERMIT**

- A. Prior to taking any photographs or video recordings – either for internal record or as required by the terms of the Contract – prepare a request for a photography permit, in letter format, and submit it to the Contracting Officer using AF Form 3000. The request shall indicate:
  - 1. The Contract number.
  - 2. The term of the Contract.
  - 3. The locations or the Site(s) to be photographed.
  - 4. Proposed dates and times to be accomplished.
  - 5. Reason for photography complete with justification.
  - 6. Whether the Contractor intends to take photographs and/or video recordings.
- B. Provide a copy of any and all photographs and/or video recordings to the Government within ten calendar days of being taken, using AF Form 3000.
  - 1. Still images shall be digital and submitted in compact disc (CD) format.
  - 2. Video recordings shall be provided in either of the following formats:
    - a. Digital Versatile Disc (DVD).
    - b. Video Home System (VHS).
  - 3. Clearly label the CD, DVD, or the videocassette and the videocassette case indicating:
    - a. The Contract number.
    - b. The Project number.
    - c. The Project title.
    - d. The date taken.

PART 2 – PRODUCTS – Not Used

PART 3 – EXECUTION – Not Used

END OF SECTION 01 00 00

## SECTION 01 33 00 - SUBMITTAL PROCEDURES

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section, including – but not limited to – the following.
  - 1. SECTION 01 00 00 – GENERAL REQUIREMENTS: Other required submittals:
    - a. The Waste Disposal Plan for the recycling and disposal of waste materials resulting from the Work under this Contract.
    - b. A monthly accounting of the amount of waste disposed of – and all associated weight tickets.
    - c. A monthly accounting of the amount of material recycled – and all associated weight tickets.
    - d. Marked-up Contract Drawings.
    - e. The Manual of Information.
    - f. A Request-for-Photography Permit.
    - g. Copies of any and all photographs and/or video recordings.
  - 2. SECTION 01 35 43 – ENVIRONMENTAL PROCEDURES: The required detailed proposal for implementing specified requirements for environmental pollution control, including a Sediment and Erosion Control Plan.

#### 1.2 REFERENCES

- A. United States Air Force (USAF or AF) Forms: The following documents can be found at the end of this Section.
  - 1. Schedule of Material Submittals (AF Form 66) aka "Submittal Register."
  - 2. The Material Approval Submittal Transmittal Form (AF Form 3000).
  - 3. The Contract Progress Schedule (AF Form 3064).

#### 1.3 DEFINITIONS

- A. Submittals requiring "Government approval":
  - 1. "Government approval" is required for:
    - a. Extensions of design.
    - b. Critical materials.
    - c. Deviations.
    - d. Equipment whose compatibility with the entire system is required to be checked.
    - e. Other items as designated by the Contracting Officer.

2. Within the terms of the Contract, submittals requiring "Government approval" are considered to be "Shop Drawings."
- B. Approved Submittals:
1. The approval of submittals by the Contracting Officer shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory. Approval will not relieve the Contractor of the responsibility for any error that might exist. The Contractor remains responsible for the dimensions and the design of adequate connections, details, and satisfactory construction of the Work.
  2. After submittals have been approved by the Contracting Officer, no resubmittal for the purpose of substituting materials or equipment will be given consideration unless accompanied by an explanation as to why a substitution is necessary.
- C. Disapproved Submittals: Make all corrections required by the Contracting Officer and furnish a corrected submittal within five calendar days in the form and number of copies as specified for the initial submittal.
1. If the Contractor considers any correction indicated on the submittals to constitute a change to the Contract, give prompt notice to the Contracting Officer as required by the terms of the Contract.

## PART 2 – PRODUCTS – Not Used

## PART 3 – EXECUTION

### 3.1 GENERAL

- A. Submit four copies of all items listed on the Submittal Register or specified in the other sections of the Specifications.
- B. The Contracting Officer may request submittals in addition to those listed when deemed necessary to adequately describe the work covered in the respective sections.
- C. Units of weights and measures used on all submittals shall be the same used on the Contract Drawings.
- D. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with the requirements of the Contract.
- E. Prior to submittal, all items shall be checked and approved by the Contractor.
- F. Proposed deviations from the contract requirements shall be clearly identified.



G. Submittals shall include items as:

1. The Contractor's, manufacturer's, or fabricator's drawings.
2. Descriptive literature including – but not limited to:
  - a. Catalog cuts.
  - b. Diagrams.
  - c. Operating charts or curves.
3. Test reports.
4. Test cylinders.
5. Samples
6. Operations and maintenance manuals (including parts list).
7. Certifications.
8. Warranties.
9. Other similar required submittals.

H. Submittals requiring Government approval shall be scheduled and made prior to the acquisition of the material or equipment covered thereby.

3.2 SUBMITTAL REGISTER

- A. At the end of this Section is a Submittal Register showing – at a minimum – which submittals are required by the Specifications.

3.3 SCHEDULING

- A. Submittals covering component items forming a system or items that are interrelated shall be scheduled to be coordinated and submitted concurrently.
- B. Certifications that are specified to be submitted with related Shop Drawings shall be so scheduled.
- C. Allow adequate time for review and approval. No delays, damages or time extensions will be allowed for time lost due to late submittals.

3.4 SUBMITTAL FORM

- A. Use AF Form 3000 for submitting Government-approved submittals in accordance with the instructions on the reverse side of the form. Copies of this form will be furnished to the Contractor.
- B. Properly complete this form by filling out all the heading blank spaces and identifying each item submitted. Exercise special care to ensure proper listing of the specification paragraph and/or sheet number of the Contract Drawings pertinent to the data submitted for each item.

### 3.5 SUBMITTAL PROCEDURE

A. Submittals shall be made as follows:

- 1 Schedule:
  - a. Prepare and submit to the Contracting Officer for approval, three copies of the Submittal Register found at the end of this Section.
  - b. The proposed schedule shall reflect the Contractor's practicable schedule of planned dates of submittal of AF Form 3000.
  - c. The Submittal Register shall be submitted concurrently with the Contractor's submittal of the required AF Form 3064.
  - d. The Contracting Officer will review and return submittals received, approved or disapproved, within ten calendar days after receipt.
  - e. Warranties and operating instructions are required at the completion of the Work, after final inspection.
- 2 Deviations: For submittals that include proposed deviations requested by the Contractor, set forth in writing the reason for any deviations and annotate such deviations on the submittal. The Government reserves the right to rescind inadvertent approval of submittals containing un-noted deviations.

### 3.6 NOT USED

### 3.7 GOVERNMENT - APPROVED SUBMITTALS

- A. Upon completion of review of submittals, the submittals will be identified as having received approval by being signed and dated. Three copies of the submittal will be retained by the Contracting Officer and one copy of the submittal will be returned to the Contractor to be retained at the Site.

END OF SECTION 01 33 00

910<sup>th</sup> Airlift Wing  
Youngstown Air Reserve Station  
Sustain Airfield Markings & Rubber Removal

USAFR ZQEL 23-0001

THIS PAGE INTENTIONALLY LEFT BLANK.

SCHEDULE OF MATERIAL SUBMITTALS													PROJECT NUMBER ZQEL 23-0001		PROJECT TITLE Sustain airfield Markings & Rubber Removal		SOLICITATION/CONTRACT NUMBER				
TO BE COMPLETED BY CONTRACTOR													TO BE COMPLETED BY CONTRACT ADMINISTRATOR								
LINE NUMBER	ITEM OR DESCRIPTION OF ITEM, CONTRACT REFERENCE, TYPE OF SUBMITTAL	NUMBER OF COPIES REQUIRED										PLANNED SUBMISSION DATE	DATE RECEIVED IN CONTRACTING	DATE TO CIVIL ENGINEERING	RETURN SUSPENSE DATE	SUBMITTAL NUMBERS	DATE CONTRACTOR NOTIFIED		CONTRACTOR RESUBMITTAL	FINAL APPROVAL	REMARKS
		CERTIFICATION OF	SHOP DRAWINGS	SAMPLES	COLOR SELECTION	MANUFACTURER'S	MANUFACTURER'S	CATALOG DATA	OPERATING								APPROVED	DIS- APPROVED			
1	DIVISION 01 – Gen'l Rqmts Waste Disposal Plan 01000, 11.E QA/QC Procedure																				
2	Monthly Report of Construction Debris – Disposed of 01000, 11.G QA/QC Report																				
3	Monthly Report of Construction Debris – Recycled 01000, 11.I QA/QC Report																				
4	Marked-Up Contract Drawings 01000. 17.A,B Close Out Submittal																				
5	Environmental Protection Plan 01 35 43, 1.5 A Informational Submittal																				
6	DIVISION 32- Rubber/Paint Removal from Airfield Pavements Schedule of Work/Process Plan 32 01 11.51, 1.4, SD-01 Informational Submittal																				
7	Rubber/PaintRemoval from Airfield Pavements – Product Data 32 01 11.51, 1.4, SD-03 Action Submittal																				
8	Rubber/PaintRemoval from Airfield Pavements –Test Reports 32 01 11.51, 1.4, SD-06 Action Submittal																				
9	Pavement Markings Product Data 32 17 23 1.3, SD-03 Action Submittal																				

SCHEDULE OF MATERIAL SUBMITTALS													PROJECT NUMBER ZQEL 23-0001		PROJECT TITLE Sustain airfield Markings & Rubber Removal		SOLICITATION/CONTRACT NUMBER				
TO BE COMPLETED BY CONTRACTOR													TO BE COMPLETED BY CONTRACT ADMINISTRATOR								
LINE NUMBER	ITEM OR DESCRIPTION OF ITEM, CONTRACT REFERENCE, TYPE OF SUBMITTAL	NUMBER OF COPIES REQUIRED										PLANNED SUBMISSION DATE	DATE RECEIVED IN CONTRACTING	DATE TO CIVIL ENGINEERING	RETURN SUSPENSE DATE	SUBMITTAL NUMBERS	DATE CONTRACTOR NOTIFIED		CONTRACTOR RESUBMITTAL	FINAL APPROVAL	REMARKS
		CERTIFICATION OF	SHOP DRAWINGS	SAMPLES	COLOR SELECTION	MANUFACTURER' S	MANUFACTURER' S	CATALOG DATA	OPERATING								APPROVED	DIS- APPROVED			
10	Pavement Markings Test Reports 32 17 23 1.3, SD-06 Action Submittal																				
11	Pavement Markings Certificates Qualificatons 32 17 23 1.3, SD-07 Action Submittal																				
12	Pavement Markings Waterborne Paint 32 17 23 1.3, SD-08 Informational Submittal																				
13																					
14																					
15																					
16																					
17																					
18																					

Form Approved  
OMB No 9000-0062  
Expires May 31, 2005

Public reporting burden for this collection of information is estimated to average 20 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to the Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project OMB No 9000-0062, Washington DC 20503. Please DO NOT RETURN your form to either of these addresses. Send your completed form to: SAF/AQPC, 1060 Air Force Pentagon, Washington DC

TO: (Contracting Officer)		FROM: (Contractor)		DATE (YYYYMMDD)	
CONTRACT NUMBER		SUBMISSION NUMBER		SUBMITTAL <input type="checkbox"/> NEW <input type="checkbox"/> RESUBMITTAL	
PREVIOUS SUBMISSION NUMBER			PROJECT NUMBER		

[illegible]

BY COMPLETING THIS FORM, THE UNDERSIGNED CONTRACTOR CERTIFIES THAT THE MATERIAL COMPLIES WITH ALL SPECIFICATIONS OF SUBJECT CONTRACT.

DATE (YYYYMMDD)	TYPE OR PRINT NAME AND TITLE	SIGNATURE
-----------------	------------------------------	-----------

FOR GOVERNMENT USE ONLY

**TO:** (Base Civil Engineering Officer)

### For Evaluation and Action

DATE (YYYYMMDD)	TYPE OR PRINT NAME AND GRADE	SIGNATURE
-----------------	------------------------------	-----------

TO: (AF Contracting Office)

RECOMMEND		APPROVAL		DISAPPROVAL AS INDICATED ABOVE AND SUBJECT TO ANY APPLICABLE COMMENTS ON THE REVERSE
-----------	--	----------	--	--

DATE (YYYYMMDD)	TYPE OR PRINT NAME AND GRADE	SIGNATURE
-----------------	------------------------------	-----------

TO: (Contractor)

☐ APPROVED ☐ DISAPPROVED AS INDICATED ABOVE AND SUBJECT TO ANY APPLICABLE COMMENTS ON THE REVERSE SIDE. REQUEST RESUBMITTAL ON DISAPPROVED ITEMS WITHIN \_\_\_\_\_ DAYS OF DATE SHOWN BELOW

DATE (YYYYMMDD)	TYPE OR PRINT NAME AND GRADE	SIGNATURE
-----------------	------------------------------	-----------



**COMMENTS**  
*(Number to correspond with applicable Item Number on reverse)*

**INSTRUCTIONS TO CONTRACTORS**

1. The term "material" is defined as articles, supplies, raw materials, equipment, parts, components, and end items that are to be incorporated into the work required by the contract.
2. This form is to be used by contractors for submitting Shop Drawings, Equipment Data, Manufacturer's Literature and Certificates and samples of Materials to the Government for approval in accordance with the provisions of this contract. Unless otherwise specified, it is to be prepared in 4 copies, signed, and provided to the contracting officer with appropriate attachments.
3. Item(s) to be approved will be clearly tabbed or identified. Data pertaining to item(s) to be approved will be clearly identified or tabbed, particularly where documents are voluminous, in order to properly evaluate the materials or articles to be incorporated in the work. Each attachment will be numbered to correspond with the item number shown on the face of this form.
4. Requests submitted shall be numbered consecutively, by contract, in the space entitled "Submission No.". This number, in addition to the Contract No., will be used to identify each Material Approval Submittal. Resubmissions will be indicated in the appropriate block and the insertion of previous submission number and data in addition to a new submission number. A single submission should be used for all work of a section of the specifications, but in NO instance should the submission include work for more than one (1) contract. Submittals requiring priority handling will be submitted by separate submittal using the form and so marked across the face of the form.
5. This Material Approval Submittal is not valid unless it is signed by the contracting officer. This approval is required as called for by the contracting officer under the terms of this contract.

*(See Contractor's Instructions on Reverse)*

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302, and to the Office of Management and Budget Paperwork Reduction Project 0704-0188, Washington DC 20503. Please DO NOT RETURN your form/questionnaire to either of these addresses. Send your completed form/questionnaire to : SAF/AQCP, 1060 Air Force Pentagon, Washington DC 20330-1060

[illegible]



## INSTRUCTIONS TO CONTRACTORS

1. Prepare three copies of AF Form 3064, in accordance with these instructions, and submit to the contracting officer at the time stated in the contract or as established by the contracting officer.
2. Blocks 1, 2, and 3. Enter the contract number, starting date, and completion date as shown on the contract.
3. Block 8. Enter the title of the project as shown on the contract.
4. Block 9. Enter name and address of your firm. The three copies submitted to the contracting officer must be dated and signed by the contractor or an authorized representative of the firm.
5. Lines 1 through 12. Major elements of work (*whether unit price or lump sum contract*) such as excavation, concrete work, carpentry, engineering, installation of communication electronic facilities, etc., will be shown in Column B in logical sequence and in sufficient detail to identify the element. If the contract calls for more than 11 work elements, additional copies of the AF Form 3064 may be used as a continuation for the work elements.
6. The percentage of each listed work element to the complete job will be shown opposite each element in Column C. As an example, if 3 work elements are shown: excavation, concrete work, and backfill, and it is estimated that excavation is 50% of the total job, concrete 30%, and backfill 20%, these percentages will be shown opposite each element. The total must equal 100%.
7. Columns D through Q will be used to show planned periodic progress, as required by the contracting officer, during the period of the contract. Only the top half of the space under these columns will be used by contractors. Using the example cited above and assuming that the contract period for performance is 8 weeks, and it is planned to accomplish 10% of the excavation work the 1st week and 20% each week until excavation is complete, 10 would be shown in the upper half of Line 1 under Column D, 20 under Column E, and 20 under Column F for a total of 50%. If it is planned to accomplish the concrete work during the 4th, 5th, and 6th weeks in equal amounts, 10 would be entered under Columns G, H, and I on Line 2. Assuming the backfill will be accomplished during the 7th and 8th weeks, 10 would be entered under Columns J and K on Line 3. If the contract extends beyond 14 weeks, additional copies of AF Form 3064 may be used as a continuation of performance record.
8. Total amount of work planned at intervals as shown in Columns D through Q will be totaled and entered in the top half of the space under the appropriate column of Line 12. Again, using the example cited above, the totals under Columns D through K would read 10, 20, 20, 10, 10, 10, 10, 10 for a total of 100%. These totals will be used to plot an overlay graph using Lines 4 through 11, beginning with Column D and extending to the right the number of columns (*weeks*) authorized by the contract for performance time.
9. In the event the contract is modified by the contracting officer under terms of the contract, changing the progress of work as originally scheduled, adding or deleting work or changing the original completion date, a revised progress schedule will be prepared and submitted to the contracting officer for approval. In preparing the revised schedule, the amount of work completed will be considered, together with the changed new completion date set forth in the contract modification. Considering these factors, the work under the contract will be rescheduled over the new total performance time in the same manner that the original schedule was prepared. The new completion date will be entered in Block 3. "First Revised Schedule," "Second Revised Schedule," etc., will be entered to the left of the form title. Time of submission of the revised schedule will be determined by the contracting officer.
10. At such intervals as may be established by the contracting officer, the contractor will submit to the contracting officer AF Form 3065, "Contract Progress Report," indicating the percentage of work accomplished for each work element during the established reporting period. Accurate reports are of the utmost importance to the contractor and to the Government, since the percentage of completion, or progress, thus reported is used in administration of the contract and may be used in connection with approval of partial payments under the contract. Care should be taken to plan the work in such manner that it can be accomplished as stated in this schedule. If, for any reason, it becomes known that any part of the progress under this contract will be delayed, this fact should be reported to the contracting officer immediately.



## 1.8 PROJECT/SITE CONDITIONS

### 1.8.1 Environmental Requirements

Ensure pavement surface is free of snow, ice or slush. Ensure surface temperature is at least 40 degrees F and rising at the beginning of operations. Cease operation during thunder and lightning storms. Cease operation during rainfall except for waterblasting. Cease waterblasting where surface water accumulation alters the effectiveness of material removal.

### 1.8.2 Airfield Traffic Control

Coordinate performance of all work in the controlled zones of the airfield with the Contracting Officer and with the Airfield Manager. Neither equipment nor personnel can use any portion of the airfield without permission of these officers unless the runway is closed. Contractor to submit for approval his proposed dates that the Runway will be closed at the following times:

Day or Date	Runway Closing Time	Runway Opening Time	Important Notes
[ ]	[ ]	[ ]	[ ]

### 1.8.3 Radio Communication

No personnel or equipment will be allowed in the controlled zones of the airfield until radio contact has been made with the control tower and permission is granted by the control tower. A radio for this purpose will be provided by the Government. The Contractor is responsible for the radio and must reimburse the Government for repair or replacement of the radio if it is lost, damaged, or destroyed. Maintain contact with the control tower at all times during work in vicinity of the airfield. Notify the control tower when work is completed and all personnel, equipment and materials have been removed from all aircraft operating surfaces.

### 1.8.4 Emergency Landing and Takeoff

Emergencies take precedence over all operations. Upon notification from the

Control Tower of an emergency landing or imminent takeoff, stop all operations immediately and evacuate all personnel and equipment to an area not utilized for aircraft traffic which is at least 250 feet measured perpendicular to and away from the near edge of the runway unless otherwise authorized by the Contracting Officer or the Contracting Officer's Representative. Equipment and chemicals or detergents as well as excess water must be able to clear the work area within 3 minutes.

## Section 01 35 43 – ENVIRONMENTAL PROCEDURES

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Contractor Liabilities for Environmental Protection:
  - 1. Government installations must comply with environmental protection laws including – but not limited to the following:
    - a. The Clean Water Act
    - b. The Clean Air Act
    - c. The Resource Conservation and Recovery Act.
    - d. The Federal Facilities Compliance Act.
  - 2. The United States Environmental Protection Agency (USEPA) has granted inspection and enforcement authority to the State of Ohio Environmental Protection Agency (Ohio EPA).
    - a. Inspection by either agency might include questioning of the construction personnel who are working with or have contact with hazardous materials and waste.
    - b. Complete – and provide documentation of – environmental training required by federal, state, and local regulations.

#### 1.3 REFERENCES

- A. The publications listed below form a part of the requirements of this Section to the extent referenced. The publications are referenced in the text using the basic designation only.
  - 1. United States Air Force (USAF or AF) Forms: The following documents can be found at the end of SECTION 01 33 00 – SUBMITTAL PROCEDURES.
    - a. Material Approval Submittal (AF Form 3000).
    - b. Contractors Progress Reports (AF Form 3065).
  - 2. Code of Federal Regulations (CFR):
    - a. 40 CFR 261: Identification and Listing of Hazardous Waste (1999).
    - b. 40 CFR 262: Generators of Hazardous Waste (1999).
    - c. 40 CFR 263: Transporters of Hazardous Waste (1999).
    - d. 40 CFR 264: Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (1999).
    - e. 40 CFR 265: Interim Status Standard for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (1999).
    - f. 40 CFR 300: National Oil and Hazardous Substances Pollution Contingency Plan (1999).

- g. 40 CFR 355: Emergency Planning and Notification (2003)
  - 1) Appendix A: The List of Extremely Hazardous Substances and Their Threshold Planning Quantities.
- h. 49 CFR 171: General Information, Regulations, and Definitions (1999).
- i. 49 CFR 172: Hazardous Materials, Tables, and Hazardous Materials Communications Regulations (1999).
- j. 49 CFR 178: Shipping Container Specification (1999).
- 3. Corps of Engineers (COE): Safety and Health Requirements Manual (COE EM-385-1-1 (1996)).
- 4. Executive Orders: Greening the Government Through Leadership in Environmental Management, 21 April 2000 (13148).
- 5. NFPA International: Safeguarding Construction, Alteration, and Demolition operations (NFPA 241 (2000)).
- 6. United States Department of Defense (USDoD) Military Standard: Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment, Revision E (MIL-STD-461E, 20 August 1999).

#### 1.4 DEFINITIONS

- A. Sediment = Soil and other debris that have eroded and have been transported by runoff water or wind.
- B. Solid Waste = Rubbish, debris, garbage, and other discarded solid materials (except hazardous waste as defined in paragraph entitled "Hazardous Waste") resulting from industrial, commercial, and agricultural operations and from community activities.
- C. Sanitary Wastes = Wastes characterized as domestic sanitary sewage.
- D. Rubbish = Combustible and noncombustible wastes such as paper, boxes, glass, crockery, metal, lumber, cans, and bones.
- E. Debris = Combustible and noncombustible wastes such as ashes and waste materials resulting from construction or maintenance and repair work, leaves, and tree trimmings.
- F. Chemical Wastes = This includes salts, acids, alkalis, herbicides, pesticides, and organic chemicals.
- G. Garbage = Refuse and scraps resulting from preparation, cooking, dispensing, and consumption of food.
- H. Hazardous Waste = Hazardous substances as defined in 40 CFR 261 or as defined by applicable state and local regulations.
- I. Hazardous Materials = Hazardous materials as defined in 49 CFR 171 and listed in 49 CFR 172.
- J. Landscape Features = Trees, plants, shrubs, and ground cover.
- K. Lead Acid Battery Electrolyte = The electrolyte substance (liquid medium) within a battery cell.



- L. Oily Waste = Petroleum products and bituminous materials.
- M. Class I Ozone-Depleting Substance (ODS) = Class I ODS is defined in Section 602(a) of The Clean Air Act and includes the following chemicals:
  - 1. Chlorofluorocarbon-11 (CFC-11).
  - 2. Chlorofluorocarbon-12 (CFC-12).
  - 3. Chlorofluorocarbon-13 (CFC-13).
  - 4. Chlorofluorocarbon-111 (CFC-111).
  - 5. Chlorofluorocarbon-112 (CFC-112).
  - 6. Chlorofluorocarbon-113 (CFC-113).
  - 7. Chlorofluorocarbon-114 (CFC-114).
  - 8. Chlorofluorocarbon-115 (CFC-115).
  - 9. Chlorofluorocarbon-211 (CFC-211).
  - 10. Chlorofluorocarbon-212 (CFC-212).
  - 11. Chlorofluorocarbon-1, 213 (CFC-213).
  - 12. Chlorofluorocarbon-214 (CFC-214).
  - 13. Chlorofluorocarbon-215 (CFC-215).
  - 14. Chlorofluorocarbon-216 (CFC-216).
  - 15. Chlorofluorocarbon-217 (CFC-217).
  - 16. Halon-1211.
  - 17. Halon-1301.
  - 18. Halon-2402.
  - 19. Carbon tetrachloride.
  - 20. Methyl chloroform.
- N. Industrial Hygienist = A hygienist certified by the American Board of Industrial Hygiene.

## 1.5 SUBMITTALS

- A. Statements (SD-08): Within ten calendar days after Notice-to-Proceed – and prior to commencement of the Work at the Site – submit in writing (in accordance with SECTION 01 30 01 – SUBMITTAL PROCEDURES) a detailed proposal for an Environmental Protection Program to implement requirements for the environmental pollution controls specified herein, including a Sediment and Erosion Control Plan.

## 1.6 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Hazardous Waste, Spills, and Asbestos:
    - a. Hazardous Waste/Spill Response:
      - 1) Unless otherwise specified in this Contract, no hazardous waste as defined in 40 CFR 261 will be generated by the Contractor; however, should the Contractor cause a hazardous material release, the Contractor shall immediately take action to stop the release and clean up the material.
        - A. Notify the Base Fire Department immediately if a large spill occurs.

- B. The Contractor shall verbally notify the Contracting Office as soon as the leak has been stopped and cleaned up – followed by a written notification/report of the incident to the Contracting Officer within one day.
- C. The Contractor shall be responsible for having adequate spill response equipment and material at the Site to clean up any hazardous material release created by the Contractor.
- D. The spill residue, which includes the hazardous material, absorbent used in the clean up action, and contaminated soil, if any, will be placed in an appropriate container.
- E. Replace any excavated contaminated soil with suitable fill material and return the area to its original condition, all at the Contractor's expense.
- F. It shall be the Contractor's responsibility to analyze the spill residue for hazardous waste characteristics – and to dispose of accordingly.
- G. Clean-up actions, hazardous waste analysis, and disposal shall be at the Contractor's expense and shall be accomplished per all applicable USEPA and OSHA requirements.
- 2) The Contractor will be monitored for compliance with USEPA hazardous waste requirements. Any violations of said requirements will be made known to the Ohio EPA and/or the USEPA. The Contractor shall be responsible for any fines or penalties assessed by either agency.
- b. Spill Containment:
  - 1) The Contractor shall provide secondary containment for all hazardous material containers that have a capacity greater than 30 gallons. This shall include fuels, lubricants, chemical additives, and any other material that requires a Material Safety Data Sheet (MSDS).
  - 2) The secondary containment units may be dikes, containment pallets, overpacks, or similar equipment that will contain a release from the primary container. Secondary containment units shall be compatible with the hazardous material. The Contractor shall ensure that rainwater does not accumulate in the secondary containment units.
- 2 Environmental Protection:
  - a. Provide and maintain, during the life of the Contract, environmental protection as defined. Plan for – and provide – environmental protective measures to:
    - 1) Control pollution that develops during normal construction practice.
    - 2) Correct conditions that develop during the construction of permanent or temporary environmental features associated with the Project.
  - b. Comply with federal, state, and local regulations pertaining to the environment, including- but not limited to – those regulating water, air, and noise pollution.
  - c. Class I ODS Prohibition: Class I ODS as defined and identified herein shall not be used in the performance of this Contract – nor be provided as part of the equipment. This prohibition will be considered to prevail over any other provision, specification, drawing, or referenced document.

3. Safety Program:

- a. Entry: Entry into a confined or enclosed space by personnel for any purpose, including hot work, shall be prohibited until the qualified person has conducted appropriate tests to ensure the confined or enclosed space is safe for the Work intended. The following definitions apply to this Subsubparagraph only:
  - 1) Confined Spaces (first of two parts) = Refers to spaces that by design have one or more of the following characteristics:
    - A. Have limited openings for entry and exit.
    - B. Have unfavorable natural ventilation that could contain or produce dangerous air contaminants.
    - C. Are not intended for continuous employee occupancy.
  - 2) Confined Spaces (second of two parts) = Include – but are not limited to – the following:
  - 3) Qualified Person = A person designated by the Contractor, in writing, as capable (by education or specialized training) of anticipating, recognizing, and evaluating employee exposure to hazardous substances or other unsafe conditions in a confined space. This person shall be capable of specifying necessary control and protective action to ensure worker safety. Where work involves facilities that handle combustible and hazardous materials, this qualified person shall be an NFPA -certified marine chemist.
  - 4) Entry Permit: The Contractor shall submit for review and approval a Daily Confined Space Entry Permit at any location deemed necessary by the Contracting Officer. Complete the permit at least 24 hours prior to entering a designated confined space. The permit shall be posted in a conspicuous place close to the confined space entrance with a copy furnished to the Contracting Officer.
  - 5) Letter of Certification: Submit to the Contracting Officer a letter of certification for the qualified person. The letter shall state the qualified person's name and qualifications and delineate the qualified person's authority to direct work stoppage in the event of hazardous conditions.



- b. Unforeseen Hazardous Material:
  - 1) If material that is not indicated on the Drawings is encountered that might be dangerous to human health upon disturbance during construction operations, stop that portion of the Work and notify the Contracting Officer immediately.
  - 2) The intent is to identify materials such as:
    - a. Polychlorinated biphenyl (PCB).
    - b. Lead paint.
    - c. Friable and non-friable asbestos.
  - 3) Within 14 calendar days, the Government will determine if the material is hazardous. If the material is not hazardous or poses no danger, the Government will direct the Contractor to proceed without change. If the material is hazardous and handling of the material is necessary to accomplish the Work, the Government will issue a modification per the terms of the Contract.
- c. Hazardous Noise: Provide hazardous noise signs, as directed, wherever equipment and work procedures produce sound-pressure levels greater than 85 dBA steady state or 140 dBA impulse, regardless of the duration of the exposure. When personnel are subject to sound-pressure levels exceeding the limits specified in COE EM-385-1-1, Table 5-3, they shall be provided with hearing protection.

## PART 2 – PRODUCTS

### 2.1 GENERAL

#### A. Green Purchasing:

- 1. Youngstown ARS is obligated to comply with the affirmative procurement requirements of:
  - a. Section 6007 of the Resource Conservation and Recovery Act (RCRA).
  - b. Executive Order 13148.
  - c. The policies of the United States Department of Defense (USDoD) “Green Procurement Program (GPP).”
- 2. In order to comply, Youngstown ARS requires its Contractors to use, provide, and/or install environmentally preferable products and services in accordance with federally mandated preference programs.
- 3. Green purchasing includes the acquisition of:
  - a. Recycled content products.
  - b. Environmentally preferable products and services.
  - c. Bio-based products.
  - d. Energy- and water-efficient products.
  - e. Alternate fuel vehicles.
  - f. Products using renewable energy.
  - g. Alternatives to hazardous or toxic chemicals.
- 4. The elements of GPP are described on the Office of the Federal Environmental Executive website (<http://www.ofee.gov/gp/gp.htm>).

5. The Contractor shall comply with the following agency listings and guidelines/recommendations:

Agency	Listing/Guidelines Website
United States Environmental Protection Agency (USEPA) Comprehensive Procurement Guidelines (CPG)	<a href="http://www.epa.gov/cpg">http://www.epa.gov/cpg</a>
United States Department of Agriculture (USDA) Bio - based Products Guidelines	<a href="http://www.biobased.oce.usda.gov">http://www.biobased.oce.usda.gov</a>
United States Department of Energy (USDOE) Federal Energy Management Program (FEMP) Energy Efficiency Recommendations	<a href="http://www.eere.energy.gov/femp/technologies/eep_eerecommendations.cfm">http://www.eere.energy.gov/femp/technologies/eep_eerecommendations.cfm</a>
Green Seal Product Standards	<a href="http://www.greenseal.org/certproducts.htm">http://www.greenseal.org/certproducts.htm</a>

If it is determined that a guideline/recommended product does not meet the specified performance requirements (or other known Government performance requirements), the Contractor shall submit for approval a proposed alternative with the lowest environmental impact that would meet the performance requirements.

6. The Contractor shall provide EPA-designated products containing recovered material unless the item cannot be acquired:
    - a. Competitively within a reasonable time frame.
    - b. Meeting the appropriate performance standards.
    - c. At a reasonable price.
  7. Items identified in the USEPA's CPG shall be viewed as the minimum that can be considered when evaluating recycled/reused materials. Other materials and products not listed, but commonly used in industry outside of the Government, shall also be considered.
  8. Material and product submittals for all recycled-content items shall list the recycled and recovered materials used and the percentage content listed.
- B. Hazardous Materials (HazMat) Management:
1. HazMat Management Program (HMMP): The Contractor shall participate in the HMMP to the extent described in this Contract. Participation shall include:
    - a. Designation of a single individual who has experience and knowledge of hazardous materials as the point of contact for HazMat issues.
    - b. Provision of MSDSs for all HazMat used or stored on the Base.
    - c. Limited storage of HazMat on the Base.
    - d. Identification of all HazMat stored or used on the Base through the provisions of contract submittal documentation.
    - e. Tracking all HazMat stored or used on the Base.

- f. Implementation of best management practices to prevent spills and other releases to the environment.
      - g. Proper storage and management of HazMat while in use or in storage to meet NFPA, OSHA, and RCRA requirements
      - h. Participation in an accurate exit inventory of HazMat used on the Base.
- 2. HAZMART is the central tracking function for HazMat used on the Base. It is located at Building 205.
- 3. Review of HazMat for Use on the Base:
  - a. The Contractor shall submit the current Material Safety Data Sheet (MSDS) for each HazMat to be used for the performance of the Work under this Contract to the Contracting Officer using AF Form 3000 – for review – prior to bringing any HAZMAT onto the Base.
    - 1) HazMat will be reviewed by personnel in Bioenvironmental Engineering, Safety, and Environmental Engineering.
    - 2) HazMat reviews are for material tracking purposes only. The Contractor remains responsible for compliance with applicable health and safety requirements for use of HazMat.
  - b. Substantiating documentation for the use of any HazMat required to complete work shall be submitted with the MSDS if the HazMat contains any of the following:
    - 1) USEPA Industrial Toxics Program Chemicals, also known as EPA 17 toxic chemicals.
    - 2) Carcinogens as defined by OSHA.
    - 3) Ozone-depleting chemicals (ODC).
    - 4) Compounds with high volatile organic contents (VOCs).
    - 5) CERCLA 102(a) Extremely Hazardous Substances (EHS) – see Appendix A of 40 CFR 355.
    - 6) Hazardous air pollutants (HAP) – see Section 112 (b)(1) of the Clean Air Act and its amendments.
  - c. For each HazMat stored or used on the Base, the Contractor shall maintain a current MSDS at the Site where the HazMat is being stored or used, and shall make the MSDSs available for inspection upon request from the Contracting Officer or authorized representative.
- 4. Tracking Usage of HazMat: The Contractor shall maintain a daily Usage Log for each HazMat.
  - a. Submit a copy of the updated Usage Log to the Contracting Officer, biweekly – concurrently with AF Form 3065.
  - b. The Usage Log shall indicate the:
    - 1) Name of the material.
    - 2) Date used.
    - 3) Quantity used in units of measurement consistent with units marked on container.
    - 4) Cumulative quantity used by material for the time period of the log.
    - 5) User of the material.
  - c. The Usage Log shall include a provision for identification of a HazMat tracking number that will be designated by the Government.
  - d. Maintain the Usage Logs sequentially for tracking of HazMat.

- e. When a HazMat from an individual container is totally used during the Contract period, annotate the Usage Log using a designation for the empty container and noting the date the container was empty. Ensure that all empty containers are removed from the Base and disposed of – or recycled – properly.
- f. The Usage Log shall have:
  - 1) The Contractor's name.
  - 2) The Contract number
  - 3) The Project number and title.
  - 4) A sequence/date designation on the sheets.
- g. Each sheet of the Usage Log shall be signed and dated by the Contractor.
- h. Make the Usage Log available for review upon request by the Contracting Officer or authorized representative.
- i. Indicate on the Usage Log the quantities and dates of spillage (if any) for each container – on a daily basis.
- j. Upon completion of the Project/Work – and concurrently with submission of the AF 3065 that reflects 100 percent completion –submit a final version of the Usage Log to the Contracting Officer. Include certification that the final version of the Usage Log is complete and accurate. Such certification shall include:
  - 1) Signature of the firm's authorized representative.
  - 2) Date.
  - 3) Typed/printed name, title, and firm name.
- 5. HazMat Storage Area:
  - a. Store all HazMat in their designated HazMat storage area. The Contractor will be subject to visits by the Contracting Officer or the Contracting Officer's representative for assessment of their HazMat storage Site/area for compliance with the requirements specified herein for HAZMAT MANAGEMENT during the Contract period.
  - b. Ensure that all BEST MANAGEMENT PRACTICES (immediately below) are in place while HazMat is used or stored on the Base.
  - c. Provide secondary containment for all HazMat being stored and used on the Base when the primary container exceeds 30 gallons. Secondary containment shall be chemically inert to the HazMat being stored and impervious to absorption of that HazMat. The containment volume shall not be less than 10 percent of the total quantity being stored or the equal quantity of the largest container being stored – whichever is greater in volume. Provide separate secondary containment for incompatible HazMat.
- 6. Best Management Practices:
  - a. Ensure that the segregation of incompatible materials is accomplished at all times in the Contractor's field office, storage, staging, and work areas.
  - b. Keep all containers closed when not in use. At the end of the workday, or when finished using any material, return the container to a proper storage area.
  - c. Follow all Manufacturers' recommendations for storage/use of HazMat.
  - d. Have current MSDS documents available at all times where employees can access them in case of an emergency at the Site.

7. Spill Control and Cleanup:
  - a. Be responsible for the cleanup and disposal of all spilled materials whether or not they are hazardous materials, including all materials used to contain and absorb the spill.
  - b. Spills of hazardous materials shall be managed in accordance with HazMat Emergency Response requirements.
  - c. Dispose of wastes generated from spill cleanup per the provisions of solid waste and hazardous waste disposal requirements.
8. Hazardous Materials Transport:
  - a. When quantities of HazMat transported onto the installation meet certain United States Department of Transportation (USDOT) thresholds, use only drivers and vehicles that are permitted by the State of Ohio to transport hazardous materials onto or off of the Base per the USDOT regulations. Under these conditions:
    - 1) Properly manifest hazardous materials coming onto the Base.
    - 2) Mark vehicles per USDOT specifications for the materials being transported.
  - c. Remove all unused materials from the Base upon completion of the Work – or when the materials are no longer needed – whichever comes first.

## PART 3 – EXECUTION

### 3.1 GENERAL

- A. Perform all of the Work in a manner that minimizes the pollution of air, water, or land. Control – within reasonable limits–noise and the disposal of solid waste materials, as well as other pollutants.
  1. Develop a Sediment and Erosion Control Plan.
    - a. Maintain and control stormwater runoff to ensure that during the construction time period:
      - 1) Erosion does not occur.
      - 2) Sediment is not discharged into the stormwater collection system.
    - b. Submit the Sediment and Erosion Control Plan for approval by the Contracting Officer prior to commencing of construction.

### 3.2 PROTECTION OF LAND AREAS

- A. The land areas outside the limits of the permanent work performed under this Contract shall be preserved in their present condition.
  1. Exception: Work on storage areas and access routes specifically assigned for the use of the Contractor under this Contract
- B. Confine construction activities to areas defined for the Work on the Drawings or specifically assigned for the use of the Contractor. Storage and related areas – and access routes required temporarily by the Contractor in the performance of the work – will be assigned by the Contracting Officer. No other areas on Government premises shall be used by the Contractor without written consent of the Contracting Officer.

- C. Protection of Natural Resources: Preserve the natural resources within the project boundaries and outside the limits of permanent work. Restore to an equivalent or improved condition upon completion of work. Confine construction activities to within the limits of the work indicated or specified.
  - 1. Land Resources:
    - a. Do not remove, cut, deface, injure, or destroy trees or shrubs without the Contracting Officer's permission.
      - 1) Exception: Areas to be cleared.
    - b. Do not fasten or attach ropes, cables, or guys to existing nearby trees for anchorages unless recommended by the arborist or nurseryman and approved by the Contracting Officer. Where such use of attached ropes, cables, or guys is authorized, the Contractor shall be responsible for any resultant damage.
  - 2. Protection:
    - a. Protect existing trees that are indicated to remain and that may be injured, bruised, defaced, or otherwise damaged by construction operations.
    - b. Remove displaced rocks from uncleared areas.
    - c. By approved excavation, remove trees with 30 percent or more of their root systems destroyed.
  - 3. Replacement: Remove trees and other landscape features scarred or damaged by equipment operations, and replace with equivalent, undamaged trees and landscape features. Obtain the Contracting Officer's approval before replacement.

### 3.3 PROTECTION OF WATER RESOURCES

- A. Control the disposal of fuels, oils, bitumens, calcium chloride, acids, or harmful materials, both on and off the Government premises.
- B. Comply with applicable federal, state, county and municipal laws concerning pollution of rivers and streams while performing the Work under this Contract.
- C. Special measures shall be taken to prevent chemicals, fuels, oils, greases, bituminous materials, herbicides and insecticides from entering public waters.
- D. Water used at the Site for material processing, concrete curing, foundation and concrete cleanup, and other waste waters shall not be allowed to reenter a stream if an increase in the turbidity of the stream could result therefrom.
- E. Oily Wastes: Prevent oily or other hazardous substances from entering the ground, drainage areas, or local bodies of water. Surround all temporary fuel oil or petroleum storage tanks with a temporary earth berm of sufficient size and strength to contain the contents of the tanks in the event of leakage or spillage.

### 3.4 TEMPORARY CONSTRUCTION

- A. Remove traces of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other signs of

construction. Grade temporary roads, parking areas, and similar temporarily used areas to conform to surrounding contours.

### 3.5 NOISE

- A. Make the maximum use of low-noise emission products, as certified by the USEPA. Blasting or use of explosives will be grounds for rejection of the installation.

### 3.6 RESTRICTIONS ON EQUIPMENT

#### A. Electromagnetic Interference Suppression

1. Electric motors shall comply with MIL-STD-461 relative to radiated and conducted electromagnetic interference.
  - a. A test for electromagnetic interference will not be required for motors that are identical physically and electrically to those that have previously met the requirements of MIL-STD-461.
  - b. An electromagnetic interference suppression test will not be required for electric motors without commutation or sliprings having no more than one starting contact and operated at 3,600 revolutions per minute or less.
2. Construction equipment used by the Contractor shall comply with the following:
  - a. For devices capable of producing radiated or conducted interference: MIL-STD-461.
3. Tests for Electromagnetic Interference Suppression:
  - a. Conduct tests on electric motors and the Contractor's construction equipment per MIL-STD-461.
  - b. The test location shall be reasonably free from radiated and conducted interference.
  - c. Furnish:
    - 1) The testing equipment, instruments, and personnel for making the tests.
    - 2) A test location.
    - 3) Other necessary facilities.

- B. Radio Transmitter Restrictions: Conform to the restrictions and procedures for the use of radio transmitting equipment, as directed. Do not use transmitters without prior approval.

- C. Laser/Radioactive Device(s): Comply with the requirements of the Occupational Safety and Health Administration (OSHA). Comply with other restrictions and procedures for the use of laser/radioactive devices, as directed by the Contracting Officer.

1. Use AF Form 3000 to notify the Base Safety Office of – and to obtain approval from the Contracting Officer for – the use of each such device prior to bringing it onto the Base. Indicate when and where the laser/radioactive device will be used so that:
  - a. An evaluation of the potential hazards to base personnel can be assessed.
  - b. Precautionary actions can be taken to protect the population at the Base.

### 3.7 BURNING

- A. Air pollution restrictions applicable to this Project are as follows:
  - 1. Materials shall not be burned on the Government premises.
  - 2. If the Contractor elects to dispose of waste materials off of the Government premises, by burning, he shall make his own arrangements for such burning area and shall conform to all local regulations.
- B. Compliance: COE EM-385-1-1, NFPA 2, T1, and activity fire regulations. Obtain approval from the activity Fire Chief prior to commencement of hot work operations.

### 3.8 EROSION CONTROL

- A. Surface drainage from cuts and fills within the construction limits (whether or not completed) – and from borrow and waste disposal areas – shall be graded to control erosion within acceptable limits. Provide and maintain temporary control measures until permanent drainage facilities are completed and operative. Hold the area of bare soil exposed at any one time by construction operations to a minimum. Outline additional erosion control measures in the Sediment and Erosion Control Plan.
- B. Burn-Off: Burn-off of the ground cover will be grounds for rejection of the installation.
- C. Borrow Pit Areas: Manage and control borrow pit areas that are not at the Base to prevent sediment from entering nearby streams or lakes.
  - 1. Restore areas – including those outside the borrow pit – disturbed by borrow and haul operations. Restoration shall include the following:
    - a. Grading.
    - b. Replacement of topsoil.
    - c. Establishment of a permanent vegetative cover.
  - 2. Uniformly grade side slopes of borrow pit to not more than a slope of one part vertical to two parts horizontal. Uniformly grade the bottom of the borrow pits to provide a flat bottom and drain by outfall ditches or other suitable means.
  - 3. Stockpile topsoil remove during the borrow pit operation, and use as part of restoring the borrow pit area.
- D. Protection of Erodible Soils: Immediately finish the earthwork brought to a final grade, as indicated or as specified. Immediately protect the side slopes and back slopes upon completion of rough grading. Plan and conduct earthwork to minimize the duration of exposure of unprotected soils. Use the following methods to temporarily protect erodible soils by preventing erosion and controlling sedimentation:
  - 1. Mechanically retard and control the rate of runoff from the Site. This shall include construction of diversion ditches, benches, berms, and use of silt fences and straw bales to retard and divert runoff to protected drainage courses.



2. Vegetation and Mulch: Provide temporary protection on sides and back slopes as soon as rough grading is completed or sufficient soil is exposed to require erosion protection.
  - a. Protect slopes by:
    - 1) Accelerated growth of permanent vegetation.
    - 2) Temporary vegetation.
    - 3) Mulching.
    - 4) Netting.
  - b. Stabilize slopes by:
    - 1) Hydro-seeding.
    - 2) Anchoring mulch in place.
    - 3) Covering with anchored netting.
    - 4) Sodding.
    - 5) Such combination of these and other methods necessary for effective erosion control.
  - c. Seeding: Provide new seeding where ground is disturbed. Include topsoil or nutriment during the seeding operation necessary to reestablish a suitable stand of grass.

### 3.9 DUST CONTROL

- A. Maintain all excavations, stockpiles, access roads, waste areas, and all other work free from excess dust to such reasonable degree as to avoid causing a hazard or nuisance to the Users or to others.
- B. Keep dust down at all times, including nonworking periods. Using dust suppressants, sprinkle or treat the soil at:
  1. The Site.
  2. Haul roads.
  3. Other areas disturbed by operations.
- C. Dry power-brooming will be grounds for rejection of the installation. Instead, use:
  1. Vacuuming.
  2. Wet-mopping.
  3. Wet-sweeping.
  4. Wet power-brooming.
- D. Air-blowing used for anything other than cleaning non-particulate debris such as steel reinforcing bars will be grounds for rejection of the installation.
- E. Cutting bituminous concrete, Portland cement concrete, and concrete masonry units by other means than wet-cutting will be grounds for rejection of the installation.
- F. Do not shake bags of cement, concrete mortar, or plaster unnecessarily.
- G. The proposed dust control method shall be approved by the Contracting Officer.

### 3.10 FIELD QUALITY CONTROL

- A. Upon receipt of a notice in writing of any noncompliance with the foregoing provisions, take immediate corrective action. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the Work until satisfactory corrective action has been taken. No part of the time lost due to any such stop work order shall be made the subject of a claim for extension of time or for excess costs of damages by the Contractor.

- 1. Exception: If it is later determined that the Contractor was in compliance.

### 3.11 POST-CONSTRUCTION CLEANING OR OBLITERATION

- A. Unless other wise instructed in writing by the Contracting Officer, obliterate all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other vestiges of construction prior to final acceptance of the Work. Grade and fill the disturbed areas and seed the entire area.

### 3.12 CULTURAL RESOURCES

- A. It is not likely that cultural resources such as historic or archeological items (for example, Native-American artifacts or human remains) will be found on the Base; however, should a potential cultural resource be discovered during demolition or excavation, the Contractor shall immediately stop work in that area and notify the Contracting Officer.

### 3.13 CONTAMINATION

- A. Should the Contractor discover and/or encounter contaminated soil and/or hazardous materials during demolition or excavation, immediately stop work in that area and notify the Contracting Officer.

### 3.14 CONTROL AND DISPOSAL OF SOLID WASTES

- A. General: Remove and dispose of rubbish and debris away from Government premises.
  - 1. Pick up solid wastes and place in covered containers that are regularly emptied.
  - 2. Do not prepare or cook food at the Site.
  - 3. Prevent contamination of the Site or other areas when handling and disposing of wastes.
  - 4. At project completion, leave the areas clean.

### 3.15 SEWAGE, ODOR, AND PEST-CONTROL

- A. Dispose of sewage through connection to a municipal, sanitary sewage system. Where such system is not available, propose one of the following alternatives:
  - 1. Use chemical toilets – or comparably effective units – and periodically empty wastes into a municipal sanitary sewage system.
  - 2. Construct and maintain an approved type of adequate sanitary convenience for the use of persons employed on the Work.

- B. Include provisions for pest-control and elimination of odors.

### 3.16 GARBAGE DISPOSAL

- A. Place garbage in approved containers, and move to a pickup point or disposal area, where directed.

### 3.17 CONTROL AND DISPOSAL OF HAZARDOUS WASTE

- A. Hazardous Waste Generation: Handle generated hazardous waste per 40 CFR 262.
- B. Hazardous Waste Disposal: Dispose of hazardous waste per federal, state, and local regulations, especially 40 CFR 263, 40 CFR 264, and 40 CFR 265.
- C. Hazardous Waste Storage: Store hazardous waste in containers per 49 CFR 178. Identify hazardous waste per 40 CFR 261 and 40 CFR 262.
- D. Spills of Oil and Hazardous Materials: Take precautions to prevent spills of oil and hazardous material. In the event of a spill, immediately notify the Contracting Officer. Spill response shall be per 40 CFR 300 – and applicable state regulations.
- E. Petroleum Products: Protect against spills and evaporation during fueling and lubrication of equipment and motor vehicles. Properly dispose of:
  - 1. Lubricants to be discarded.
  - 2. Excess oil.

### 3.18 ABRASIVE BLASTING

- A. Do not use silica sand in abrasive blasting.
- B. Enclose abrasive blasting operations using tarpaulin drop cloths and windscreens to confine and collect dust, abrasive, agent, paint chips, and other debris per the requirements specified herein.
- C. Disposal Requirements: Collect dust, sand, paint, and other debris resulting from abrasive blasting operations and store in 55-gallon drums with watertight lids. Take a representative sample of this material, and test for EP toxicity with respect to lead, chromium, and cadmium content. Perform the sampling and testing per 40 CFR 261.

END OF SECTION 01 35 43

## SECTION 32 01 11.51 - RUBBER AND PAINT REMOVAL FROM AIRFIELD PAVEMENTS

### PART 1 GENERAL

#### 1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

#### U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910 Occupational Safety and Health Standards

#### 1.3 ADMINISTRATIVE REQUIREMENTS

Submit a schedule of work to the Contracting Officer. Describe the work to be accomplished; noting the location of work, distances from the ends of runways, taxiways, buildings, and other structures; and indicating dates and hours during which the work will be accomplished. Schedule the work to conform to aircraft operating schedules. The Government will try to schedule aircraft operations so as to permit the maximum amount of time for the Contractor's work. However, in the event of any emergency, intense operational demands, adverse wind conditions, and other unforeseen difficulties, discontinue all work at locations in the aircraft operational area. Keep the approved schedule of work current and notify the Contracting Officer of any changes prior to beginning each day's work.

#### 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals Schedule of work  
Rubber and Paint Removal Process Plan

Waste Collection, Identification and Disposal Plan

SD-03 Product Data

Mechanical rubber and paint removal equipment

SD-06 Test Reports

Test Section Results

#### 1.5 MECHANICAL REMOVAL EQUIPMENT

Submit product data for mechanical rubber and paint removal equipment including area of coverage per pass, range of water pressures, and water tank capacity. Mechanical

removal equipment includes waterblasting, grinding or scarifying, or other approved non-chemical systems. Control the equipment used on asphalt or tar concrete to remove rubber and paint accumulations while minimizing disturbances to asphalt or tar mixtures. Control the equipment used on portland cement concretes to remove rubber and paint accumulations and prevent removal of hardened paste from the concrete. Basic hand tools and the following major types of mechanical equipment are considered acceptable for this project:

- a. Waterblasting Equipment.
- b. Grinding or Scarifying Equipment.

#### 1.5.1 Waterblasting Equipment

Provide mobile waterblasting equipment capable of producing a pressurized stream of water that effectively removes rubber and paint from the pavement surface without significantly damaging the pavement. Provide equipment, tools, and machinery which are safe and in good working order at all times. Provide equipment interlocks to prohibit high pressure water discharge when the vehicle or cleaning head is stationary not moving forward or side to side.

#### 1.5.2 Grinding or Scarifying Equipment

Provide equipment capable of removing surface contaminants, paint build-up, or extraneous markings from the pavement surface without leaving any residue. If a weed torch is used to remove paint, the surface must be cleaned by hydro blast afterwards to remove surface contaminants and ash.

### 1.6 TEST SECTION

Prior to the start of work, remove rubber and paint on designated test areas not less than 50 feet in length. Use procedures, water pressures, nozzle height, nozzle spacing's, nozzle angle, and equipment movement rate to achieve the required degree of rubber and paint removal in accordance with Paragraph RUBBER AND PAINT REMOVAL. Methods included in paragraph COMPLIANCE TESTING will be used to determine if the rubber and paint was successfully removed from the test section. The test will examine seven random locations within the test section. Submit the test section results before conducting any further removal work. Provide photos of seven random locations within the test area taken before and after the removal. Provide photos of four random locations at joint seals within the test area taken before and after removal.

### 1.7 DELIVERY, STORAGE, AND HANDLING

Deliver required materials in original manufacturer's containers labeled with appropriate EPA, OSHA, or other agency warnings, if applicable, and Safety Data Sheets. Protect materials from degrading until their use is required during execution of the work.

#### 1.8.5 Airfield Lighting

When night operations are necessary, provide all necessary lighting and equipment. Direct or shade lighting to prevent interference with aircraft, the air traffic control tower, and other base operations. Provide lighting and related equipment capable of being removed from the runway within 15 minutes of notification of an emergency. Night work must be coordinated with the Airfield Manager and approved in advance by the Contracting Officer or authorized representative.

#### 1.8.6 Water

Water to be used for high-pressure water equipment will be made available from Government hydrant[s] at no cost to the Contractor. Furnish equipment and labor for delivery of water from the hydrant to the job site. Notify the Contracting Officer on location of fire hydrant[s] to be used and the respective times of use. The Contracting Officer will notify the Fire Department of fire hydrants to be used and designated times of use. Connections to a fire hydrant will be subject to the Contracting Officer's inspection and approval. The Contractor must provide and use a backflow prevention device for filling water tanks. The Contractor is responsible for testing, treating, and filtering the water to ensure it will not interfere with the rubber removal or damage or clog the rubber removal equipment.

#### 1.10 SAFETY

Comply with OSHA 29 CFR 1910.

### PART 2 PRODUCTS

### PART 3 EXECUTION

#### 3.0 RUBBER AND PAINT REMOVAL

Prior to any work being completed, submit a Rubber and Paint Removal Process Plan for approval by the Contracting Officer.

- a. The pavement surface type is portland cement concrete on the Apron area and asphalt on the short field runway.
- b. Remove 85 percent of all visible rubber on asphaltic concrete pavements. Remove 85 percent of paint on portland cement and asphaltic concrete pavement. Remove all paint that is loose, flaking, chalky, or not to be re-marked or does not comply with size or pattern standards.
- c. Exercise close control of water pressure and blasting time/duration to prevent damage to joints, existing markings that are not intended for removal, or the wearing surface.

- d. Demonstrate the ability to remove rubber at a touchdown area of the runway selected by the Contracting Officer; at least one site per runway will be chosen. Rubber removal must not damage the pavement surface. The surface texture of the cleaned demonstration area will be compared to that of non-rubber traffic areas to determine satisfactory completion of the removal operation.
- e. After approval of the Contractor's operations by the Contracting Officer, the cleaned sample area will become the standard for rubber removal and final surface texture for the remainder of work.
- f. Compliance testing for the amount of rubber and paint to be removed must conform to the requirements in paragraph COMPLIANCE TESTING.

### 3.1 RATE OF REMOVAL

Do not permit high-pressure water application to remove the existing pavement surface, joint seals or crack seals.

### 3.2 WATER PRESSURE

Provide water pressure impact upon the indicated pavement areas sufficient to remove the designated rubber and paint to the required degree of removal without damaging the existing pavement, joint sealant, or other airfield appurtenances. The Contractor is responsible for repairing any damage caused by the removal work.

### 3.3 CLEANUP AND WASTE DISPOSAL

Keep the worksite clean of by-products, debris and waste from rubber and paint removal operations. Perform cleanup operations continuously. Residue will be removed from the pavement by Contractor-furnished sweepers and personnel. Notify the Contracting Officer for coordination. Remove all residue from the pavement. Obtain the approval of residue removal and disposal method from the Contracting Officer prior to beginning work. Submit a Waste Collection, Identification and Disposal Plan describing proposed actions regarding waste collection, control, identification, and disposal to the

Contracting Officer's Representative for approval prior to the start of work. The plan will address disposal methods and requirements for hazardous and non-hazardous wastes.

### 3.4 COMPLIANCE TESTING

- a. Compliance with the rubber and paint removal requirements must be determined by direct testing within the designated work area.
- b. Use a one square foot section of transparent material inscribed with a grid of 100 equal squares as a tool for quantitative measure of the percent removal. Place the grid pattern on the pavement surface at random locations. Then count the squares



- c. which contain rubber and/or paint deposits. The number of squares containing rubber and/or paint deposits must not exceed the allowed percentage in each of the randomly selected locations.
- d. Divide each work area designated for rubber and paint removal into at least four equal zones for the purpose of compliance testing. The layout of each zone must be approved by the Contracting Officer. Within each zone, a minimum of seven random locations must be evaluated. The amount of rubber and paint removed at each of the randomly selected test locations within each zone must meet the requirement described in paragraph RUBBER AND PAINT REMOVAL. Evaluate each zone independently. A zone not meeting the required percentage must be re-cleaned by the Contractor at the Contractor's expense.
- e. Deposits of rubber or rubber buildup and paint are defined as any surface deposit that can be removed by scratching the deposit with a flat sharp object such as a pocket knife without damaging the pavement surface. Stains are defined as materials in the pavement surface micro texture that cannot be removed without damaging the pavement surface. Stain is generally embedded in the surface of the pavement below the horizontal plane of the surface texture. The Contractor is not responsible for stain removal.

### 3.5 DAMAGE REPAIR

Repair any damage to the pavement surface, joint, joint and crack seals, or other Government property caused during the performance of the work at the Contractor's expense. Submit a repair plan to include methods and material to the Contracting Officer's Representative for approval prior to performance of the repairs. Complete the repairs within the performance period of the Contract.

-- End of Section --

## SECTION 32 17 23 - PAVEMENT MARKINGS

### PART 1 GENERAL

#### 1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

#### AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 247 (2013) Standard Specification for Glass Beads Used in Pavement Markings

AASHTO M 248 (1991; R 2012) Standard Specification for Ready-Mixed White and Yellow Traffic Paints

#### ASTM INTERNATIONAL (ASTM)

ASTM D4061 (2013) Standard Test Method for Retroreflectance of Horizontal Coatings

ASTM E1710 (2011) Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer

ASTM E2177 (2011) Standard Test Method for Measuring the Coefficient of Retroreflected Luminance (RL) of Pavement Markings in a Standard Condition of Wetness

ASTM E2302 (2003; R 2016) Standard Test Method for Measurement of the Luminance Coefficient under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer

#### MASTER PAINTERS INSTITUTE (MPI)

MPI 32 (2012) Traffic Marking Paint, S.B.

MPI 97 (2012) Traffic Marking Paint,

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 150/5370-10 (2018; Rev H; Errata 1 2019) Standard  
Specifications for Construction of Airports

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD (2015) Manual on Uniform Traffic Control  
Devices

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-B-1325 (Rev D; Notice 1; Notice 2 2017) Beads (Glass  
Spheres) Retro-Reflective (Metric)

FS TT-P-1952 (2015; Rev F) Paint, Traffic and Airfield  
Markings, Waterborne

1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Surface Preparation Equipment List;

Application Equipment List;

Exterior Surface Preparation;

Safety Data Sheets;

Reflective media for airfields; Reflective media  
for roads; Waterborne Paint;

SD-06 Test Reports

Reflective Media for Airfields;

Reflective Media for Roads;

Waterborne Paint;

Test Reports

SD-07 Certificates Qualifications;

Reflective Media for Airfields

Reflective Media for Roads

## Waterborne Paint

### SD-08 Manufacturer's Instructions Waterborne

Paint;

## 1.4 QUALITY ASSURANCE

### 1.4.1 Regulatory Requirements

Submit certificate stating that the proposed pavement marking paint meets the Volatile Organic Compound, (VOC) regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located. Submit Safety Data Sheets for each product.

### 1.4.2 Qualifications

Submit documentation certifying that pertinent personnel are qualified for equipment operation and handling of applicable chemicals. The documentation should include experience on five projects of similar size and scope with references for all personnel.

### 1.4.3 Qualifications For Airfield Marking Personnel

Submit documentation of qualifications in resume format a minimum of 14 days before pavement marking work is to be performed showing personnel who will be performing the work have experience working on airfields, operating mobile self-powered marking, cleaning, and paint removal equipment and performing these tasks. Include with resume a list of references complete with points of contact and telephone numbers. Provide certification for pavement marking machine operator and Foreman demonstrating experience successfully completing a minimum of two airfield pavement marking projects of similar size and scope. Provide documentation demonstrating personnel have a minimum of two years of experience operating similar equipment and performing the same or similar work in similar environments, similar in size and scope of the planned project. The Contracting Officer reserves the right to require additional proof of competency or to reject proposed personnel.

## 1.5 DELIVERY AND STORAGE

Deliver paint materials, thermoplastic compound materials, and reflective media in original sealed containers that plainly show the designated name, specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer. Provide storage facilities at the job site, only in areas approved by the Contracting Officer, for maintaining materials at temperatures recommended by the manufacturer.

## 1.6 PROJECT/SITE CONDITIONS

### 1.6.1 Environmental Requirements

#### 1.6.1.1 Weather Limitations for Application

Apply pavement markings to clean, dry surfaces, and unless otherwise approved, only when the air and pavement surface temperature is at least 5 degrees F above the dew point and the air and pavement temperatures are within the limits recommended by the pavement marking manufacturer. Allow pavement surfaces to dry after water has been used for cleaning or rainfall has occurred prior to striping or marking. Test the pavement surface for moisture before beginning work each day and after cleaning. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the Contracting Officer. Employ the "plastic wrap method" to test the pavement for moisture as specified in paragraph TESTING FOR MOISTURE. Weather Limitations for Removal of Pavement Markings on Roads and Automotive Parking Areas

Pavement surface must be free of snow, ice, or slush; with a surface temperature of at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting or grinding. Cease operation during thunderstorms, or during rainfall, except for waterblasting and removal of previously applied chemicals. Cease waterblasting where surface water accumulation alters the effectiveness of material removal.

#### 1.6.2 Traffic Controls

Place warning signs near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Place small markers along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Mark painting equipment with large warning signs indicating slow-moving painting equipment in operation. When traffic must be rerouted or controlled to accomplish the work, provide necessary warning signs, flag persons, and related equipment for the safe passage of vehicles.

#### 1.6.3 Airfield Traffic Control

Coordinate performance of all work in the controlled zones of the airfield with the Contracting Officer and with the Airfield Manager. Neither equipment nor personnel can use any portion of the airfield without permission of these officers unless the runway is closed. Contractor to submit for approval his proposed dates that the Runway will be closed at the following times:

Day or Date	Runway Closing Time	Runway Opening Time	Important Notes
[ ]	[ ]	[ ]	[ ]

#### 1.6.4 Airfield Radio Communication

No personnel or equipment will be allowed in the controlled zones of the airfield until radio contact has been made with the control tower and permission is granted by the control tower. A radio for this purpose [will be provided by the Government. The Contractor is responsible for the radio and must reimburse the Government for repair or replacement of

the radio if it is lost, damaged, or destroyed. Maintain contact with the control tower at all times during work in vicinity of the airfield. Notify the control tower when work is completed and all personnel, equipment and materials have been removed from all aircraft operating surfaces.

#### 1.6.5 Airfield Emergency Landing and Takeoff

Emergencies take precedence over all operations. Upon notification from the control tower of an emergency landing or imminent takeoff, stop all operations immediately and evacuate all personnel and equipment to an area not utilized for aircraft traffic which is at least 250 feet measured perpendicular to and away from the near edge of the runway unless otherwise authorized by the Contracting Officer. Equipment and chemicals or detergents as well as excess water must be able to be removed from the work area within 3 minutes.

#### 1.6.6 Lighting

When night operations are necessary, provide all necessary lighting and equipment. Direct or shade lighting to prevent interference with aircraft, the air traffic control tower, and other base operations. Provide lighting and related equipment capable of being removed from the runway within 15 minutes of notification of an emergency. Night work must be coordinated with the Airfield Manager and approved in advance by the Contracting Officer. The Government reserves the right to accept or reject night work on the day following night activities by the Contractor.

### PART 2 PRODUCTS

#### 2.1 EQUIPMENT

##### 2.1.1 Surface Preparation and Paint Removal

##### 2.1.1.1 Surface Preparation and Paint Removal Equipment for Airfield Pavements

Prepare all airfield surfaces and remove paint from airfield surfaces in accordance with UFGS 32 01 11.51 Rubber and Paint Removal from Airfield Pavements. Provide submittals in accordance with specification section 32 01 11.51 Rubber and Paint Removal from Airfield Pavements.

##### 2.1.1.2 Surface Preparation Equipment for Roads and Automotive Parking Areas

Submit a surface preparation equipment list by serial number, type, model, and manufacturer. Include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation. Mobile equipment must allow for removal of markings without damaging the pavement surface or joint sealant. Maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition.

##### 2.1.1.2.1 Waterblasting Equipment

Use mobile waterblasting equipment capable of producing a pressurized stream of water that effectively removes paint from the pavement surface without significantly damaging the pavement. Provide equipment, tools, and machinery which are safe and in good

working order at all times.

#### 2.1.1.2.2 Grinding or Scarifying Equipment

Use equipment capable of removing surface contaminants, paint build-up, or extraneous markings from the pavement surface without leaving any residue. Clean the surface by hydro blast to remove surface contaminants and ash after a weed torch is used to remove paint.

#### 2.1.2 Application Equipment

Submit application equipment list appropriate for the material(s) to be used. Include manufacturer's descriptive data and certification for the planned use that indicates area of coverage per pass, pressure adjustment range, tank and flow capacities, and all safety precautions required for operating and maintaining the equipment. Provide and maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition, or remove them from the work site. Provide mobile and maneuverable application equipment to the extent that straight lines can be followed and normal curves can be made in a true arc.

#### 2.1.2.1 Paint Application Equipment

##### 2.1.2.1.1 Hand-Operated, Push-Type Machines

Provide hand-operated push-type applicator machine of a type commonly used for application of water based paint or two-component, chemically curing paint, thermoplastic, or preformed tape, to pavement surfaces for small marking projects, such as legends and cross-walks, automotive parking areas, or surface painted signs. Provide applicator machine equipped with the necessary tanks and spraying nozzles capable of applying paint uniformly at coverage specified. Hand operated spray guns may be used in areas where push-type machines cannot be used.

##### 2.1.2.1.2 Self-Propelled or Mobile-Drawn Spraying Machines

Provide self-propelled or mobile-drawn spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. Provide machine having a speed during application capable of applying the stripe widths indicated at the paint coverage rate specified herein and of even uniform thickness with clear-cut edges.

##### 2.1.2.1.2.1 Road Marking

Provide equipment used for marking roads capable of placing the prescribed number of lines at a single pass as solid lines, intermittent lines, or a combination of solid and intermittent lines using a maximum of three different colors of paint as specified.

##### 2.1.2.1.2.2 Airfield Marking

Provide self-propelled or mobile-drawn spraying machine for applying the paint for airfield

pavements with an arrangement of atomizing nozzles capable of applying the specified line width in a single pass. Provide paint applicator with paint reservoirs or tanks of sufficient capacity and suitable gages to apply paint in accordance with requirements specified. Equip tanks with suitable mechanical agitators. Equip spray mechanism with quick-action valves conveniently located, and include necessary pressure regulators and gages in full view and reach of the operator. Install paint strainers in paint supply lines to ensure freedom from residue and foreign matter that may cause malfunction of the spray guns. The paint applicator must be readily adaptable for attachment of a dispenser for the reflective media approved for use.

#### 2.1.2.1.2.3 Hand Application

Provide spray guns for hand application of paint in areas where the mobile paint applicator cannot be used.

## 2.2 MATERIALS

Use waterborne paint for roads. The maximum allowable VOC content of pavement markings is 150 grams per liter. Color of markings are indicated on the drawings and must conform to ASTM D6628 for roads and SAE AMS-STD-595A for airfields. Provide materials conforming to the requirements specified herein.

### 2.2.1 Waterborne Paint

Federal Specification TT-P-1952, Type I.

### 2.2.5 Reflective Media

#### 2.2.5.1 Reflective Media for Airfields

FS TT-B-1325, Type I, Gradation A,

#### 2.2.5.2 Reflective Media for Roads

FS TT-B-1325, Type I, Gradation A.

## PART 3 EXECUTION

### 3.1 EXAMINATION

#### 3.1.1 Testing for Moisture



Test the pavement surface for moisture before beginning pavement marking after each period of rainfall, fog, high humidity, or cleaning, or when the ambient temperature has fallen below the dew point. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the Contracting Officer or authorized representative. Employ the "plastic wrap method" to test the pavement for moisture as follows: Cover the pavement with a 12 inch by 12 inch section of clear plastic wrap and seal the edges with tape. After 15 minutes, examine the plastic wrap for any visible moisture accumulation inside the plastic. Do not begin marking operations until the test can be performed with no visible moisture accumulation inside the plastic wrap. Re-test surfaces when work has been stopped due to rain.

### 3.1.2 Surface Preparation Demonstration

Prior to surface preparation, demonstrate the proposed procedures and equipment. Prepare areas large enough to determine cleanliness, adhesion of remaining coating and rate of cleaning. Perform a demonstration removal of pavement marking in an area designated by the Contracting Officer. Approved demonstration area establishes the standard for the remainder of the work.

### 3.1.3 Test Stripe Demonstration

Prior to paint application, demonstrate test stripe application within the work area using the proposed materials and equipment. Apply separate test stripes in each of the line widths and configurations required herein using the proposed equipment. Make the test stripes long enough to determine the proper speed and operating pressures for the vehicle(s) and machinery, but not less than 50 feet long.

### 3.1.4 Application Rate Demonstration

During the Test Stripe Demonstration, demonstrate compliance with the application rates specified herein. Document the equipment speed and operating pressures required to meet the specified rates in each configuration of the equipment and provide a copy of the documentation to the Contracting Officer prior to proceeding with the work.

### 3.1.5 Retroreflective Value Demonstration

After the test stripes have cured to a "no-track" condition, demonstrate compliance with the average retroreflective values specified herein. Take a minimum of ten readings on each test stripe with a Retroreflectometer with a direct readout in millicandelas per square meter per lux (mcd/m<sup>2</sup>/lx).

Perform testing in accordance with ASTM D4061, ASTM E1710, ASTM E2177, and ASTM E2302.

### 3.1.6 Level of Performance Demonstration

The Contracting Officer will be present at the application demonstrations to observe the results obtained and to validate the operating parameters of the vehicle(s) and equipment. If accepted by the Contracting Officer, the test stripe is the measure of performance required for this project. Do not proceed with the work until the demonstration results are satisfactory to the Contracting Officer.

### 3.2 EXTERIOR SURFACE PREPARATION

### 3.2 APPLICATION

Apply pavement markings to dry pavements only.

#### 3.2.1 Paint

Apply paint with approved equipment at rate of coverage specified herein. Provide guidelines and templates as necessary to control paint application. Take special precautions in marking numbers, letters, and symbols. Manually paint numbers, letters, and symbols. Sharply outline all edges of markings. The maximum drying time requirements of the paint specifications will be strictly enforced, to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. If there

is a deficiency in drying of the markings, painting operations must cease until the cause of the slow drying is determined and corrected.

#### 3.2.1.1 Waterborne Paint

##### 3.2.1.1.1 Airfields

For non-reflectorized and reflectorized markings, apply paint conforming to FS TT-P-1952 Type I at a rate of 121 plus or minus 6 square feet per gallon. For reflectorized markings, apply FS TT-B-1325 beads at a rate of 8 plus or minus 0.5 pounds of glass spheres per gallon.

##### 3.2.1.1.2 Roads

Apply paint at a rate of 105 plus or minus 5 square feet per gallon. Apply FS TT-B-1325 Type I (Gradation A) beads at a rate of 7 plus or minus 0.5 pounds of glass spheres per gallon.

### 3.3.2 Cleanup and Waste Disposal

Keep the worksite clean and free of debris and waste from the removal and application operations. Immediately cleanup following removal operations in areas subject to aircraft traffic. Dispose of debris at approved sites.

### 3.4 FIELD QUALITY CONTROL

#### 3.4.1 Material Inspection

Examine material at the job site to determine that it is the material referenced in the report of test results or certificate of compliance. Provide test results substantiating conformance to the specified requirements with each certificate of compliance.

### 3.4.2 Dimensional Tolerances

Apply all markings in the standard dimensions provide in the drawings. New markings may deviate a maximum of 10 percent larger than the standard dimension. The maximum deviation allowed when painting over an old marking is up to 20 percent larger than the standard dimensions.

### 3.4.3 Bond Failure Verification

Inspect newly applied markings for signs of bond failure based on visual inspection and comparison to results from Test Stripe Demonstration paragraph.

### 3.4.4 Reflective Media and Coating Application Verification

Use a wet film thickness gauge to measure the application of wet paint. Use a microscope or magnifying glass to evaluate the embedment of glass beads in the paint. Verify the glass bead embedment with approximately 50 percent of the individual bead spheres embedded and 50 percent of the individual bead spheres exposed.

### 3.4.5 Retroreflective Markings

Collect and record readings for white and yellow retroreflective markings at the rate of one reading per 1000 linear feet. The minimum acceptable average for white markings is 200 millicandelas per square meter per lux (mcd/m<sup>2</sup>/lx) (measured with Retroreflectometer). The minimum acceptable average for yellow markings is 175 millicandelas per square meter per lux (mcd/m<sup>2</sup>/lx). Compute readings by averaging a minimum of 10 readings taken within the area at random locations. Re-mark areas not meeting the retroreflective requirements stated above.

### 3.4.6 Material Bond Verification and Operations Area Cleanup for Airfields

Vacuum sweep the aircraft operating area before it is opened for aircraft operations to preclude potential foreign object damaged to aircraft engines. Visually inspect the pavement markings and the material captured by the vacuum. Verify that no significant loss of reflective media has occurred to the pavement marking due to the vacuum cleaning.

-- End of Section --

# UNIFIED FACILITIES CRITERIA (UFC)

---

## AIRFIELD AND HELIPORT MARKING



APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

## UNIFIED FACILITIES CRITERIA (UFC)

### AIRFIELD AND HELIPORT MARKING

Any copyrighted material included in this UFC is identified at its point of use.

Use of the copyrighted material apart from this UFC must have the permission of the copyright holder.

U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND

AIR FORCE CIVIL ENGINEER CENTER (Preparing Activity)

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

Change No.	Date	Location

---

This UFC supersedes Air Force ETL 04-2, *Standard Airfield Pavement Marking Schemes*, 19 July 2004; Army TM 5-823-4 C1, *Marking of Army Airfield-Heliport Operational and Maintenance Facilities*, July 1987; UFC 3-260-05A, *Marking of Army Airfield Heliport Operational and Maintenance Facilities*, 16 January 2004; Army Engineering and Construction Bulletin, *Marking of Army Airfields and Heliports*, 1 October 2012; and Army ETL 1110-3-512, *Army Airfield and Heliport Markings*, 30 September 2015.

THIS PAGE INTENTIONALLY LEFT BLANK.

## FOREWORD

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with [USD \(AT&L\) Memorandum](#) dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and, in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the most stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Civil Engineer Center (AFCEC) are responsible for administration of the UFC system. Defense agencies should contact the preparing Service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective Service proponent office by the following electronic form: [Criteria Change Request](#). The form is also accessible from the Internet site listed below.

UFC are effective upon issuance and are distributed only in electronic media from the following source:

- Whole Building Design Guide web site <http://dod.wbdg.org/>.

Refer to UFC 1-200-01, *DoD Building Code (General Building Requirements)*, for implementation of new issuances on projects.

### AUTHORIZED BY:



LARRY D. McCALLISTER, PhD, PE,  
PMP, SES  
Chief, Engineering and Construction  
Directorate of Civil Works  
U.S. Army Corps of Engineers



JOSEPH E. GOTT, P.E.  
Chief Engineer  
Naval Facilities Engineering Command



EDWIN H. OSHIBA, SES  
Director, AF Civil Engineer Center



MICHAEL McANDREW  
Deputy Assistant Secretary of Defense  
(Facilities Investment and Management)  
Office of the Assistant Secretary of Defense  
(Energy, Installations, and Environment)

## UNIFIED FACILITIES CRITERIA (UFC) NEW DOCUMENT SUMMARY SHEET

**Document:** UFC 3-260-04, *Airfield and Heliport Marking*

**Superseding:** Air Force Engineering Technical Letter (ETL) 04-2, *Standard Airfield Pavement Marking Schemes*, 19 July 2004; Army TM 5-823-4 C1, *Marking of Army Airfield-Heliport Operational and Maintenance Facilities*, July 1987; UFC 3-260-05A, *Marking of Army Airfield Heliport Operational and Maintenance Facilities*, 16 January 2004; and Army Engineering and Construction Bulletin, *Marking of Army Airfields and Heliports*, 1 October 2012, and Army ETL 1110-3-512, *Army Airfield and Heliport Markings*, 30 September 2015

**Description:** The purpose of this document is to provide standard dimensions, colors, retro-reflectivity requirements, layout, placement, and orientation standards for marking airfield pavements. It gives the minimum level of marking necessary for paved surfaces of fixed and rotary wing runways, taxiways, helipads, and landing lanes. It also provides authority to mark hazards to air navigation as obstructions in accordance with national standards or military agreements within host countries. See TM 3-34.48-2, *Theater of Operations: Roads, Airfields, and Heliports – Airfield and Heliport Design*, Volume II, for landing zone marking requirements. This document applies to all Department of Defense (DoD) activities except those operating at airports owned and controlled by an authority other than the DoD. For airports under Federal Aviation Administration (FAA) jurisdiction, use FAA Advisory Circular (AC) 150/5340-1, *Standards for Airport Markings*. For DoD facilities overseas, if a written agreement exists between the host nation and DoD that requires application of North Atlantic Treaty Organization (NATO), International Civil Aviation Organization (ICAO), or FAA standards, those standards apply as stipulated within the agreement. For cases where a Status of Forces Agreement (SOFA) specifically requires international standards, use ICAO Annex 14, Volume I, *Aerodromes* (for fixed wing runways), or Annex 14, Volume II, *Heliports* (for rotary wing helipads and runways), as appropriate. Air Force tenant organizations on civil airports use these standards on the military portion of the airfield to the maximum extent practicable.

**Reasons for Document:** This document combines and consolidates standards for the Services to ensure uniformity in visual guidance aids on DoD airfields.

**Impact:** Impacts of implementing these updated standards have been minimized by allowing existing markings to remain pending a need to remark pavement due to age or normal wear.

**Unification Issues:** Naval Air Systems Command (NAVAIR) is the Office of Primary Responsibility for airfield marking on U.S. Navy facilities. The NAVAIR standard is NAVAIR 51-50AAA-2, *General Requirements for Shore Based Airfield Marking and Lighting*. Additionally, the NAVAIR publication includes airfield lighting standards which are not unified with UFC 3-535-01, *Visual Air Navigation Facilities*. The Pavements Discipline Working Group (DWG) continues to work with NAVAIR to unify airfield marking standards across DoD. Waiver processing differs among the Services due to differences in organizational structure.



## TABLE OF CONTENTS

<b>CHAPTER 1 BACKGROUND AND GENERAL INFORMATION .....</b>	<b>1</b>
<b>1-1 BACKGROUND. ....</b>	<b>1</b>
<b>1-2 GENERAL INFORMATION. ....</b>	<b>1</b>
<b>1-3 PURPOSE AND SCOPE. ....</b>	<b>1</b>
<b>1-4 APPLICABILITY. ....</b>	<b>1</b>
<b>1-5 JOINT USE FACILITIES. ....</b>	<b>2</b>
1-5.1 Within the Continental United States (CONUS). ....	2
1-5.2 Outside the Continental United States (OCONUS). ....	2
<b>1-6 GENERAL BUILDING REQUIREMENTS. ....</b>	<b>2</b>
<b>1-7 REFERENCES. ....</b>	<b>2</b>
<b>1-8 SUMMARY OF BEST PRACTICES IN APPENDIX B. ....</b>	<b>3</b>
1-8.1 Airfield Marking Handbook. ....	3
1-8.2 Maintenance of Marking Patterns from Previous Standards. ....	3
1-8.3 Use of Metrics for Markings. ....	3
<b>1-9 GLOSSARY. ....</b>	<b>3</b>
<b>CHAPTER 2 WAIVERS .....</b>	<b>5</b>
<b>2-1 REQUIREMENTS AND PROCEDURES. ....</b>	<b>5</b>
<b>CHAPTER 3 TOLERANCES, MATERIALS, APPLICATION RATES, AND COLORS .</b>	<b>7</b>
<b>3-1 PATTERN SIZE ALLOWANCES. ....</b>	<b>7</b>
3-1.1 Tolerances for New Markings and Remarkings. ....	7
3-1.2 Paint. ....	7
3-1.3 Alternate Marking Materials. ....	8
3-1.4 Alternate Visual Aids. ....	8
3-1.5 Contrasting Markings to Increase Conspicuity. ....	8
3-1.6 Obliteration of Extraneous Markings. ....	8
<b>3-2 COLORS FOR PAVEMENT AND OBSTRUCTION MARKINGS. ....</b>	<b>9</b>
3-2.1 Airfields and Roadways. ....	9
3-2.2 Colors for Marking Obstructions. ....	10
<b>3-3 RETRO-REFLECTIVE PAVEMENT MARKINGS. ....</b>	<b>10</b>
3-3.1 Painted Pavement Markings. ....	10
3-3.2 Post Applied Retro-Reflective Media. ....	10
3-3.3 Material Selection. ....	10

3-3.4	Lifecycle Cost Analysis .....	11
<b>CHAPTER 4</b>	<b>UNIQUE MARKING PRACTICES .....</b>	<b>13</b>
<b>4-1</b>	<b>PRACTICES FOR SPECIAL CIRCUMSTANCES. ....</b>	<b>13</b>
<b>4-2</b>	<b>OPEN GRADED WEARING SURFACES AND CLEANING EXISTING MARKINGS. ....</b>	<b>13</b>
4-2.1	Painting Porous Pavements. ....	13
4-2.2	Cleaning Markings. ....	13
<b>4-3</b>	<b>MAXIMUM PAINT THICKNESS. ....</b>	<b>13</b>
<b>4-4</b>	<b>OBSTRUCTION MARKING. ....</b>	<b>13</b>
<b>4-5</b>	<b>ROADWAY MARKING. ....</b>	<b>14</b>
<b>CHAPTER 5</b>	<b>RUNWAY MARKINGS .....</b>	<b>15</b>
<b>5-1</b>	<b>GENERAL INFORMATION. ....</b>	<b>15</b>
<b>5-2</b>	<b>RUNWAY MARKING SCHEMES. ....</b>	<b>15</b>
5-2.1	Runway Marking Elements Based on Highest Intended Use. ....	15
5-2.2	Additional Markings. ....	15
5-2.3	Unmanned Aircraft System (UAS) Runways. ....	15
5-2.4	Basic Visual Flight Rule (VFR) Runway. ....	16
5-2.5	Non-Precision Instrument Runways. ....	16
5-2.6	Precision Instrument Runway. ....	20
5-2.7	Runway Marking Precedence. ....	20
5-2.8	Runway Centerline. ....	20
5-2.9	Threshold Marking. ....	22
5-2.10	Runway Designations. ....	23
5-2.11	Dimensions for Designation Numbers and Letters. ....	24
5-2.12	Runway Overruns. ....	24
5-2.13	Runway Side Stripes. ....	27
5-2.14	Displaced Threshold Marking Schemes. ....	27
5-2.15	Touchdown Zone and Fixed Distance Markings. ....	34
<b>CHAPTER 6</b>	<b>TAXIWAY AND APRON MARKINGS .....</b>	<b>37</b>
<b>6-1</b>	<b>GENERAL INFORMATION. ....</b>	<b>37</b>
<b>6-2</b>	<b>TAXIWAY AND TAXILANE CENTERLINE STRIPE. ....</b>	<b>37</b>
6-2.1	Directional Changes. ....	37
6-2.2	Taxiway and Taxilane Turn Radii. ....	37
<b>6-3</b>	<b>TAXIWAY, APRON, AND TAXILANE EDGE STRIPES. ....</b>	<b>38</b>

6-3.1	Taxiway and Apron Edge Stripes. ....	38
6-3.2	Taxilane Edge Stripes. ....	38
<b>6-4</b>	<b>PARKING STOP BARS. ....</b>	<b>40</b>
<b>6-5</b>	<b>HOLDING POSITIONS. ....</b>	<b>43</b>
6-5.1	Runway Hold Positions. ....	43
6-5.2	Runway/Runway Holding Position Marking Layout and Placement. ....	49
6-5.3	Enhanced Hold Position Marking. ....	49
6-5.4	Intermediate Hold Position Markings. ....	49
6-5.5	Surface Painted Signs. ....	52
6-5.6	Surface Painted Holding Position Signs. ....	53
6-5.7	Surface Painted Taxiway Location Signs. ....	55
6-5.8	Surface Painted Taxiway Direction Signs. ....	55
6-5.9	Towway Markings. ....	61
6-5.10	Restricted Area and Restricted Area Entry Control Points (ECP). ....	63
<b>CHAPTER 7</b>	<b>MARKING PAVEMENTS FOR ROTARY WING OPERATIONS .....</b>	<b>65</b>
<b>7-1</b>	<b>GENERAL. ....</b>	<b>65</b>
<b>7-2</b>	<b>MARKING WITH PAINT OR THERMOPLASTICS. ....</b>	<b>65</b>
<b>7-3</b>	<b>COLORS AND REFLECTIVITY OF MARKINGS. ....</b>	<b>65</b>
<b>7-4</b>	<b>PAVEMENT CURING TIME AND APPLICATION RATES. ....</b>	<b>65</b>
7-4.1	Rigid Pavements. ....	65
7-4.2	Flexible pavements. ....	65
<b>7-5</b>	<b>INCREASING VISIBILITY OF MARKINGS. ....</b>	<b>66</b>
<b>7-6</b>	<b>HELICOPTER RUNWAY AND LANDING LANE MARKINGS. ....</b>	<b>66</b>
7-6.1	Rotary-Wing Runway Designator. ....	66
7-6.2	Azimuth Runway Designation Marking. ....	66
7-6.3	Runway Centerline Marking. ....	67
7-6.4	Runway Side Stripe (Edge) Marking. ....	67
<b>7-7</b>	<b>TAXIWAY MARKINGS. ....</b>	<b>71</b>
7-7.1	Centerline Marking. ....	71
7-7.2	Hold-Line Marking. ....	71
<b>7-8</b>	<b>HOVERPOINTS. ....</b>	<b>71</b>
<b>7-9</b>	<b>APRON MARKINGS. ....</b>	<b>73</b>
<b>7-10</b>	<b>HELIPADS. ....</b>	<b>73</b>

7-10.1	Hospital Helipad Markings. ....	73
7-10.2	Elevated Helipad Markings. ....	73
7-10.3	Application. ....	79
7-10.4	Location. ....	79
<b>7-11</b>	<b>OVERRUNS AND SHOULDER MARKINGS. ....</b>	<b>79</b>
7-11.1	General. ....	79
7-11.2	Color. ....	79
7-11.3	Materials. ....	79
7-11.4	Overrun Areas. ....	79
7-11.5	Runway Shoulder Areas. ....	80
<b>CHAPTER 8</b>	<b>OTHER PAVEMENT MARKINGS .....</b>	<b>87</b>
<b>8-1</b>	<b>CLOSED PAVEMENT MARKINGS. ....</b>	<b>87</b>
<b>8-2</b>	<b>PERMANENTLY CLOSED RUNWAYS. ....</b>	<b>87</b>
8-2.1	Runway Markings. ....	87
8-2.2	Intersections. ....	87
<b>8-3</b>	<b>PERMANENTLY CLOSED TAXIWAYS OR TAXILANES. ....</b>	<b>87</b>
<b>8-4</b>	<b>PERMANENTLY CLOSED APRONS. ....</b>	<b>88</b>
<b>8-5</b>	<b>TEMPORARILY CLOSED AIRFIELD PAVEMENTS. ....</b>	<b>88</b>
8-5.1	Temporarily Closed Runways. ....	88
8-5.2	Temporarily Closed Taxiways or Taxilanes. ....	88
8-5.3	Temporarily Closed Aprons. ....	88
<b>8-6</b>	<b>BARRICADES. ....</b>	<b>91</b>
<b>8-7</b>	<b>NON-MOVEMENT AREA BOUNDARY MARKING. ....</b>	<b>93</b>
8-7.1	Location. ....	93
8-7.2	Layout. ....	93
<b>8-8</b>	<b>OBSTRUCTION CLEARANCE LINE. ....</b>	<b>93</b>
<b>8-9</b>	<b>DECEPTIVE SURFACES (SHOULDER MARKINGS). ....</b>	<b>95</b>
<b>8-10</b>	<b>RUNWAY SHOULDERS. ....</b>	<b>95</b>
<b>8-11</b>	<b>TAXIWAY AND APRON SHOULDERS. ....</b>	<b>95</b>
<b>8-12</b>	<b>VEHICULAR ACCESS MARKING. ....</b>	<b>95</b>
<b>8-13</b>	<b>INERTIAL NAVIGATION SYSTEM (INS) CHECKPOINT MARKINGS. .</b>	<b>95</b>
<b>8-14</b>	<b>GROUND RECEIVER CHECKPOINT MARKINGS. ....</b>	<b>96</b>
<b>8-15</b>	<b>COMPASS CALIBRATION PAD (CCP) MARKINGS. ....</b>	<b>101</b>

8-16	T-6 PROPELLER HAZARD PAVEMENT MARKINGS. ....	103
8-17	F-16 ENGINE INLET DANGER AREA PAVEMENT MARKINGS. ....	103
8-18	HYDRANT FUEL PIT LID MARKING. ....	103
8-19	STATIC GROUND MARKINGS. ....	103
8-20	C-12 PROP HAZARD WARNING MARKING. ....	104
8-21	EXPEDIENT AIRFIELD MARKINGS. ....	104
APPENDIX A REFERENCES .....		109
APPENDIX B BEST PRACTICES .....		113
APPENDIX C GLOSSARY .....		121

## FIGURES

Figure 5-1 Runway Marking Schemes .....	17
Figure 5-2. VFR Runway Markings .....	18
Figure 5-3. Non-Precision Instrument Runway Markings .....	19
Figure 5-4. Touchdown Zone and Fixed Distance (Aiming Point) Markings .....	21
Figure 5-5. UAS Runway Markings .....	22
Figure 5-6 Runway Designators .....	25
Figure 5-7. Overrun Markings .....	26
Figure 5-8 Permanently Displaced Threshold Where Preceding Pavement is Used as Runway (Take-Off or Landing) .....	30
Figure 5-9. Permanently Displaced Threshold Where Preceding Pavement is Used as a Taxiway .....	31
Figure 5-10. Permanently Displaced Threshold Where Displacement Area is Used as a Taxiway and for Take-Off and/or Landing Ground Roll .....	32
Figure 5-11. Temporarily Displaced Threshold .....	33
Figure 5-12. Aircraft Arresting System (AAS) Warning Markings .....	35
Figure 6-1. Typical Taxiway and Taxilane Markings .....	39
Figure 6-2. Typical Mass Apron Layout for Cargo Aircraft .....	42
Figure 6-3. VFR Hold Position Markings .....	44
Figure 6-4. ILS Hold Position Details .....	46
Figure 6-5. Locating Instrument Hold Position to Protect Glideslope Critical Area	47
Figure 6-6. Locating Instrument Hold Positions to Protect Touchdown Zone Critical Area .....	48
Figure 6-7. Enhanced Hold Position Markings .....	50

Figure 6-8. Intermediate Holding Position Marking .....	51
Figure 6-9. Taxilane Edge Stripes .....	52
Figure 6-10. Surface Painted Runway Hold Position Signs .....	54
Figure 6-11. Surface Painted Taxiway Location Sign .....	57
Figure 6-12. Surface Painted Taxiway Direction Sign .....	58
Figure 6-13. Surface Painted Sign Inscription Layout, A through P .....	59
Figure 6-14. Surface Painted Sign Inscription Layout, Q through 6 .....	60
Figure 6-15. Surface Painted Sign Inscription Layout, 7 through 0 and Directional Arrow .....	61
Figure 6-16 Towway Centerline Marking .....	62
Figure 6-17. Restricted Area Entry Control Points (ECP) .....	63
Figure 6-18. Typical Restricted Area Boundary Warning Sign .....	64
Figure 7-1. Helicopter Runway Markings .....	68
Figure 7-2. Rotary-Wing Designator and Designation Markings .....	69
Figure 7-3. Rotary-Wing Runway Designation Numbers and Letters .....	70
Figure 7-4. Heliport Markings .....	72
Figure 7-5. Helipad Markings .....	74
Figure 7-6. Hospital Helipad Markings .....	75
Figure 7-7. Landing Lane Layout .....	76
Figure 7-8. Landing Lane Helipad and 1/3rd Length Marker Panels .....	77
Figure 7-9. Elevated Helipad Example .....	77
Figure 7-10. Dimensions for Supplemental Elevated Helipad Markings .....	78
Figure 7-11. Rotary Wing Overruns and Shoulder Markings .....	81
Figure 7-12. Type 1 Parking for CH-47 .....	82
Figure 7-13. Type 1 Parking for all Rotary Wing Aircraft Except CH-47 .....	83
Figure 7-14. Type 2 Parking for Wheeled Rotary Wing Aircraft .....	84
Figure 7-15. Type 2 Parking for Skid Rotary Wing Aircraft .....	85
Figure 8-1. Runway, Taxiway, and Apron Area Closure Markings .....	89
Figure 8-2. Closed Runway, Taxiway, and Taxilane Pavement Markings .....	90
Figure 8-3. Placement of Permanently Closed Apron Pavement Markings .....	91
Figure 8-4. Low Profile Barricades .....	92
Figure 8-6. Runway Shoulder Markings (Deceptive Surfaces) .....	97
Figure 8-7. Taxiway and Apron Shoulder Markings (Deceptive Surfaces) .....	98
Figure 8-8. Typical Inertial Navigation System Marking .....	99

Figure 8-9. Ground Receiver Checkpoint (Directional) .....	100
Figure 8-10. Compass Calibration Pad Markings .....	102
Figure 8-11. Compass Calibration Pad Numerals .....	103
Figure 8-12. T-6 Propeller Hazard Area Pavement Markings .....	105
Figure 8-13. F-16 Engine Inlet Danger Area Pavement Markings for Idle Thrust	106
Figure 8-14. Hydrant Fuel Pit Markings .....	107
Figure 8-15. C-12 Propeller and Exhaust Hazard Area Pavement Markings .....	108

## **TABLES**

Table 6-1. Cargo Aircraft Apron Layout Dimensions .....	41
Table B-1 Inches to Millimeters .....	116
Table B-2 Feet to Meters .....	117

*This Page Intentionally Left Blank*



## CHAPTER 1 BACKGROUND AND GENERAL INFORMATION

### 1-1 BACKGROUND.

These criteria are a compilation of U.S. and international standards, adopted from the International Civil Aviation Organization (ICAO) standards, North Atlantic Treaty Organization (NATO) agreements, and Federal Aviation Administration (FAA) standards, as well as individual Service- or aircraft-specific technical orders. Prior to publication of this UFC, each Service component promulgated independent airfield marking standards based upon mission needs and operational doctrine, none of which fully complied with NATO, ICAO, or FAA criteria. Because DoD Service components operate worldwide, it is desirable and necessary that visual aids be commonly recognized and universally accepted by all DoD personnel and our allies.

### 1-2 GENERAL INFORMATION.

Pavement markings are provided to enable and enhance safe and informed aircraft and vehicle operation on the airfield and roadways. They are required to be prominent and of uniform configuration so they are clearly understood. Do not place locally devised non-standard markings without authorization from the appropriate authority. Such markings confuse aviators and ground personnel and cause runway incursions and accidents.

### 1-3 PURPOSE AND SCOPE.

This UFC provides standards for marking DoD airfields and heliports. This UFC also requires use of the Federal Highway Administration's (FHWA) *Manual of Uniform Traffic Control Devices* (MUTCD) for marking roadways, vehicular traffic routes on airfields, and airfield service roads maintained and operated by the designated authority. It gives the minimum level of markings necessary for paved surfaces of fixed and rotary wing runways, taxiways, helipads, and landing lanes as well as unique apron or hard stand markings necessary for maintenance or calibration of aircraft. It refers to FAA or ICAO standards for marking the surfaces of obstructions when deemed necessary by the designated authority. For additional airfield facility types, such as the F-35 vertical landing (VL) pad, landing helicopter deck (LHD) simulated deck facilities, and other fixed-wing short takeoff and vertical landing (STOVL) facilities, see UFC 3-260-01.

### 1-4 APPLICABILITY.

These criteria apply to all DoD activities except those operating at airports owned and controlled by an authority other than DoD. U.S. Navy and Marine Corps pavement marking details for shore-based installations are provided in NAVAIR 51-50AAA-2, *General Requirements for Shore Based Airfield Marking and Lighting*. Download a copy at <http://www.wbdg.org/ffc/dod/supplemental-technical-criteria> (designated TSEWG NAVAIR 51-50111-2, *General Requirements for Shorebased Airfield Marking and Lighting*) or contact the management authority for NAVAIR 51-50-AAA-2 at: Commanding Officer Naval Air Warfare Center Aircraft Division, Lakehurst Logistics, Code 6.8.5.1, Lakehurst, NJ, 08733, phone (732) 323-5073.

Base the marking criteria used upon ownership of the facility or official agreements with the host nation or host aviation authority. For example, DoD-owned and -controlled facilities are marked in accordance with DoD criteria and municipally owned airfields and airports are marked in accordance with FAA or ICAO criteria, as applicable.

It is recommended that noncompliant markings be updated to comply with this UFC at the next painting cycle. However, existing markings are not required to be changed to comply with the updated criteria in this UFC until it is appropriate and economically feasible to remove and replace all noncompliant markings on a significant feature of the airfield. An entire runway, the taxiway system, or an individual apron are examples of significant features of an airfield for the purpose of complying with this UFC.

## **1-5 JOINT USE FACILITIES.**

### **1-5.1 Within the Continental United States (CONUS).**

A joint use facility is one where a written agreement between the U.S. military and a government agency authorizes use of the military runways for public transportation. For airports operated under FAA jurisdiction, use FAA AC 150/5340-1.

### **1-5.2 Outside the Continental United States (OCONUS).**

For DoD facilities overseas, if a written agreement exists between the host nation and DoD that requires application of NATO or ICAO standards, those standards apply as stipulated within the agreement. For cases where a Status of Forces Agreement (SOFA) specifically requires international standards, use ICAO Annex 14, Volume I, *Aerodromes* (for fixed wing runways), or Annex 14, Volume II, *Heliports* (for rotary wing helipads and runways), as appropriate. DoD tenant organizations on civil airports use these standards on the military portion of the airfield to the maximum extent practicable.

## **1-6 GENERAL BUILDING REQUIREMENTS.**

UFC 1-200-01 provides applicability of model building codes and government-unique criteria for typical design disciplines and building systems, as well as for accessibility, antiterrorism, security, sustainability, and safety. Use this UFC in addition to UFC 1-200-01 and the UFCs and government criteria referenced therein.

## **1-7 REFERENCES.**

Appendix A contains a list of references. The publication date of the code or standard is not included in this UFC. In general, the latest available issuance of the reference is used.

**1-8 SUMMARY OF BEST PRACTICES IN APPENDIX B.**

**1-8.1 Airfield Marking Handbook.**

Appendix B-1 contains best practices for installation and maintenance of airfield and heliport markings documented by the Innovative Pavement Research Foundation (IPRF) in Project 05-1.

**1-8.2 Maintenance of Marking Patterns from Previous Standards.**

Appendix B-2 contains the layout and dimension details for airfield markings previously used on Air Force and Army installations prior to publication of this UFC. Details for Navy and Marine Corps pavement marking details for shore-based installations are provided in NAVAIR 51-50AAA-2. The details and reference information provided facilitates maintenance of existing markings.

**1-8.3 Use of Metrics for Markings.**

Appendix B-3 is a matrix of dimensional equivalencies for various line segments, markings, and distances to or from specific geographic or feature reference points identified or referenced in this UFC.

**1-9 GLOSSARY.**

Appendix C contains acronyms, abbreviations, and terms.

*This Page Intentionally Left Blank*

## **CHAPTER 2 WAIVERS**

### **2-1 REQUIREMENTS AND PROCEDURES.**

Do not design, specify, provide, construct, or apply any airfield marking that does not comply with this UFC without first requesting and obtaining a waiver in accordance with Military Standard (MIL-STD) 3007 and agency, DoD, and Service department airfield waiver procedures. However, design markings to the extent needed to determine if a waiver is required and to prepare the waiver. Prepare and obtain separate waivers from the senior airfield authority and airfield manager if they are not included in the current agency waiver procedure. Refer to the current agency airfield markings waiver procedures in Tri-Service Pavements Working Group (TSPWG) Manual 3-260-04.18-02, *Airfield Marking Waiver Procedures*.

*This Page Intentionally Left Blank*

## **CHAPTER 3 TOLERANCES, MATERIALS, APPLICATION RATES, AND COLORS**

### **3-1 PATTERN SIZE ALLOWANCES.**

#### **3-1.1 Tolerances for New Markings and Remarking.**

Apply all markings in the standard dimensions provided in the drawings. New markings are allowed to deviate a maximum of 10 percent larger than the standard dimension. The maximum deviation allowed when painting over an old marking is up to 20 percent larger than the standard dimension. Do not use less than standard dimensions.

#### **3-1.2 Paint.**

Mark flexible and rigid pavements with lead-free pavement-marking paints, available under Federal Specification TT-P-1952. Select Type I for use under normal conditions, Type II for use under adverse conditions, or Type III for increased durability. See the latest revision of Federal Specification TT-P-1952 for additional information on applications. Apply glass beads to the paint immediately after application of paint to incorporate retro-reflective properties into the markings.

##### **3-1.2.1 Permanent Painted Markings.**

Apply markings at 12 to 14 mils (0.310 to 0.360 millimeters) wet-film thickness for coverage of 121 ( $\pm 6$ ) square feet per gallon (2.970 square meters [ $\pm 165$  square millimeters] per liter). Apply beads to permanent painted markings at the rate recommended for the type beads used. (The wet film thickness of the paint is increased when the larger diameter Type IV beads are used. See paragraph 3-3.3 for details.) It is undesirable for painted markings to build up beyond a total thickness of approximately 40 mils (1.02 millimeters). This occurs after about five marking cycles unless surface abrasion (e.g., caused by snow-removal equipment) reduces this buildup. Repeated over-painting increases stresses at the initial bond with the pavement and eventually causes the marking to crack and peel.

##### **3-1.2.2 Temporary Painted Markings.**

Apply markings at 4 to 6 mils (0.100 to 0.150 millimeter) wet-film thickness in cases where new pavements need to be opened early or for temporarily displaced thresholds. Apply beads to temporary painted markings at half the normal rate; this provides markings of sufficient prominence to allow operations. Touch up the marking in case of bleeding and remark the pavement at the normal application rate after the pavement is at least 30 days old. For temporary markings, first apply a pavement-curing compound; this makes the markings easier to remove. A lime and water solution or sea-marker dyes are also used for temporary markings; however, these materials are best suited to dirt surfaces or snow-covered pavements. Temporary marking tape is also used for temporary taxi routes or for temporarily displaced threshold markings if the pre-threshold area is only planned for operation at normal taxiing speeds. High-speed operations, turning traffic, rotor-wash, or jet blast might dislodge these materials, creating a potential for foreign object damage (FOD) to jet engines. Do not use these materials on runways for this reason.

### **3-1.3 Alternate Marking Materials.**

Thermoplastics or preformed materials such as tape are allowed for use on taxiways and aprons, but these type materials are not used on runways or helipads because of the potential FOD to aircraft if they delaminate from the pavement. Apply these materials in accordance with the manufacturer's recommendations. Pre-mix glass beads with thermoplastic materials and post-apply beads to the surface of the marking at the same application rate as noted above to provide initial retro-reflectivity. The beads are uniformly suspended throughout the material to ensure continuing retro-reflectivity as the marking wears from the effects of traffic. Add beads at a rate equivalent to that noted above for each 10 mils (0.250 millimeter) of overall application thickness.

### **3-1.4 Alternate Visual Aids.**

When appropriate, lighted barricades, traffic cones, or portable edge markers are used instead of pavement markings during short periods of construction if addressed in the construction waiver and the construction phasing plan (see Appendix B of UFC 3-260-01). Use edge markers for daytime use or expedient airfield markings such as are used on a minimum operating strip (MOS) or a landing zone (LZ). Lighted visual aids are used for night operations or instrument flight rule (IFR) operations. Fasten or weight down all such devices to prevent them from becoming dislodged by jet blast or prop wash. Use frangible markers designed and constructed of materials that collapse if struck by an aircraft. They are colored to present a sharp contrast with the surrounding terrain.

### **3-1.5 Contrasting Markings to Increase Conspicuity.**

If needed, use a non-reflectorized black border to outline markings on light-colored pavements (portland cement concrete [PCC] or oxidized asphaltic concrete [AC]). This makes the markings more prominent. The border is uniformly 6 inches (152 millimeters) wide (no variation in width beyond standard tolerances) and borders all edges of the marking

### **3-1.6 Obliteration of Extraneous Markings.**

Use black paint, or a color blend of black and white to match pavement color, to temporarily hide extraneous markings rather than risk damaging the pavement during paint removal. **Note:** This method is only used temporarily because the underlying paint shows through when illuminated at night after the black paint begins to wear off the top of the previously applied glass beads. For effective guidance, remove the old paint completely by hydro-blast, grinding, or some other method, or pave over the old marking to eliminate potential confusion from obsolesced or extraneous surface markings. Take care when obliterating old markings so the resulting pattern no longer presents the appearance of a usable marking. This requires additional scarifying or overpainting for effective obfuscation of the pattern.



## **3-2            COLORS FOR PAVEMENT AND OBSTRUCTION MARKINGS.**

### **3-2.1        Airfields and Roadways.**

For airfield pavement applications, use the following color chip numbers from SAE-AMS-STD-595 when ordering or specifying paint. See the specific layout schemes in Chapters 5 through 8 for the specific color and retro-reflective requirements for the applicable marking.

#### **3-2.1.1      White – 37925.**

Generally, retro-reflective white is used for all runway, helipad, towway, and rotary wing runway or landing lane markings. However, there are some exceptions, such as for aircraft arresting system (AAS) warning markings, runway shoulder markings, hold short runway hold position markings, taxiway lead-in and lead-out lines, and hospital helipad markings.

#### **3-2.1.2      Yellow – 33538.**

Generally, retro-reflective yellow is used for all taxiway and apron markings, as well as displaced threshold areas used only as a taxiway and for the arrowheads and chevrons when the displacement is temporary. Exceptions: Restricted area markings and legends on some surface painted taxiway and apron signs are marked in other colors. Non-reflective yellow is used in overruns and for shoulder markings.

#### **3-2.1.3      Red – 31136.**

Red is normally used to mark restricted area boundaries and some of the legend on the restricted area signs required by AFI 31-101.

#### **3-2.1.4      Black – 37038.**

Black is used as a border to increase the conspicuity of markings on light-colored pavements. It is also mixed with white (to better match pavement surface color) and used to obliterate extraneous markings. **Note:** Covering obsolete or extraneous markings with paint is a temporary solution. The only means for permanent obliteration is to grind, scarify, burn, or hydro-blast the pavement surface or place a new surface material over the old markings.

#### **3-2.1.5      Green – 34108.**

Green is used to identify obstacle clearance boundaries at U.S. Army facilities.

### **3-2.2 Colors for Marking Obstructions.**

For obstruction marking applications, use the following color chip numbers from SAE-AMS-STD-595 when ordering or specifying paint to mark obstructions.

- White – 17875
- Orange – 12197

## **3-3 RETRO-REFLECTIVE PAVEMENT MARKINGS.**

### **3-3.1 Painted Pavement Markings.**

Painted pavement markings are very difficult to see at night or during rain if they have no retro-reflective properties. Markings without beads also have a lower coefficient of friction. For these reasons, use of glass beads is encouraged for all surface painted markings. Do not place beads on black borders. Other less-expensive materials are available to improve the coefficient of friction on black painted pavement surfaces.

**Note:** Because thermoplastic materials are applied at a greater film thickness, these materials also have spherical beads premixed into the colored binder prior to application.

### **3-3.2 Post Applied Retro-Reflective Media.**

Post-apply retro-reflective media (glass beads) specified under Federal Specification TT-B-1325D (or later revision) to make surface painted markings retro-reflective. Retro-reflective runway, taxiway, and apron markings are identified in the layout scheme descriptions in Chapters 5 through 8.

### **3-3.3 Material Selection.**

Select the most appropriate material manufactured in accordance with the most current version of Federal Specification TT-B-1325D, as follows:

- Type I, Gradation A, Drop-On, Low Index of Refraction, for use on any airfield or roadway marking pattern applied with paint procured to comply with Federal Specification TT-P-1952E. Apply a minimum of 7 pounds per gallon (0.85 kilogram per liter) of paint. In accordance with the National Defense Authorization Act (NDAA) for Fiscal Year 2018, complete a life-cycle cost analysis of the beads which appropriately considers local site conditions, life-cycle cost maintenance, environmental impact, operational requirements, and the safety of flight before specifying or using beads with a refractive index of 1.6 or less, including Type I beads.
- Type II has been deleted and is no longer specified or used.
- Type III, Gradation A, Drop-On, High Index of Refraction, intended for applications where increased retro-reflectivity is needed. Apply a minimum of 10 pounds per gallon (1.2 kilograms per liter) of paint.

- Type IV Gradation A – Large coarse, direct-melt, low-index glass beads for drop-on applications are intended for highways and all airfield markings applied with paint procured to comply with Federal Specification TT-P-1952E, Type III. Apply a minimum of 8 pounds per gallon (1 kilogram per liter) of paint. A wet film paint thickness of 18 to 25 mils (0.457 to 0.635 millimeter) is specified when Type IV gradation A beads are used.
- Type IV Gradation B – Medium coarse, direct-melt, low-index glass beads for drop-on applications are intended for highways and all airfield markings applied with paint procured to comply with Federal Specification TT-P-1952E, Type III. Apply a minimum of 8 pounds per gallon (1 kilogram per liter) of paint. A wet film paint thickness of 15 to 18 mils (0.381 to 0.457 millimeter) wet film paint thickness is specified when Type IV gradation B beads are used.

### **3-3.4 Lifecycle Cost Analysis**

In accordance with the NDAA of 2016, perform a lifecycle cost analysis at every individual location to determine what type of reflective media (glass bead) to use at the installation. This is reiterated in Unified Facilities Guide Specification (UFGS) 32 17 23. In accordance with the NDAA for fiscal year (FY) 2018, complete a lifecycle cost analysis of the beads which appropriately considers local site conditions, lifecycle cost maintenance, environmental impact, operational requirements, and the safety of flight before specifying or using beads with a refractive index of 1.6 or less, including Type I beads. TSPWG Manual 3-260-04.18-01, *Life-Cycle Cost Analysis of Retroreflective Glass Beads*, provides guidance on how to accomplish a lifecycle cost analysis (LCCA) comparing Type I to Type III retroreflective glass beads in accordance with NDAA FY 2018, Section 2872(b).

*This Page Intentionally Left Blank*

## CHAPTER 4 UNIQUE MARKING PRACTICES

### 4-1 PRACTICES FOR SPECIAL CIRCUMSTANCES.

Striated markings are substituted for any solid marking pattern that is 3 feet (0.9 meter) wide or wider to reduce the effects of frost heave or improve surface friction characteristics. Do not striate markings on runways intended to support operations in instrument categories II and III. Striated markings are created by painting multiple longitudinal stripes 6 inches (152 millimeters) wide with gaps from 4 to 6 inches (102 to 152 millimeters) wide.

### 4-2 OPEN GRADED WEARING SURFACES AND CLEANING EXISTING MARKINGS.

#### 4-2.1 Painting Porous Pavements.

On porous friction surfaces or other open aggregate wearing surfaces, it is desirable, or in some cases necessary, to apply painted markings twice, approaching the area to be marked from opposite directions. Glass beads, necessary to add retro-reflective characteristics to the markings, are applied during each pass.

#### 4-2.2 Cleaning Markings.

When contaminated by fuel, oil, dirt, or other impurities, clean pavement markings using high-pressure water or a combination of applying an environmentally friendly soap and sweeping with a truck- or tractor-mounted sweeper, followed by a clear-water rinse. Sweeping new markings immediately after the paint cures also improves retro-reflectivity by abrading the overspray deposited on adjacent surface-exposed beads during subsequent paint applications.

### 4-3 MAXIMUM PAINT THICKNESS.

Each time a 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.

### 4-4 OBSTRUCTION MARKING.

Obstacles or obstructions defined by UFC 3-260-01, Federal Aviation Regulations (FAR) Part 77, or ICAO Annex 14, Volume I and Volume II, as applicable, are marked according to the following guidance:

- For installations in CONUS or its territories, use FAA AC 70/7460-1.

- For OCONUS installations, use the current edition of ICAO Annex 14, or the standard defined by the SOFA, Host Nation Funded Construction Agreement (HNFA), or Bilateral Infrastructure Agreement (BIA).

**4-5 ROADWAY MARKING.**

Markings and signs of roadways are configured in accordance with UFC 3-201-01, SDDCTEA Pamphlet 55-17, SDDCTEA Pamphlet 55-14, and the FHWA MUTCD.

## CHAPTER 5 RUNWAY MARKINGS

### 5-1 GENERAL INFORMATION.

All markings of any color on light-colored pavement are optionally highlighted by marking a black, non-reflectorized 6-inch (152-millimeter) border (see paragraph 3-1.5).

### 5-2 RUNWAY MARKING SCHEMES.

#### 5-2.1 Runway Marking Elements Based on Highest Intended Use.

There are three marking patterns for manned, fixed-wing runways; visual flight rules (VFR), non-precision instrument approach, and precision instrument approach. These are shown in Figure 5-1. Unmanned aircraft systems (UAS) are marked differently if constructed to support UAS-only operations. Determine the extent of runway markings based on the level of operations planned during day, night, and instrument meteorological conditions (IMC). Also consider available electronic navigation and visual approach lighting aids. Closed runways are marked to reflect their non-operational status. Engineers consult with the airfield managers to determine what markings are needed for each runway.

#### 5-2.2 Additional Markings.

Installation/garrison commanders authorize additional standard markings. Non-standard markings are approved by the USAF Major Command Director of Operations (MAJCOM/A3) or U.S. Army Aeronautical Services Agency (USAASA), publicized in the DoD Flight Information Publication (FLIP). Interference with standard runway markings is not allowable. Non-standard markings are those not defined within any USAF or other DoD Service standard, Department of Transportation (FAA and FHWA), ICAO, Air Standardization Coordinating Committee (ASCC), or NATO standard appropriate for application at the given installation.

#### 5-2.3 Unmanned Aircraft System (UAS) Runways.

For UAS-only runways, mark runway designation, centerline marking, and the letters "UAS" (without black borders), threshold bar, and runway edge stripes in retroreflective white, all centered on the runway width. These type runways are identified with the letters "UAS" on each end of the runway as shown in Figure 5-5.

**5-2.3.1** Shadow (RQ-7A/B) -only runways are only marked with "UAS" without a designation number and centerline marking.

**5-2.3.2** Global Hawk, Predator, and Reaper UAS-only runways are marked based on standard Class B airfield marking schemes and precedence (VFR, non-precision, or precision instrument; see Figure 5-1) and the standards provided herein.

#### **5-2.4 Basic Visual Flight Rule (VFR) Runway.**

For a VFR runway intended for use only during visual meteorological conditions (VMC), provide the following minimum markings (see Figures 5-1, 5-2, and 5-7):

- Centerline stripes
- Designation numbers (and letters, if appropriate)
- AAS warning markings (Runway only; do not mark these for emergency arresting systems located in overruns.)
- Runway/runway hold positions (if the runway intersects another runway and is used as a taxiway or is approved for simultaneous land and hold short operations [LAHSO] with the intersecting runway)
- Overrun chevrons
- Fixed distance (aiming point) marking (if the runway is 4,000 feet [1,200 meters] or longer and potentially used by jet aircraft)
- Add side stripes to all non-precision instrument runways and basic VFR runways where the shoulder pavement is the same as the full-strength runway pavement. On airfields where the width of the runway was reduced, creating a full-strength shoulder, the use of edge stripes is optional except that they must be used to mark the location of any non-full-strength pavement such as the shoulders of the previously wider runway.

#### **5-2.5 Non-Precision Instrument Runways.**

For an instrument, non-precision approach runway, also mark threshold bars and expand the centerline width to 3 feet (0.9 meter). See Figures 5-1 and 5-3 for examples.



Figure 5-1 Runway Marking Schemes

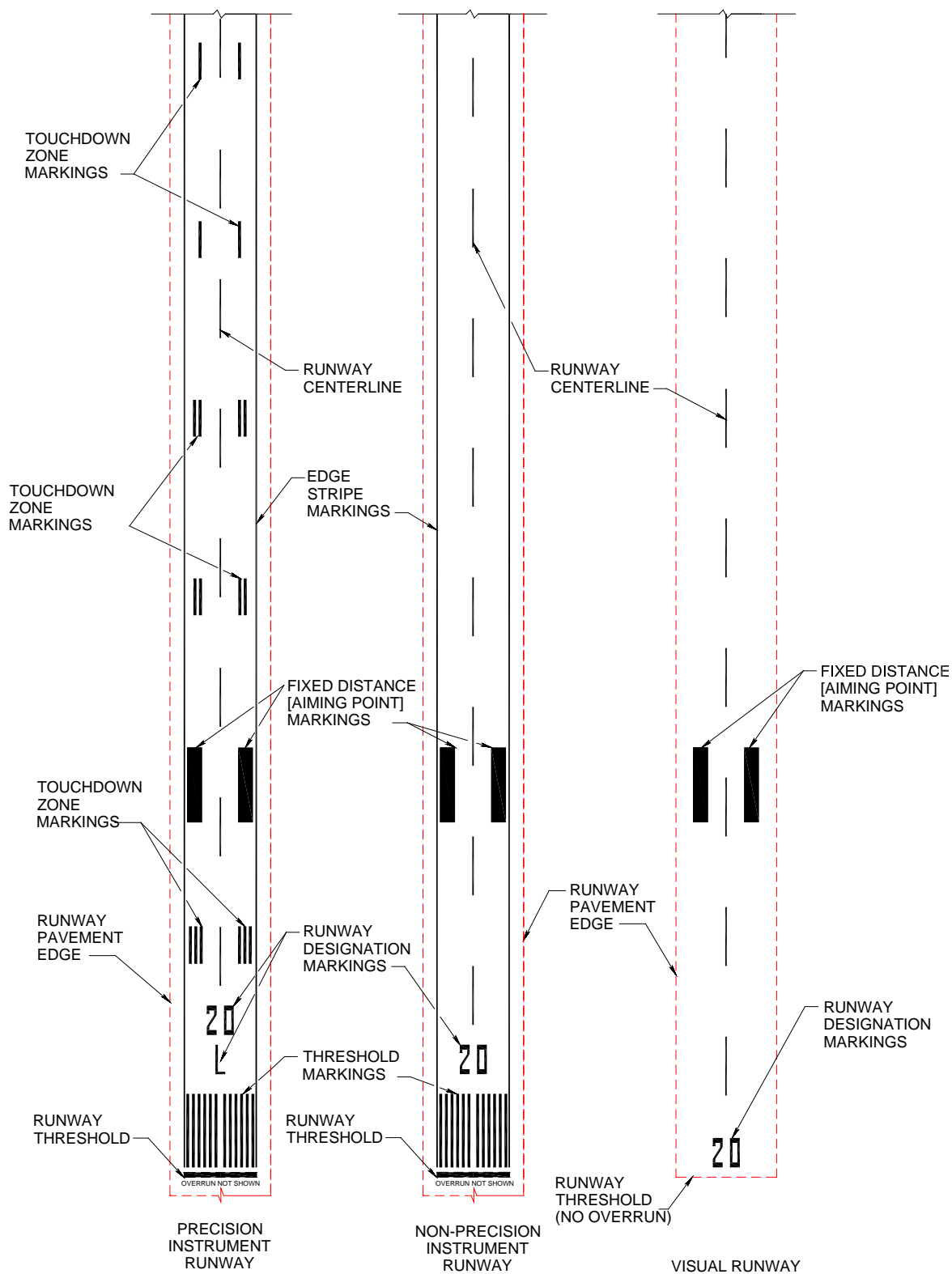


Figure 5-2. VFR Runway Markings

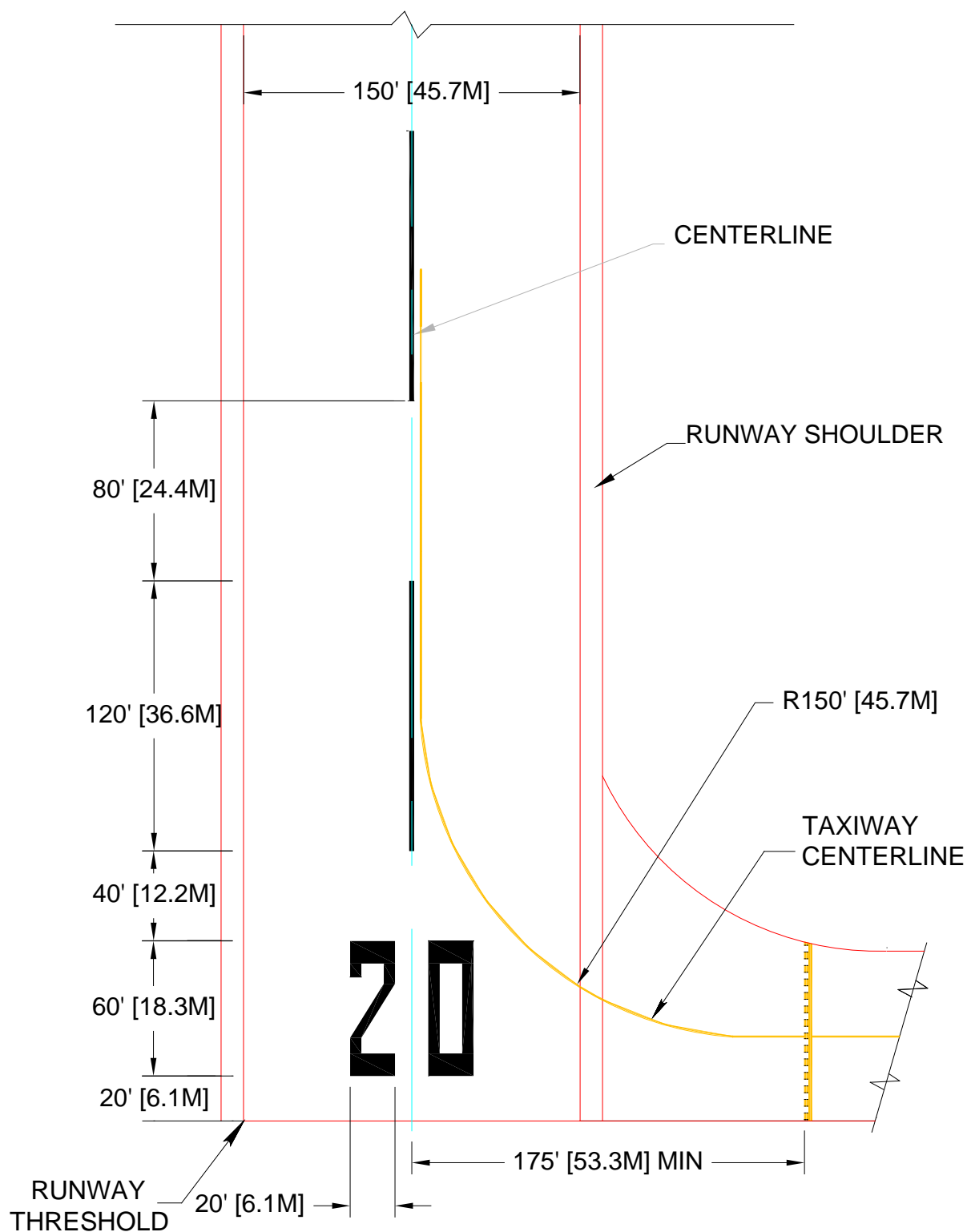
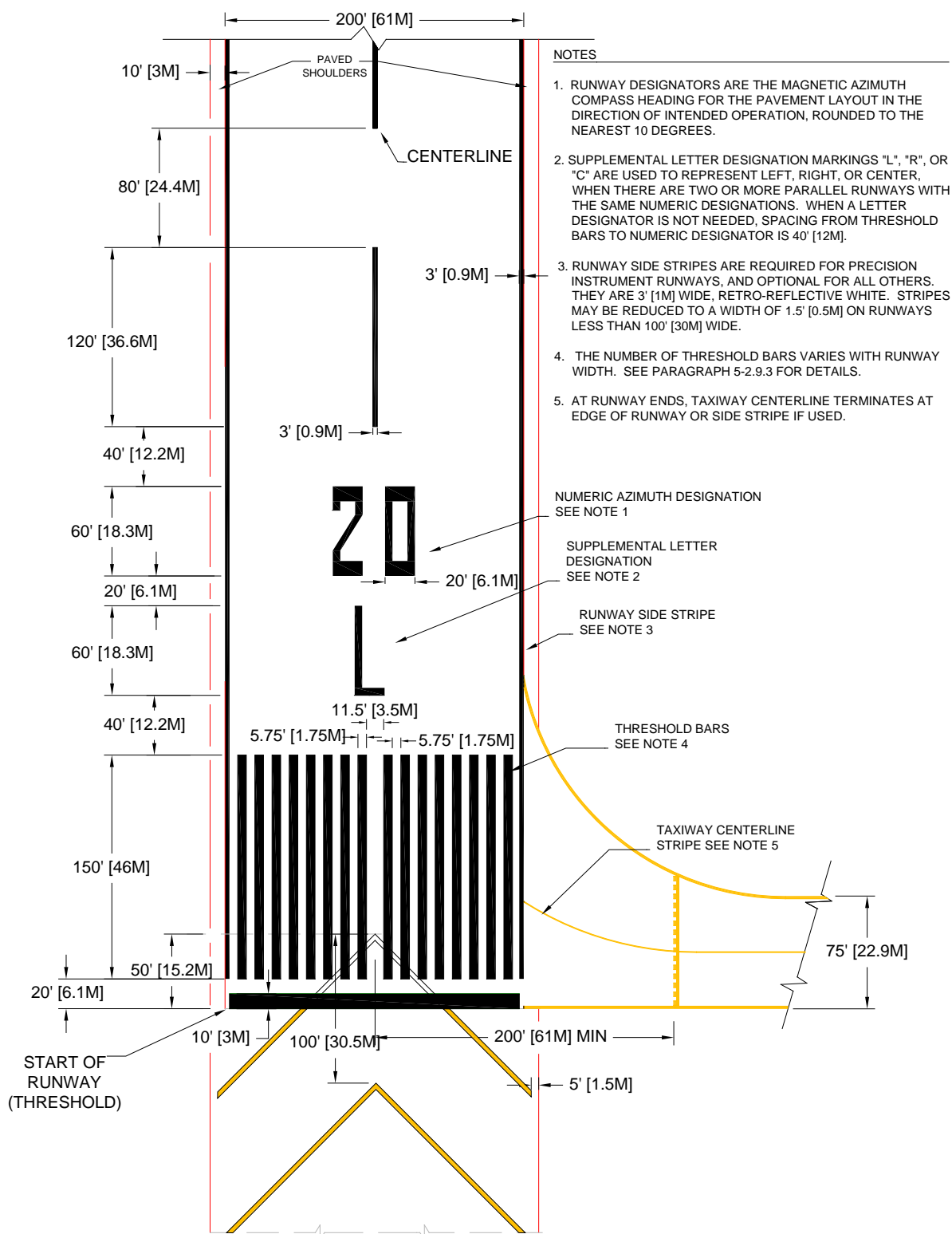


Figure 5-3. Non-Precision Instrument Runway Markings



### **5-2.6 Precision Instrument Runway.**

For precision approach runways, in addition to the non-precision instrument approach and VFR runway marking elements, provide side stripes and touchdown zone (TDZ) markings (and instrument hold lines, if appropriate). Substitute fixed distance (aiming point) markings for the second pair of TDZ markings on each end of the runway (see Figures 5-1 and 5-4).

### **5-2.7 Runway Marking Precedence.**

For runways that intersect or share a common end, interrupt or adjust markings on the runway with the lower priority. Give precedence in this order:

- Category III
- Category II
- Category I
- Non-precision instrument runway markings
- VFR runway markings

**5-2.7.1** Where a need exists to mark a taxiway centerline across a runway, interrupt the marking 3 feet (0.9 meter) on either side of the runway marking.

**5-2.7.2** Taxiway centerline is interrupted 5 feet (1.5 meters) either side of threshold markings or numbers.

### **5-2.8 Runway Centerline.**

Runway centerlines are marked with a series of uniformly spaced retro-reflective white longitudinal stripes, 3 feet (0.9 meter) wide on instrument runways and at least 12 inches (305 millimeters) wide for VFR runways. Begin layout of centerline markings 40 feet (12.2 meters) from the runway designation (numeral[s]) and continue to the midpoint of the runway. Uniformly adjust the lengths of two stripes and three gaps or three stripes and two gaps (depending on which of the two falls at the center of the runway length) near the runway midpoint. See Figures 5-2 and 5-3.

Figure 5-4. Touchdown Zone and Fixed Distance (Aiming Point) Markings

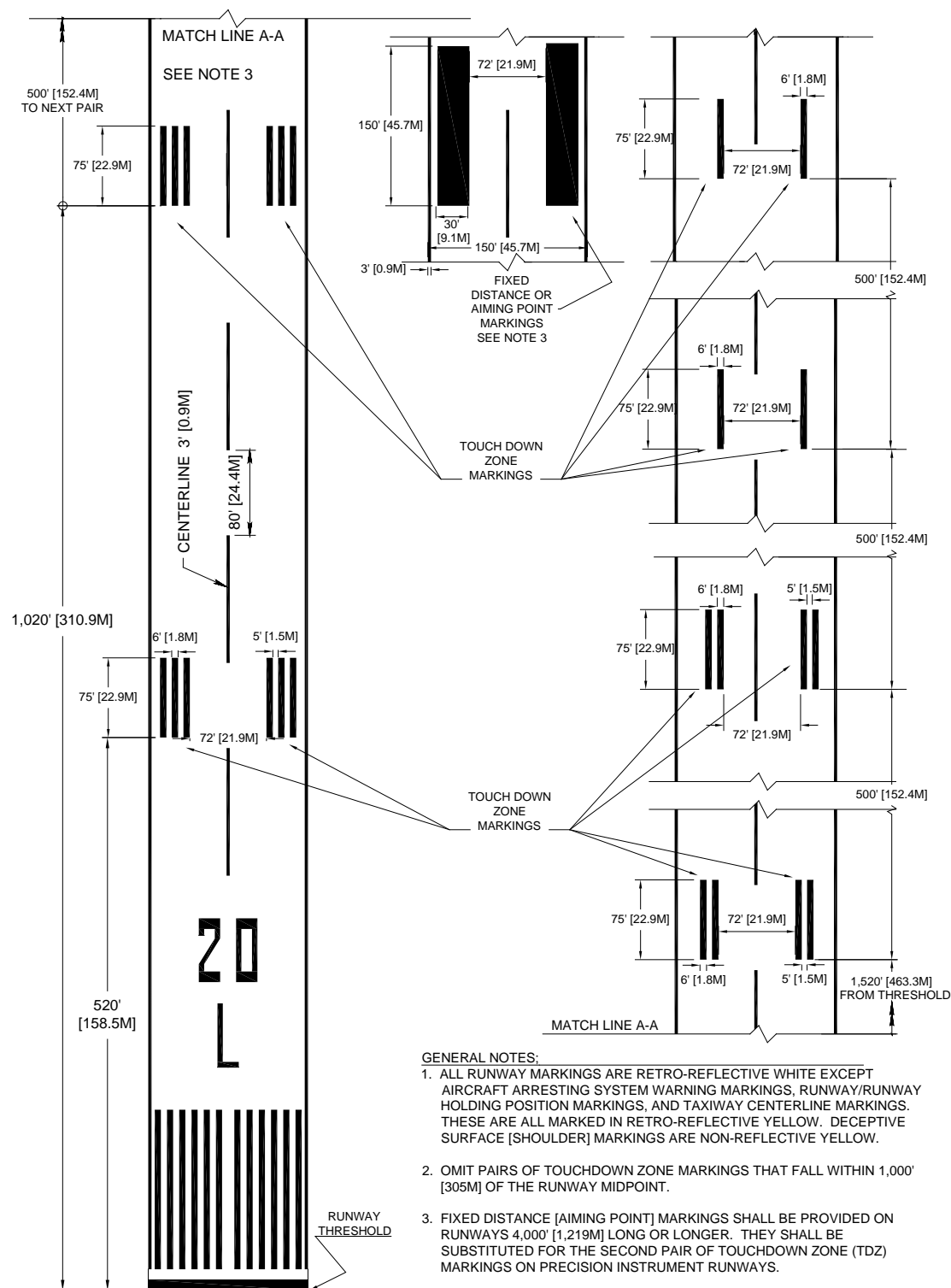
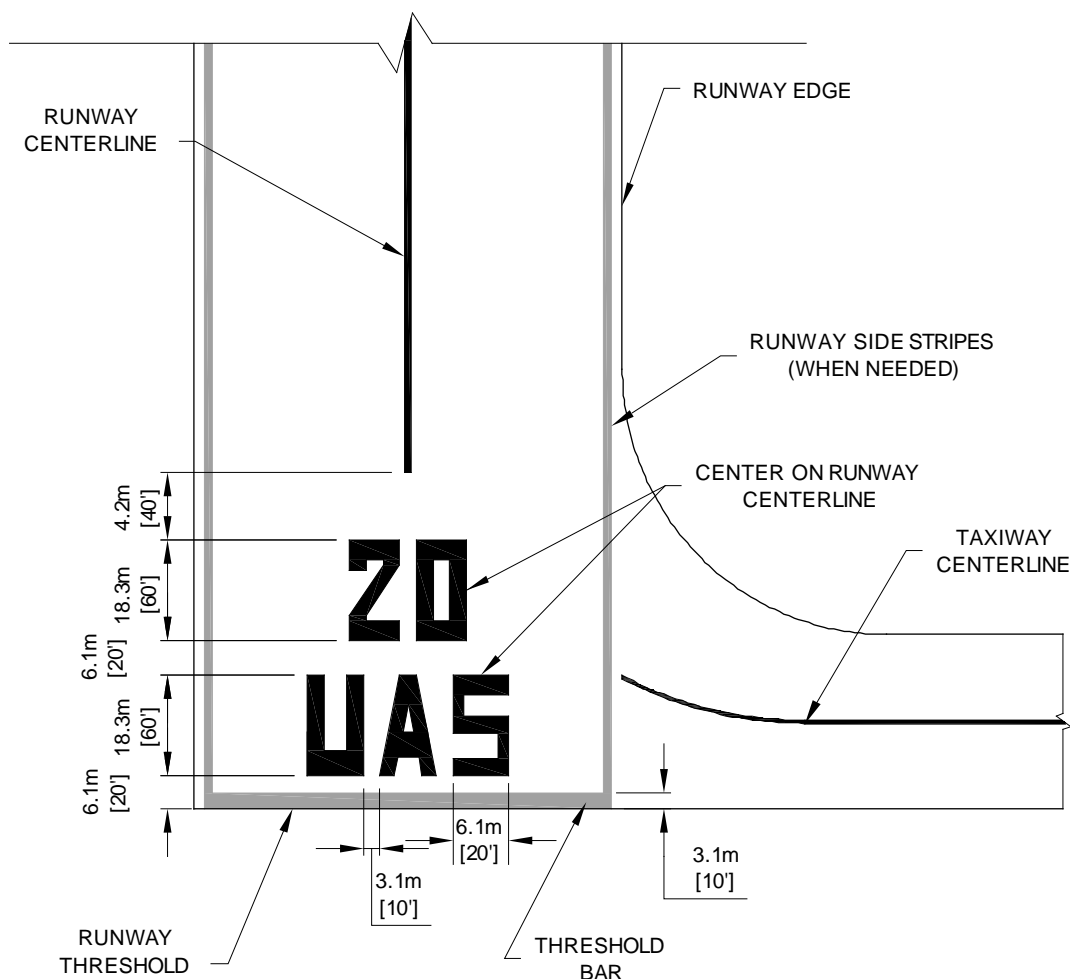


Figure 5-5. UAS Runway Markings



NOTES:

1. SEE FIGURE 5-6 FOR DESIGNATION NUMBER AND LETTER MARKING DIMENSIONS.
2. WHEN THESE MARKINGS ARE BEING USED ON RUNWAYS FOR RQ-7A/B ONLY (50' WIDE), THEN ALL DIMENSIONS SHOWN ON THIS DETAIL SHALL BE REDUCED BY ONE HALF. RUNWAYS FOR THESE AIRCRAFT WILL NOT HAVE THE CENTERLINE OR NUMERICAL DIRECTION MARKINGS EITHER.

## 5-2.9 Threshold Marking.

The runway threshold is the beginning of the full-strength pavement. The 10-foot (3 meter) wide threshold bar is marked at the threshold, and the designation number(s) or longitudinal threshold bars begin 20 feet (6.1 meters) inward from the threshold.

### 5-2.9.1 Visual Flight Rule (VFR) Runways.

Figures 5-1 and 5-2 provide the layout details for a VFR runway. Figure 5-6 provides layout dimensions and spacing details for designators.

### **5-2.9.2 Instrument Runways.**

Precision and non-precision instrument runway thresholds are marked with a group of retro-reflective white longitudinal stripes, and a transverse threshold bar when there is any type of pavement preceding the runway pavement. The longitudinal threshold bars are spaced symmetrically about the runway centerline on 11.5-foot (3.5-meter) centers, configured of 5.75-foot (1.75-meter) -wide stripes and gaps, except at the center of the runway, where the gap dimension is doubled to 11.5 feet (3.5 meters). The transverse runway threshold bar is 10 feet (3 meters) in width and extends between the runway edges (as published in the DoD FLIP or between the runway side stripes, whichever is less). Figure 5-3 provides layout details for the threshold bars and longitudinal spacing for the runway designators, and Figure 5-6 provides layout dimensions and horizontal spacing details for designators.

### **5-2.9.3 Variances in Longitudinal Threshold Patterns.**

The number of longitudinal stripes in a threshold pattern varies for different-width runways. Threshold bar length and widths are the same in all cases. The appropriate numbers of longitudinal stripes to be used are as follows:

- Four for 60-foot (18.3-meter) -wide runways;
- Six for 75-foot (22.9-meter) -wide runways;
- Eight for 100-foot (30.5-meter) -wide runways;
- Ten for 125-foot (38.1-meter) -wide runways;
- 12 for 150-foot (45.7-meter) -wide runways, and;
- 16 for 200-foot (61-meter) -wide or wider runways

### **5-2.9.4 Non-standard Width Runways.**

For non-standard runway widths, the same stripe-gap pattern is continued from the runway centerline until the outermost longitudinal stripe is no closer than 4 feet (1.2 meters) from the runway edge or side stripes. Do not mark more than 16 threshold bars, even for runways wider than 200 feet (61 meters).

### **5-2.10 Runway Designations.**

Designators for runways are retro-reflective white numeric characters that indicate the magnetic azimuth of the runway centerline to the nearest 10-degree increment. The designation consists of one or two numbers, or in the case of parallel runways, the numeric designator and a retro-reflective white letter ("L" for left, "C" for center, or "R" for right) to indicate the lateral position of the runway with respect to any others with the same numeric designator on the same airfield. See Figure 5.3 for placement on the runway pavement and Figure 5-6 for letter and numeral dimensions.

#### **5-2.11 Dimensions for Designation Numbers and Letters.**

Numbers are formed with 5-foot (1.5-meter) -wide vertical stripes and 10-foot (3-meter) -wide horizontal stripes. A zero (0) is marked to precede single-digit numbers on Class B runways except those subject to NAVAIR 51-50AAA-2. Lateral spacing between the numbers is 15 feet (4.6 meters), except for the number "11." Spacing between these numerals is 27 feet (8.2 meters). The dimensional layout is shown in Figure 5-6.

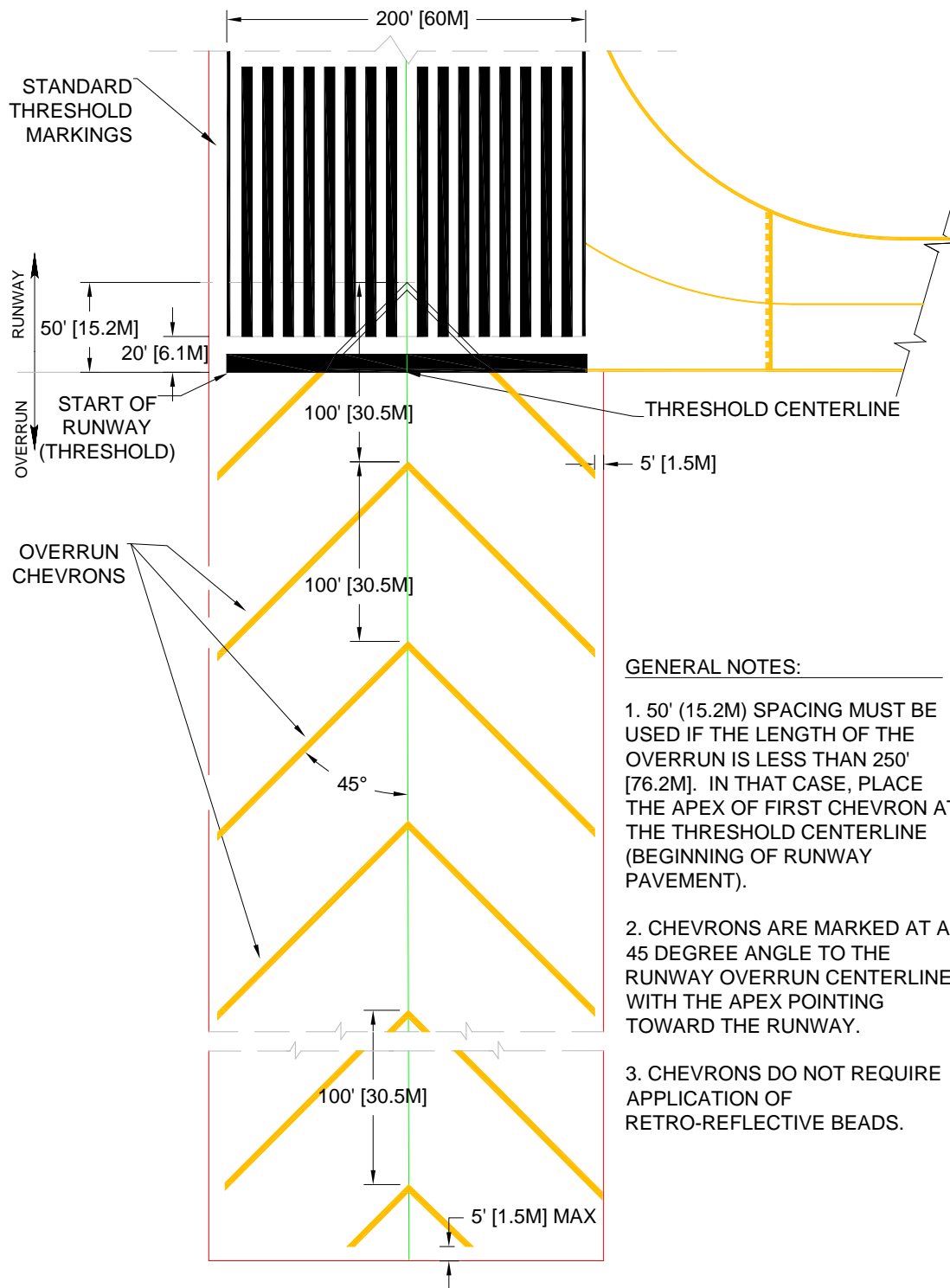
#### **5-2.12 Runway Overruns.**

Non-reflective yellow chevron markings are used on overruns to indicate the area is not a normal operational surface. For layout, the apex of the chevron is laid out (but not painted) 50 feet (15.2 meters) inward of the runway threshold. Only the portions of the chevron legs that are outward from the runway threshold are painted. Subsequent chevrons are placed at 100-foot (30.5-meter) intervals along the overrun, measured from chevron apex to chevron apex. The legs of the chevrons intersect the centerline at a 45-degree angle. The chevron legs extend laterally to within 5 feet (1.5 meters) of the paved surface edge or to align with the lateral limits of the runway shoulder markings (deceptive surface markings), if used. A typical layout plan and dimensions for these markings are shown in Figure 5-7.





Figure 5-7. Overrun Markings



### **5-2.13 Runway Side Stripes.**

Retro-reflective white side stripes are marked on precision instrument runways. They are also used optionally on non-precision instrument and VFR runways. Side stripes are not intended to identify the edge of the full-strength pavement on DoD runways; they are intended to enhance the pilot's ability to recognize the runway environment at decision height on landing. If there is a lack of contrast between the full-strength runway pavement and the shoulder pavement, use non-reflective yellow shoulder markings (deceptive surface) on the shoulder pavement. See Figures 5-3 and 5-4.

**Note:** If there is a significant gap between the inner end of the shoulder markings (deceptive surface) and the runway side stripes (such as occurs when side stripes are spaced at 144-foot [44-meter] separation on a 300-foot [91-meter] -wide runway), also mark double 6-inch (152-millimeter) -wide retro-reflective yellow stripes, separated by a 6-inch (152-millimeter) -wide gap, to enhance delineating the limits of the useable (or full-strength) pavement. Details for these markings are the same as for taxiway or apron edge markings. Place the outer edge of the outermost stripe to coincide with the outermost edge of the useable (or full-strength) pavement and the inner end of the deceptive surface marking. These stripes are curved to follow the outer edge of fillets and terminate at the intersecting taxiway edge or joined to taxiway edge markings, if used.

#### **5-2.13.1 Locating and Layout of Stripes.**

The runway side stripe markings consist of one continuous stripe placed on each side of the runway. The side stripes are placed symmetrically about the runway centerline as shown in Figures 5-1 and 5-3. They have a minimum width of 3 feet (0.9 meter) for runways 100 feet (30.5 meters) or more in width and are at least 1.5 feet (0.5 meter) wide for runways less than 100 feet (30.5 meters) wide. The stripes begin 20 feet (6.1 meters) inward from the runway threshold and continue to within 20 feet (6.1 meters) of the runway threshold on the opposite end of the runway. There are exceptions when the threshold is displaced. See paragraph 5-2.14 and Figures 5-4, 5-8, 5-9, and 5-10 for examples.

#### **5-2.13.2 Stripe Separation.**

If special missions indicate a need for wider separation on runways 200 or 300 feet (61 meters or 91.4 meters) wide, the side stripes are placed as stated above, except the separation between the inner edges of the stripes is 194 feet (59.1 meters). Separation of side stripes greater than 194 feet (59.1 meters) is not authorized without a non-standard marking waiver.

### **5-2.14 Displaced Threshold Marking Schemes.**

#### **5-2.14.1 Layouts According to Intended Use of the Pavement.**

There are four different schemes used to mark the pavement in the displaced area. Select a scheme from those shown in Figures 5-8 through 5-11 that indicates the appropriate and authorized use of the area. Note that for temporarily displaced

thresholds, existing markings need not be obliterated. However, Notice to Airmen (NOTAM), Flight Crew Information File (FCIF) memorandum, and any other available methods are used to convey the temporary changes and potential hazards that exist during the construction or maintenance period. See UFC 3-260-01, Appendix B, Section 1, for construction waiver requirements, and Appendix B, Section 14, for a construction phasing plan and safety checklist to be used for such projects.

**5-2.14.1.1 Permanently Displaced Threshold Where Displacement Area is Used for Take-Off and/or Landing Ground Roll-Out.**

Relocate the longitudinal threshold bars beginning 20 feet (6.1 meters) from the new threshold and place a retro-reflective white transverse stripe to precede them, with the outboard edges on the full-strength runway pavement, or to abut the runway side stripes. Reduce the width and length of the centerline stripes in the displaced threshold area and modify them with retro-reflective white arrowheads leading to the new threshold. Mark retro-reflective white chevrons to point toward the transverse threshold bar at evenly spaced increments across the pavement. Dimensions and layout details are shown in Figure 5-8.

**5-2.14.1.2 Permanently Displaced Threshold Where Displacement Area is Used as a Taxiway (Referred to as Relocated Threshold in the Airman's Information Manual [AIM]).**

Relocate the longitudinal threshold bars beginning 20 feet (6.1 meters) from the new threshold and place a retro-reflective white transverse threshold bar to precede them, with the outboard edge at the beginning of the runway pavement available for landing. Mark retro-reflective yellow chevrons to point toward the transverse threshold bar at evenly spaced increments across the pavement. Dimensions and layout details are shown in Figure 5-9.

**5-2.14.1.3 Permanently Displaced Threshold Where Displacement Area Used as Taxiway and Take-Off and/or Landing Ground Roll.**

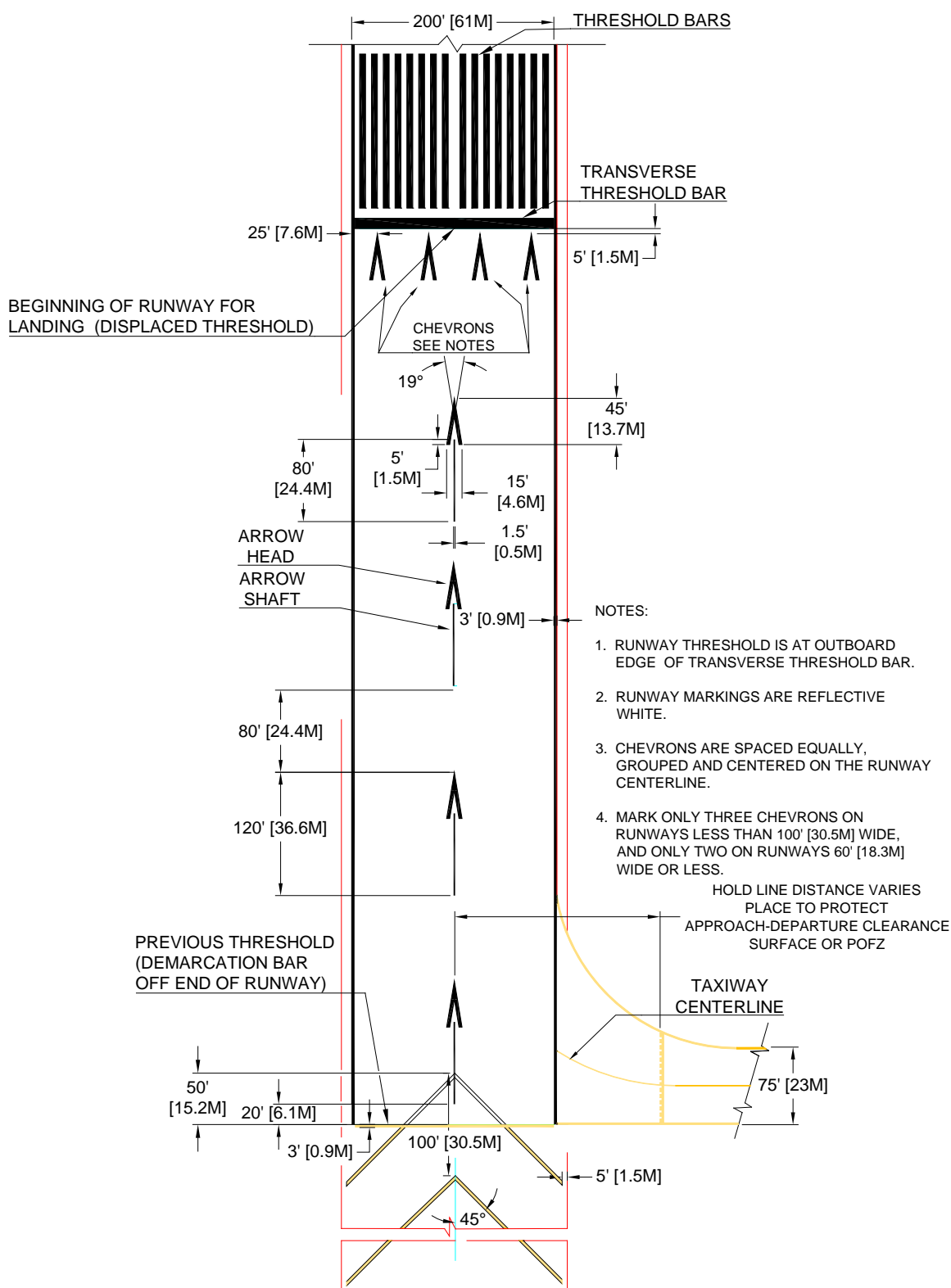
Relocate the longitudinal threshold bars beginning 20 feet (6.1 meters) from the new threshold and place a retro-reflective white transverse threshold bar to precede them, with the outboard edge at the beginning of the runway pavement. Mark retro-reflective white chevrons to point toward the transverse threshold bar at evenly spaced increments across the pavement. Modify runway centerline stripes in the displacement area used for takeoff with retro-reflective white arrowheads. Mark a retroreflective yellow demarcation bar across the full width of the pavement at the end of the aligned taxiway, delineating the point where the takeoff roll begins. Dimensions and layout details are shown in Figure 5-10.

**5-2.14.1.4 Temporarily Displaced Thresholds.**

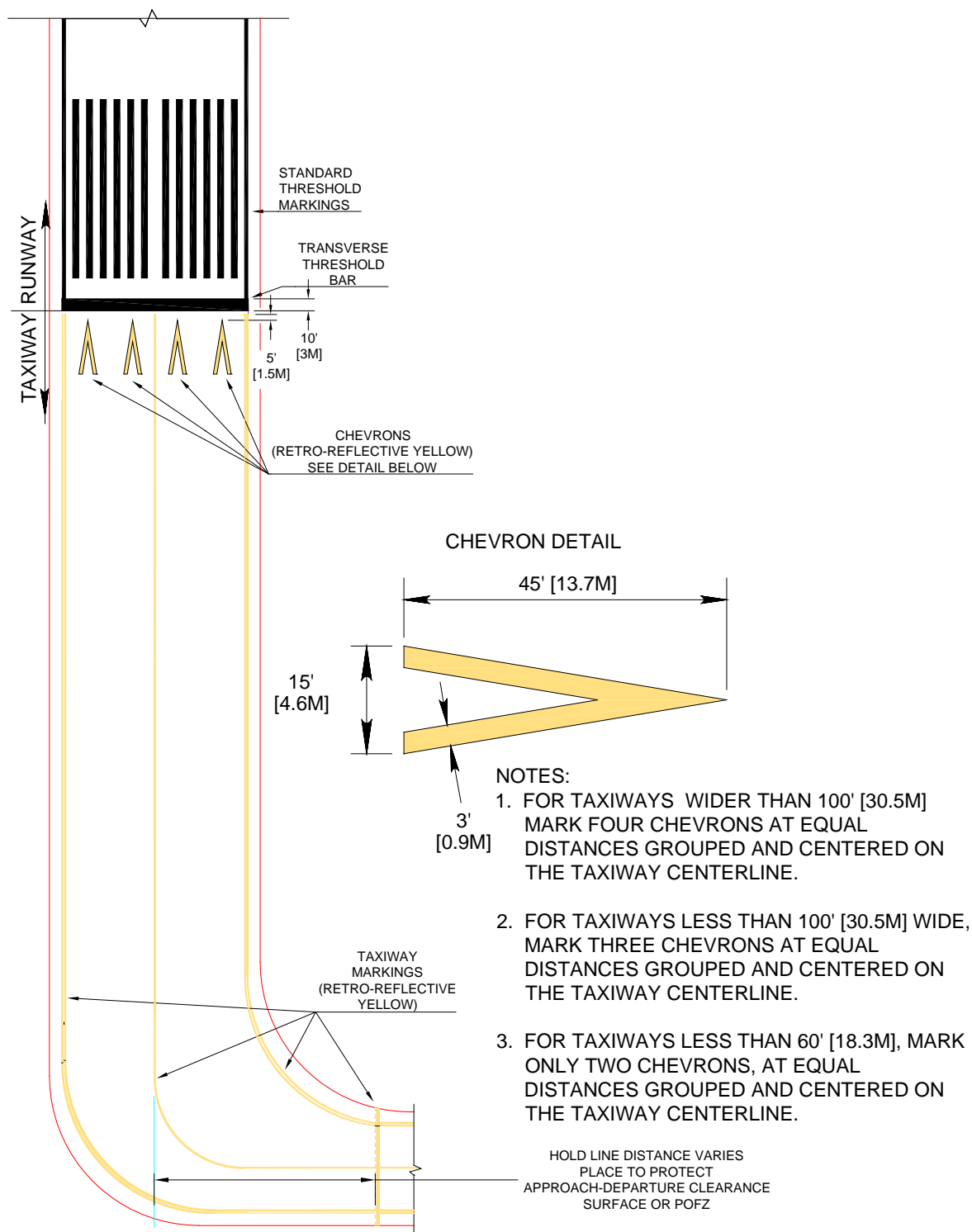
For temporarily displaced thresholds, place a retroreflective white transverse stripe that extends from side stripe to side stripe (or edge to edge of pavement if side stripes are not used) at the new threshold. Modify the centerlines within the displacement with arrowheads and mark chevrons across the runway width pointing to the transverse bar.

Use retroreflective white for arrowheads and chevrons if the area is used for takeoff or roll-out, or retroreflective yellow if the area is planned only for taxiing operations. It is not necessary to reposition the standard threshold markings, modify the width and length of centerline stripes, or obliterate other existing markings within the displaced area; however, NOTAM, FCIF memorandum, and any other available methods are used to convey the temporary changes and potential hazards to pilots. Dimensions and layout details are shown in Figure 5-11.

**Figure 5-8 Permanently Displaced Threshold Where Preceding Pavement is Used as Runway (Take-Off or Landing)**



**Figure 5-9. Permanently Displaced Threshold Where Preceding Pavement is Used as a Taxiway**



**Figure 5-10. Permanently Displaced Threshold Where Displacement Area is Used as a Taxiway and for Take-Off and/or Landing Ground Roll**

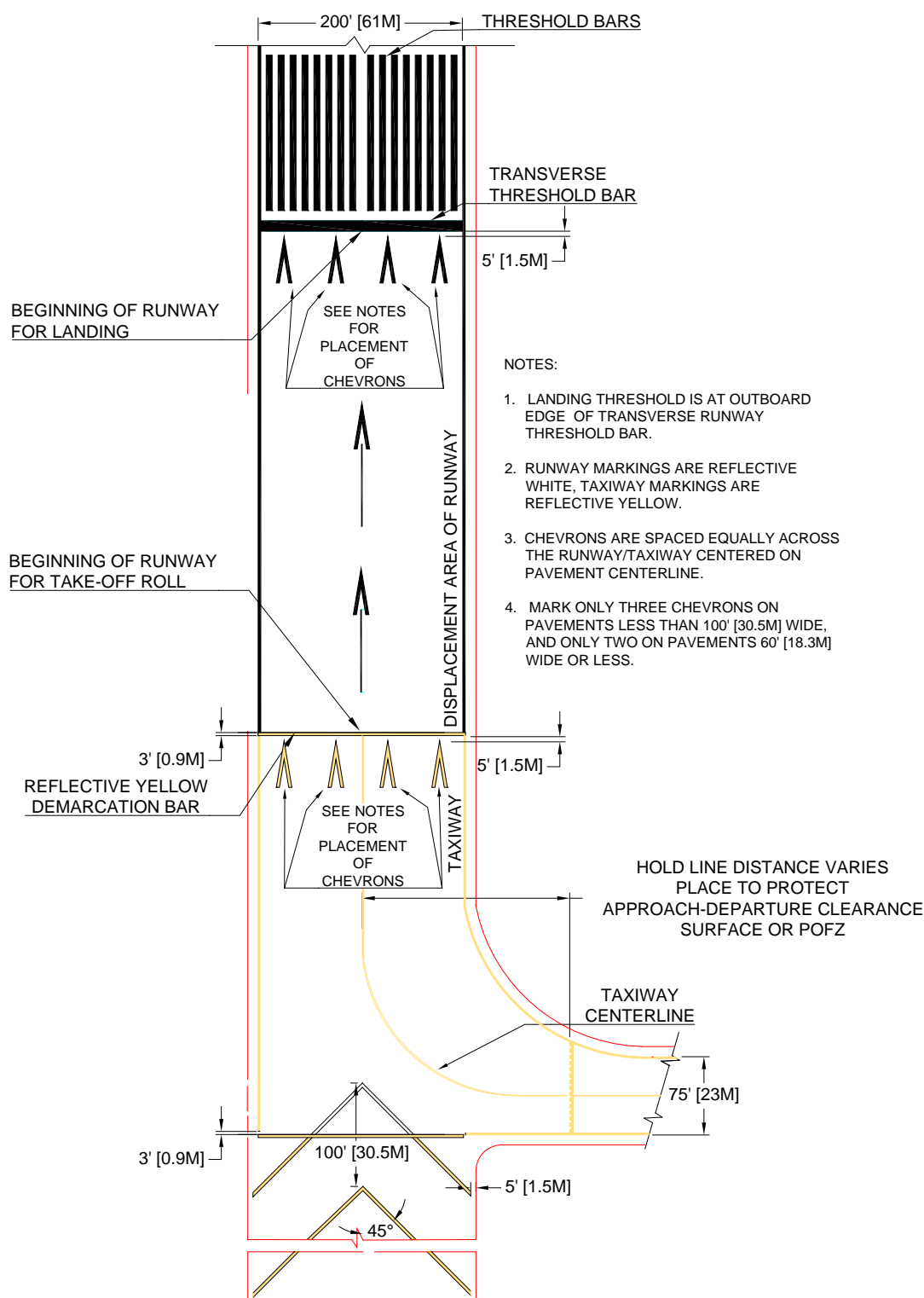
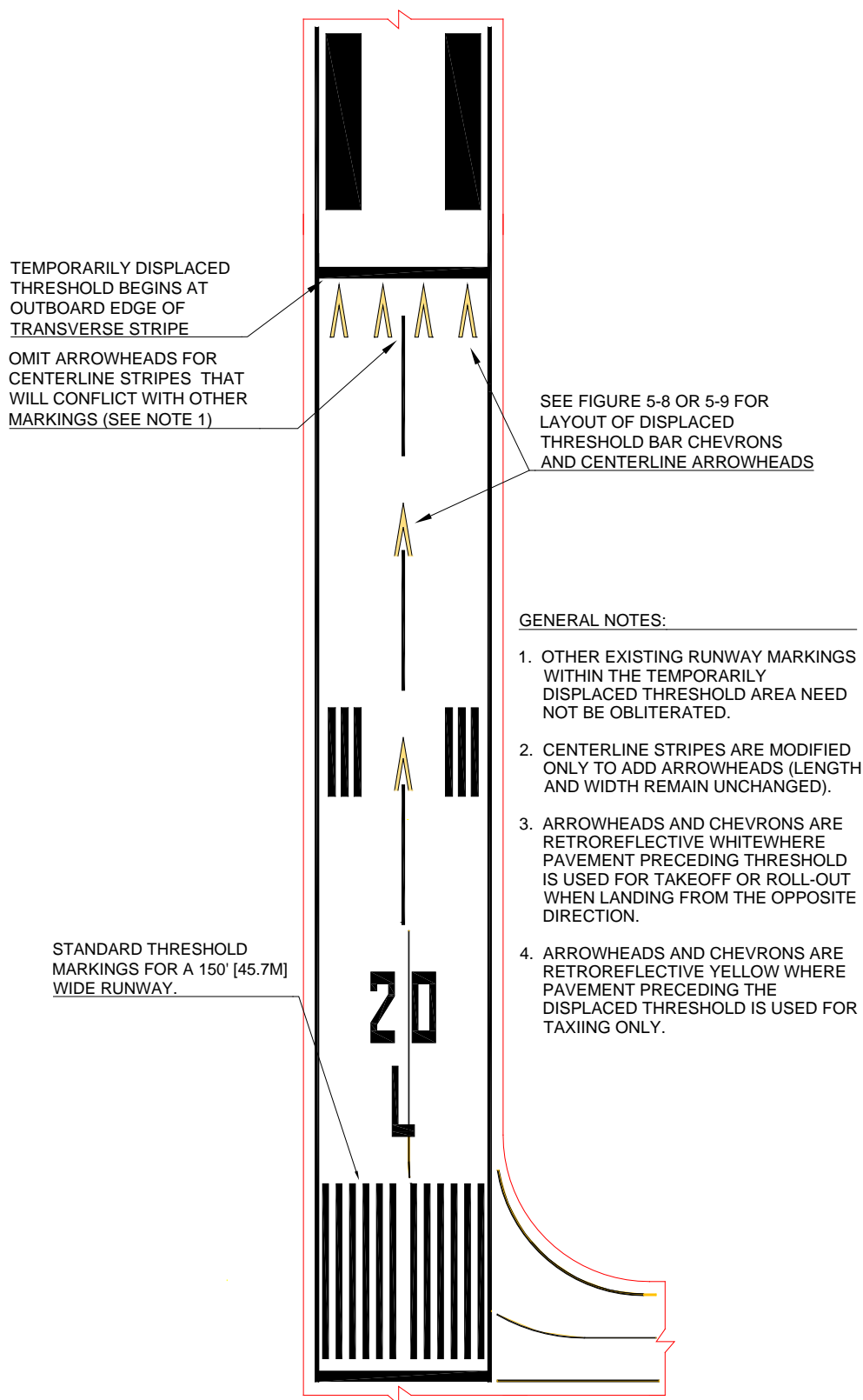




Figure 5-11. Temporarily Displaced Threshold



## **5-2.15 Touchdown Zone and Fixed Distance Markings.**

### **5-2.15.1 Touchdown Zone (TDZ) Markings.**

TDZ markings consist of pairs of longitudinal stripes placed symmetrically about the centerline. A group of three stripes are provided in the first two pairs of TDZ markings, two stripes in the next two groups of pairs, and single stripes in the last two pairs. Omit any pair of markings that fall within 1,000 feet (304.8 meters) of the runway midpoint. The lateral distance between each pair of longitudinal stripes measured at their inner edges is a constant 72 feet (21.9 meters). The layout and dimensions are shown in Figure 5-4.

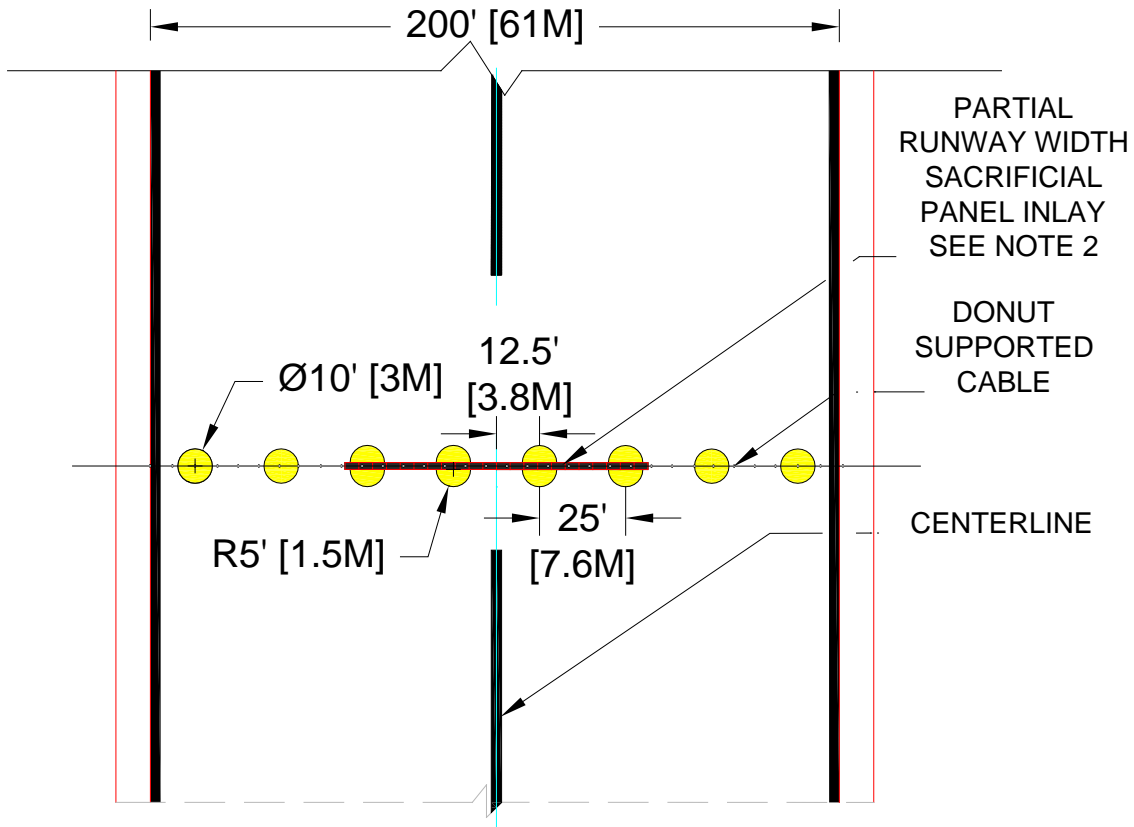
### **5-2.15.2 Fixed Distance (Aiming Point) Markings.**

Provide aiming point markings on runways that are 150 feet (45.7 meters) or more wide and at least 4,000 feet (1,219.2 meters) long. Substitute them in place of the second pair of touchdown zone markings. The layout plan and dimensions are shown in Figure 5-4.

### **5-2.15.3 Aircraft Arresting System (AAS) Warning Markings.**

Mark AAS locations on the runway with a series of discs placed beneath and centered on the pendant. Where TDZ and disc markings coincide, the TDZ marking is interrupted at that location for a minimum distance of 1 foot (0.3 meter) from the edge of the disc marking. If the designation and disc markings coincide, shift the designation marking longitudinally to eliminate the conflict. The layout plan and dimensions for these markings are shown in Figure 5-12. Do not use these markings in overruns.

Figure 5-12. Aircraft Arresting System (AAS) Warning Markings



#### NOTES

1. SIX WARNING MARKINGS ARE USED FOR 150' [46.7M] WIDE RUNWAYS, EIGHT ARE USED ON RUNWAYS 200' [61M] WIDE OR WIDER.
2. WHEN POLYETHYLENE PANELS ARE INSTALLED BENEATH PENDANTS, MARK 5' [1.5M] RADIUS SEMI-CIRCLES ON EITHER SIDE OF POLYETHYLENE PANEL INLAYS. PLACE THEM AT THE SAME SPACING ACROSS THE RUNWAY AS WHEN NO PANELS ARE USED.

*This Page Intentionally Left Blank*

## CHAPTER 6 TAXIWAY AND APRON MARKINGS

### 6-1 GENERAL INFORMATION.

Unless otherwise indicated, most taxiway, apron, and taxilane markings for both fixed and rotary-wing facilities are marked in retro-reflective yellow. All markings of any color on light-colored pavement are optionally highlighted by marking a black, non-reflectorized 6-inch (152-millimeter) border (see paragraph 3-1.5).

### 6-2 TAXIWAY AND TAXILANE CENTERLINE STRIPE.

Mark the centerline of all taxiways, guidelines on runways, and taxilanes on aprons as well as parking positions and pads, with a single continuous 6-inch (152-millimeter) -wide retro-reflective yellow stripe. The width is optionally increased to 12 inches (305 millimeters) when necessary; however, make the line width uniform (either one width or the other) wherever used over the entire airfield. Exceptions to this provision apply for parking positions and inside hangars.

#### 6-2.1 Directional Changes.

All directional changes are accomplished with smooth, single radius curves. Position nose wheel guidelines to maintain a clearance of at least 10 feet (3 meters) between the aircraft's outermost main gear and the edge of the full-strength pavement when the cockpit is maintained over the nose wheel guideline through the turn. Also ensure adequate wingtip clearance is provided for the most demanding aircraft that uses the taxi route. On runways, the curve is tangent to a line parallel with and 3 feet (0.9 meter) from the near side of the runway centerline marking. The straight segment extends 200 feet (61 meters) beyond the point of tangency. See Figure 6-1 for these and other typical layout schemes.

#### 6-2.2 Taxiway and Taxilane Turn Radii.

##### 6-2.2.1 General Intersection Geometry.

On hammerheads, aprons, and pads, and at runway/taxiway and taxiway/taxiway intersections, the radius for the curves are greater than the minimum turning radius for the assigned mission aircraft and are positioned to maintain a clearance of at least 10 feet (3 meters) between the outermost main gear of a C-5 and the edge of the full-strength pavement. See USACE Transportation Systems Center Report 13-2 for aircraft turning diagrams. The recommended radius for 90-degree runway/taxiway intersections is 150 feet (45.7 meters). The recommended radius for 90-degree taxiway/taxiway intersections is 125 feet (38.1 meters). Other radii are allowed, depending on local requirements. In all cases, ensure these radii accommodate the necessary wingtip clearance distance as well as the pavement structure (clearance between outer main gear and edge of pavement) for the most demanding aircraft that uses the intersection before marking nose wheel guidelines.

### **6-2.2.2 Aprons for Cargo Aircraft.**

Typical taxilane turning radii for cargo aircraft aprons are provided in Table 6.1 and Figure 6-2. Use these to determine the appropriate turning radii for cargo aircraft. For aircraft not shown in Table 6.1, compute the wing tip clearance and main gear distance from the appropriate aircraft characteristics found in the Facility Requirements Document (FRD) for the Mission Design Series (MDS) aircraft, or the aircraft turning diagrams found in USACE Transportation Systems Center Report 13-2. Use UFC 3-260-01, Table 6.1, "Cargo Aircraft Apron Layout Dimensions," or Table 6.2, "Rotary Wing Aprons," for minimum wingtip clearances. When marking an apron for a specific aircraft with features less stringent than for a C-5 or 747-8, coordinate with the airfield management and flight safety functions to ensure procedures are published to require aircraft wing-walkers be used for any aircraft that requires greater distances than those provided for safe clearance to obstacles. Publish this information in the Airfield Operating Instruction (AOI) at locations that require, have, or utilize an AOI.

## **6-3 TAXIWAY, APRON, AND TAXILANE EDGE STRIPES.**

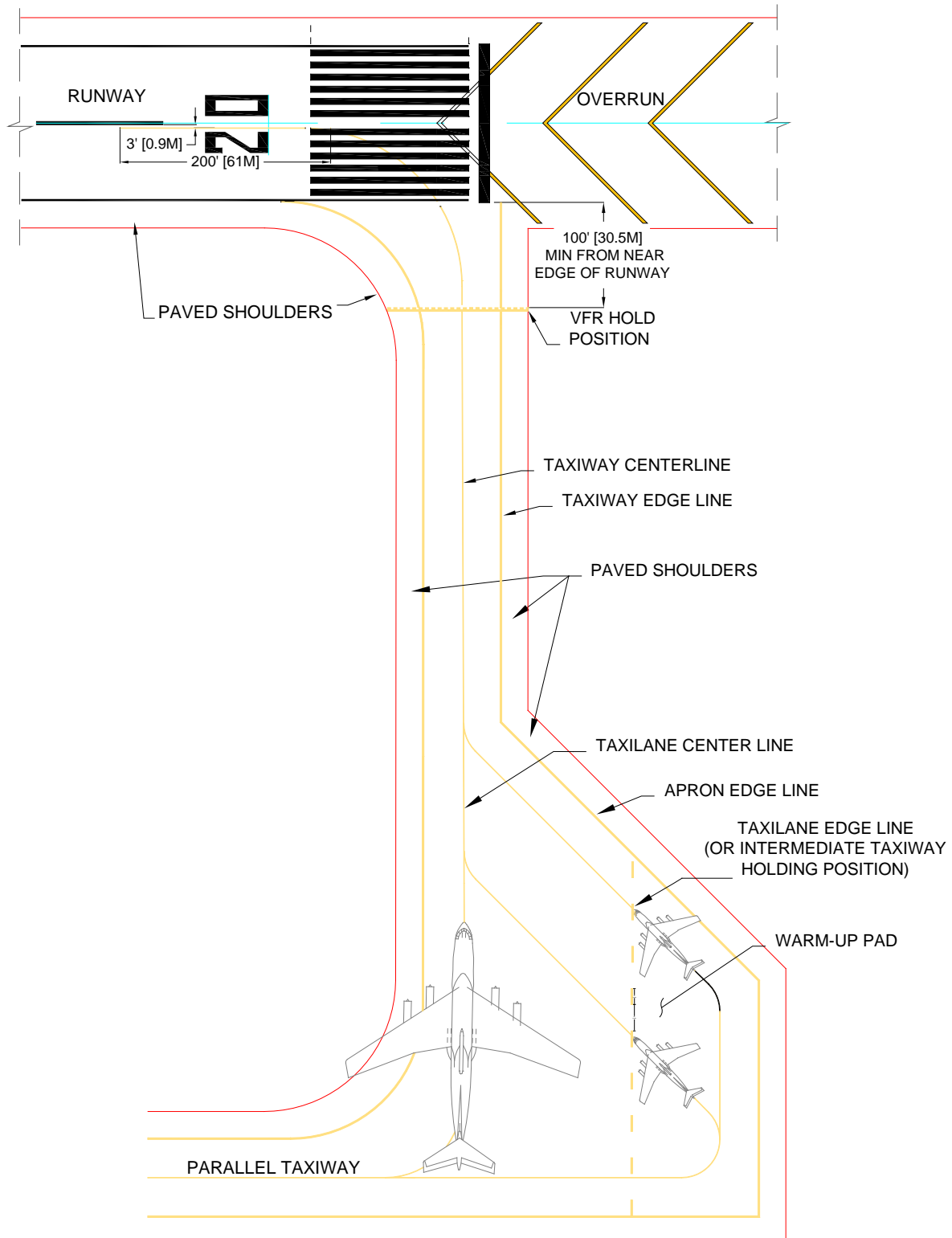
### **6-3.1 Taxiway and Apron Edge Stripes.**

When there is little contrast between the full-strength taxiway or apron boundary and the adjacent paved shoulder or other paved area, mark the edge of the usable pavement with two continuous 6-inch (152-millimeter) -wide retro-reflective yellow stripes separated by a 6-inch (152-millimeter) -wide gap. This marking is used to delineate the usable limits of the taxiway or apron from other pavements or surfaces not intended for routine use by aircraft. It is never used in areas where aircraft are required to cross the designated boundary when operated by a pilot or qualified maintainer (towing aircraft across these markings is accepted if the adjacent area is designated and/or marked as a towway). No portion of the marking is placed on non-load-bearing pavements. Use the tangents for the taxiway centerline stripe on curves; in areas where this is not practical, form a uniform arc to establish the usable area on the full-strength pavement. Figure 6-1 shows typical taxiway/apron edge lines; Figure 6-3 provides the width of the stripes and the space between them. Edge stripes are optionally highlighted with black borders on light-colored pavement (see paragraph 3-1.5).

### **6-3.2 Taxilane Edge Stripes.**

This marking is used to define the limits of a designated taxi route where the surrounding pavement is intended for use by aircraft. Aircraft movement across the designated boundary is permitted either by direction of air traffic control (ATC), a marshaller, or at the pilot's discretion. This marking consists of two 6-inch (152-millimeter) -wide broken stripes separated by a 6-inch (152-millimeter) -wide gap. The stripes are 15 feet (4.6 meters) long with gaps of 25 feet (7.6 meters). The detail and a typical layout are shown in Figures 6-1 and 6-9. Place the innermost edge of each stripe a distance from the centerline equal to half the wingspan of the most demanding aircraft that uses the taxilane, plus the appropriate wingtip clearance required by UFC 3-260-01, Table 6.1, items 5 or 6.

Figure 6-1. Typical Taxiway and Taxilane Markings



**6-4            PARKING STOP BARS.**

Parking stop bars are optionally painted at aircraft parking positions to indicate the intended location for the aircraft nose wheel when parked. Stop blocks are painted reflective yellow and are 3 feet (0.9 meter) long and 1 foot (0.3 meter) wide, centered on and oriented perpendicular to the nose wheel guideline. See Table 6-1 and Figure 6-2 for an example for locating these visual aids.

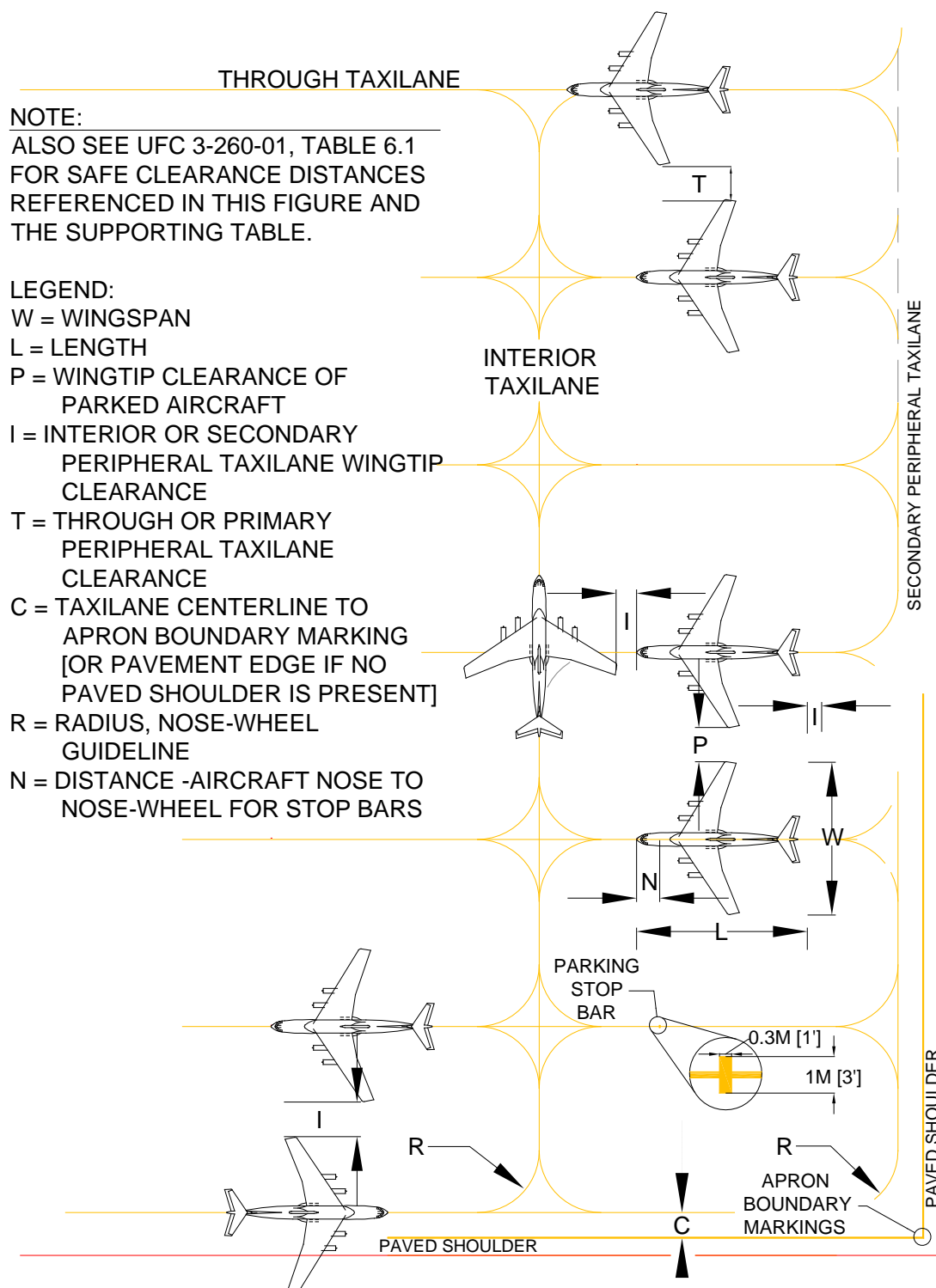


**Table 6-1. Cargo Aircraft Apron Layout Dimensions**

<b>Aircraft</b>	<b>W</b>	<b>L*</b>	<b>P</b>	<b>I</b>	<b>T</b>	<b>C</b>	<b>R</b>	<b>N</b>
C-5A	222.7' (67.9m)	247.8' (75.5m)	25' (7.6m)	30' (9.1m)	50' (15.2m)	37.5' (11.4m)	90' (27.4m)	34.7' (10.6m)
C-9A	93.4' (28.5m)	119.3' (36.4m)	20' (6.1m)	20' (6.1m)	30' (9.1m)	25' (7.6m)	90' (27.4m)	7.6' (2.3m)
C-17	170' (51.8m)	173.3' (52.8m)	25' (7.6m)	30' (9.1m)	50' (15.2m)	37.5' (11.4m)	90' (27.4m)	11' (3.4m)
C-130E/H/J	132.6' (40.4m)	99.5' (30.3m)	20' (6.1m)	30' (9.1m)	50' (15.2m)	37.5' (11.4m)	60' (18.3m)	11.8' (3.6m)
C-130J-30	132.6' (40.4m)	112.8' (34.4m)	20' (6.1m)	30' (9.1m)	50' (15.2m)	37.5' (11.4m)	60' (18.3m)	11.8' (3.6m)
C-141B	160' (48.8m)	168.3' (51.3m)	20' (6.1m)	30' (9.1m)	50' (15.2m)	37.5' (11.4m)	90' (27.4m)	10.3' (3.1m)
KC-135R	130.8' (39.9m)	136.2' (41.5m)	50' (15.2m)	30' (9.1m)	50' (15.2m)	37.5' (11.4m)	90' (27.4m)	17.4' (5.3m)
KC-10A	165.3' (50.4m)	182.1' (55.5m)	50' (15.2m)	30' (9.1m)	50' (15.2m)	37.5' (11.4m)	100' (30.5m)	28' (8.5m)
B767-200ER	156.1' (47.6m)	159.2' (48.5m)	50' (15.2m)	30' (9.1m)	50' (15.2m)	37.5' (11.4m)	90' (27.4m)	14.9' (4.5m)
B747-400	211' (64.3m)	231.8' (70.6m)	20' (6.1m)	30' (9.1m)	50' (15.2m)	37.5' (11.4m)	100' (30.5m)	25.4' (7.7m)
B777-300	200' (61m)	242.3' (73.9m)	20' (6.1m)	30' (9.1m)	50' (15.2m)	37.5' (11.4m)	110' (33.5m)	19.3' (5.9m)

\* Aircraft dimensions provided above do not include appurtenances such as antennas and do not include all model variations due to aircraft modifications.

Figure 6-2. Typical Mass Apron Layout for Cargo Aircraft



## **6-5 HOLDING POSITIONS.**

Holding positions are necessary on all pavements that lead to an active fixed-wing or rotary-wing runway or helipad, and at critical taxiway or taxilane intersections. They designate a boundary intended to protect the runway, helipad, or primary taxi route from incursions or prevent interference with signals transmitted by electronic navigational aids.

### **6-5.1 Runway Hold Positions.**

There are two patterns for marking runway hold positions: one is used to mark holding positions used for VFR conditions and the other is used to mark holding positions for IFR conditions. Both types are marked in retro-reflective yellow paint and are optionally enhanced with black borders on light-colored pavement. Runways served by precision instrument navigation aids might require an instrument holding position be marked in addition to the VFR holding position. Where practicable, collocate these markings and mark only the VFR holding position. If required, locate the instrument holding position further from the active runway to prevent taxiing or holding aircraft from interfering with signals transmitted to inbound aircraft during IMC and to prevent aircraft and vehicles from violating the precision obstacle free zone (POFZ). This marking is also used to identify the boundary of a microwave landing system (MLS) critical area and to identify the holding position for Category (CAT) II or CAT III operations.

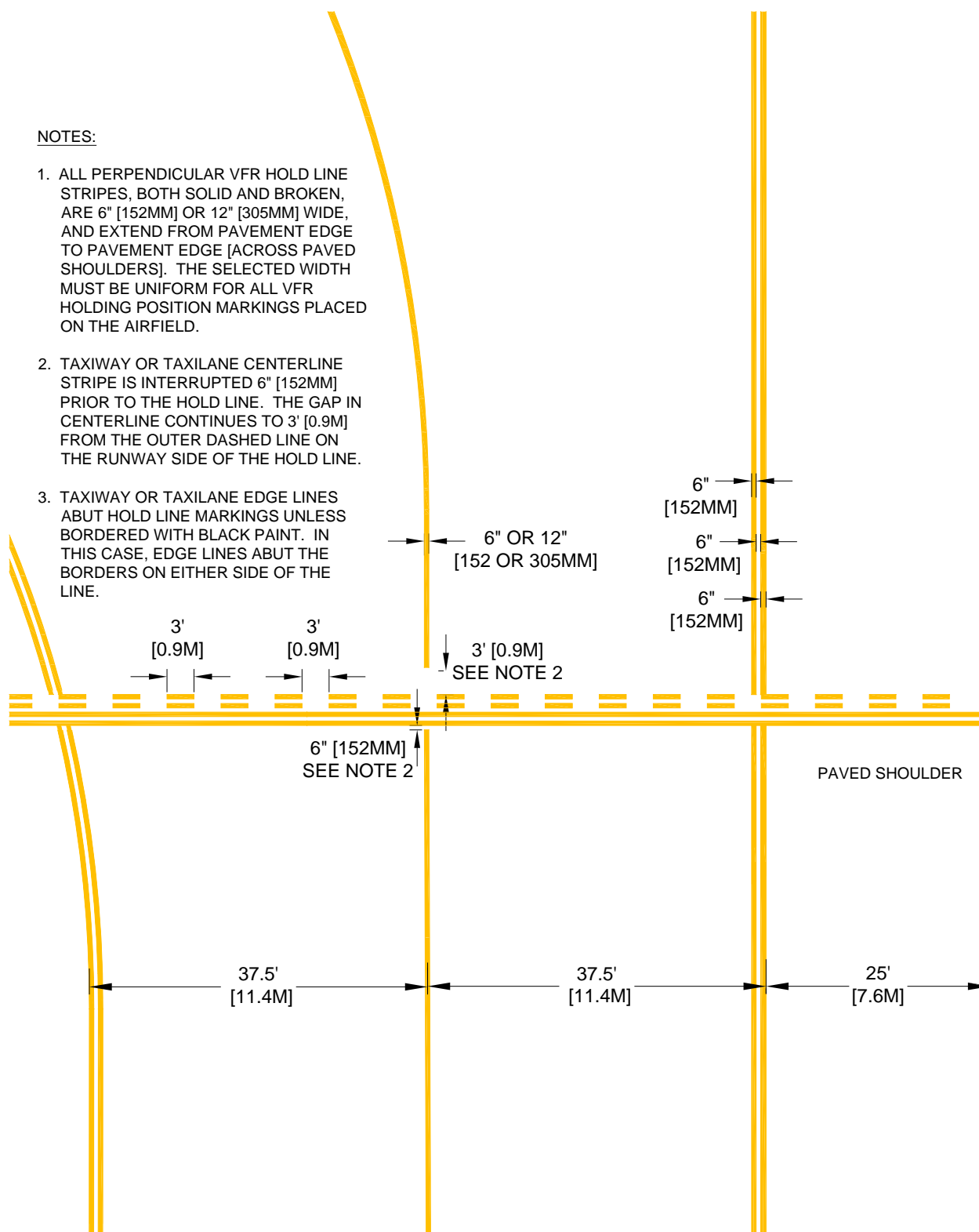
#### **6-5.1.1 VFR Runway Holding Position.**

In all cases, a VFR holding position is marked. This holding position is located 100 feet (30.5 meters) to 250 feet (76.2 meters) from the near edge of the runway. The minimum setback from the runway edge is 100 feet (30.5 meters). This distance is measured perpendicular to the long axis of the runway. Measure distances from the runway centerline (divide the published runway width shown in the DoD FLIP by 2 and add the required holding position distance). VFR holding positions are marked from edge to edge of the pavement surface, including paved shoulders. Interrupt taxiway edge lines at the outer edge of the holding position marking, or its black border, if provided. No gap at the edge line interruption is required. Figure 6-3 shows layout and typical positioning for a VFR hold line. Where practicable, setback distances for the VFR runway holding position are increased for instrument runways and where the wingspan of the controlling aircraft is greater than 79 feet (24.1 meters). Suggested setback distances from the runway edge are 175 feet (53.3 meters) for controlling aircraft with wingspans from 79 feet (24.1 meters) up to 171 feet (52.1 meters); and 205 feet (62.5 meters) for controlling aircraft with wingspans greater than 171 feet (52.1 meters). Increase these distances by 1 foot (0.3 meter) for each 100 feet (30.5 meters) of airfield elevation above mean sea level (MSL). Holding positions are placed perpendicular to the runway centerline on taxiways that enter at an angle to the runway; however, do not mark them to allow any portion of the holding aircraft to encroach beyond the minimum established distance.

Figure 6-3. VFR Hold Position Markings

NOTES:

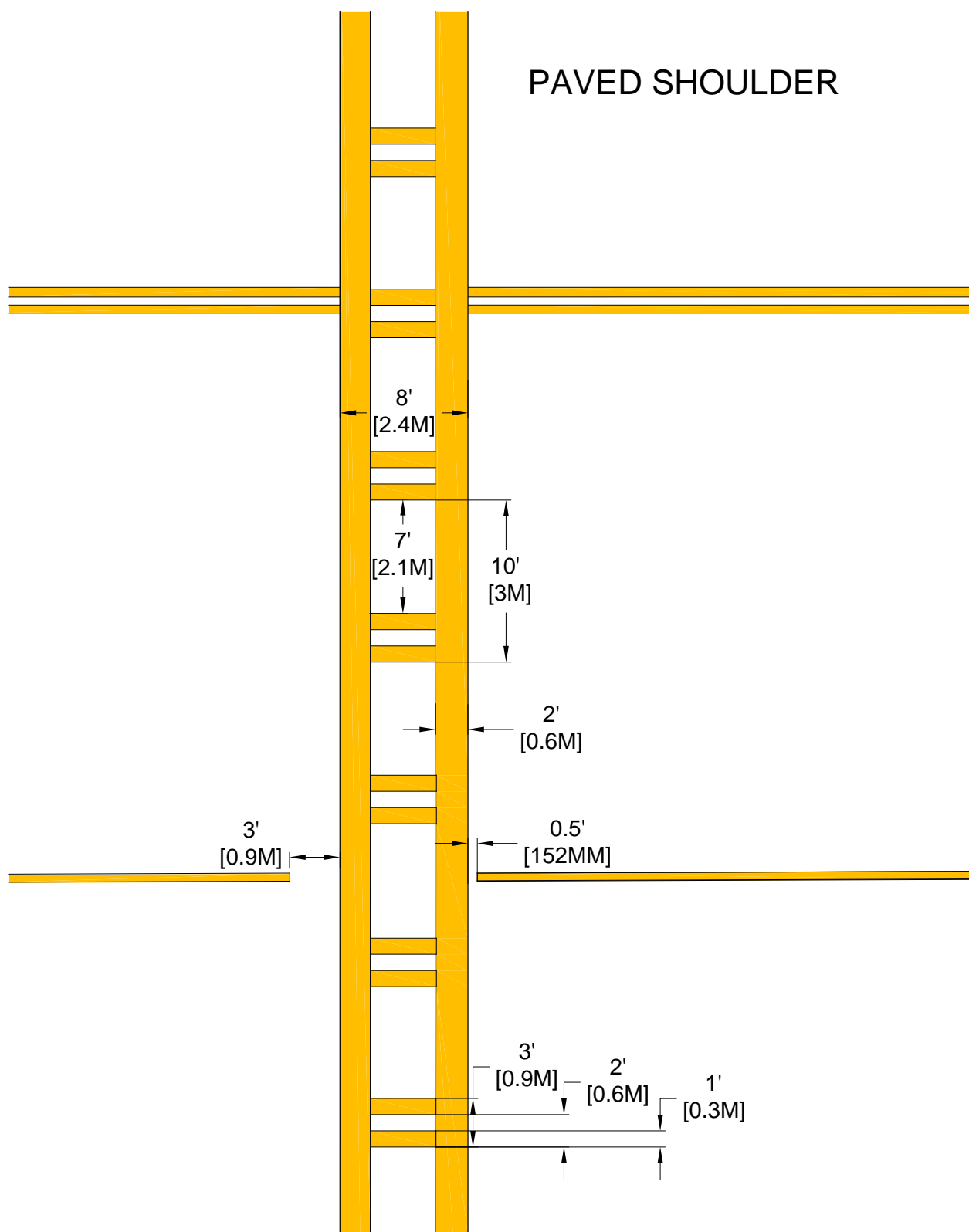
1. ALL PERPENDICULAR VFR HOLD LINE STRIPES, BOTH SOLID AND BROKEN, ARE 6" [152MM] OR 12" [305MM] WIDE, AND EXTEND FROM PAVEMENT EDGE TO PAVEMENT EDGE [ACROSS PAVED SHOULDERS]. THE SELECTED WIDTH MUST BE UNIFORM FOR ALL VFR HOLDING POSITION MARKINGS PLACED ON THE AIRFIELD.
2. TAXIWAY OR TAXILANE CENTERLINE STRIPE IS INTERRUPTED 6" [152MM] PRIOR TO THE HOLD LINE. THE GAP IN CENTERLINE CONTINUES TO 3' [0.9M] FROM THE OUTER DASHED LINE ON THE RUNWAY SIDE OF THE HOLD LINE.
3. TAXIWAY OR TAXILANE EDGE LINES ABOUT HOLD LINE MARKINGS UNLESS BORDERED WITH BLACK PAINT. IN THIS CASE, EDGE LINES ABOUT THE BORDERS ON EITHER SIDE OF THE LINE.



### **6-5.1.2 Instrument Meteorological Conditions (IMC) Holding Position.**

The IMC hold position is configured differently from a VFR hold. Locations for the instrument hold line vary, depending on the type and capability of the landing aid. An IMC holding position is only marked when located at a different point along the taxiway (or on a cross-wind runway used for taxi operations or LAHSO). When needed, they are located to prevent interference with electronic navigational aids (NAVAIDs) and provide additional safety during periods of reduced visibility. If an instrument hold line is needed and the taxiway where it needs to be marked also penetrates the POFZ, only one holding position marking is installed to delineate the applicable critical area and the POFZ. The holding position marking is located at the more conservative boundary of the two areas (generally the farthest from the runway). In this instance, the instrument and POFZ holding position markings are not replaced with a VFR runway holding position marking. The airfield manager works with the instrument procedures specialist to designate the applicable critical area and POFZ boundaries, and, as appropriate, determine the holding position location. Figure 6-4 shows the layout for an instrument hold line. Figures 6-5 and 6-6 depict typical positioning for these hold lines. The markings are typically installed perpendicular to the taxiway centerline but might be canted from the perpendicular in unique situations. All holding positions are marked from edge to edge of the pavement surface, including paved shoulders. Interrupt taxiway edge lines at the outermost edges of the holding position marking, or the black borders, if provided. Interrupt centerlines 6 inches (152 millimeters) before the side of the marking where aircraft are to hold and provide a 3-foot (1-meter) gap on the runway side of the marking. No gap at the interruption of edge lines is required. The gap distances cited for the centerline include the black borders, when provided.

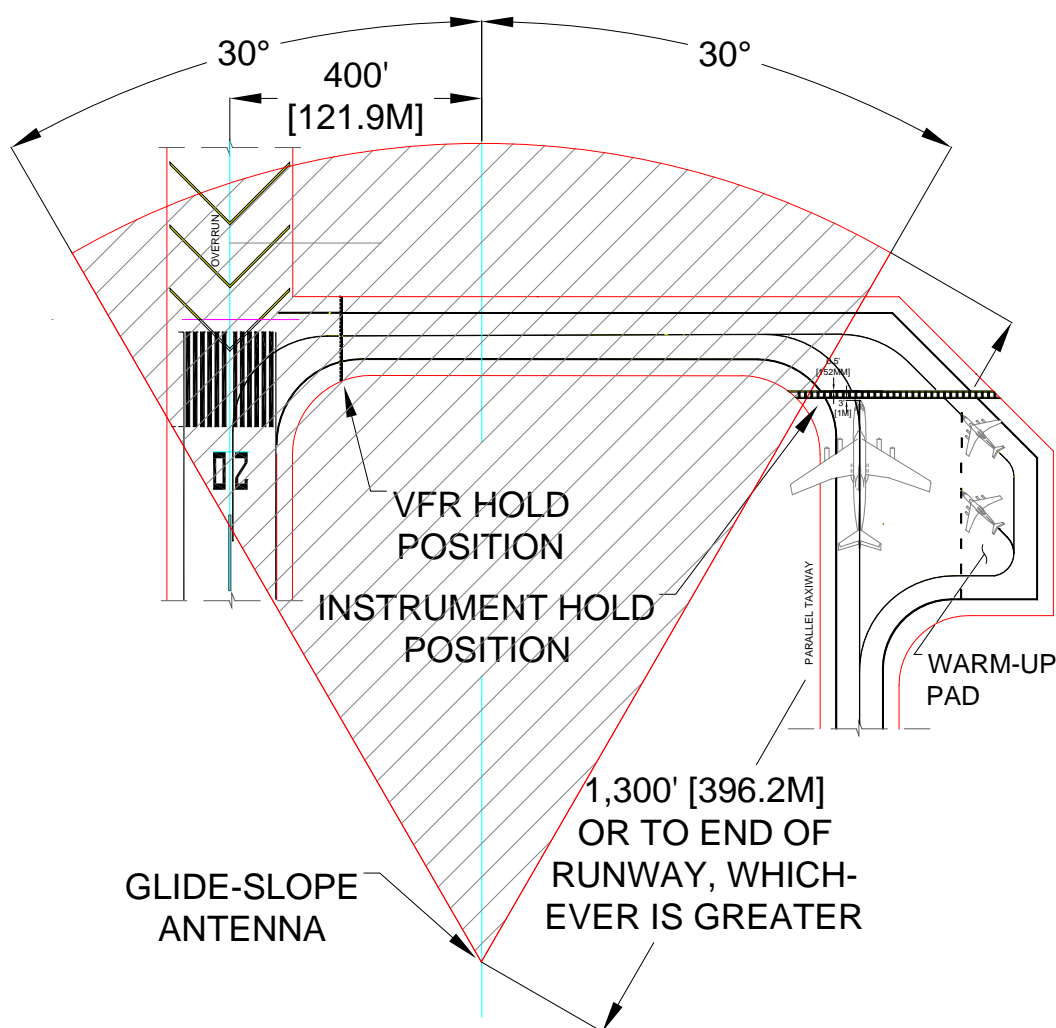
Figure 6-4. ILS Hold Position Details



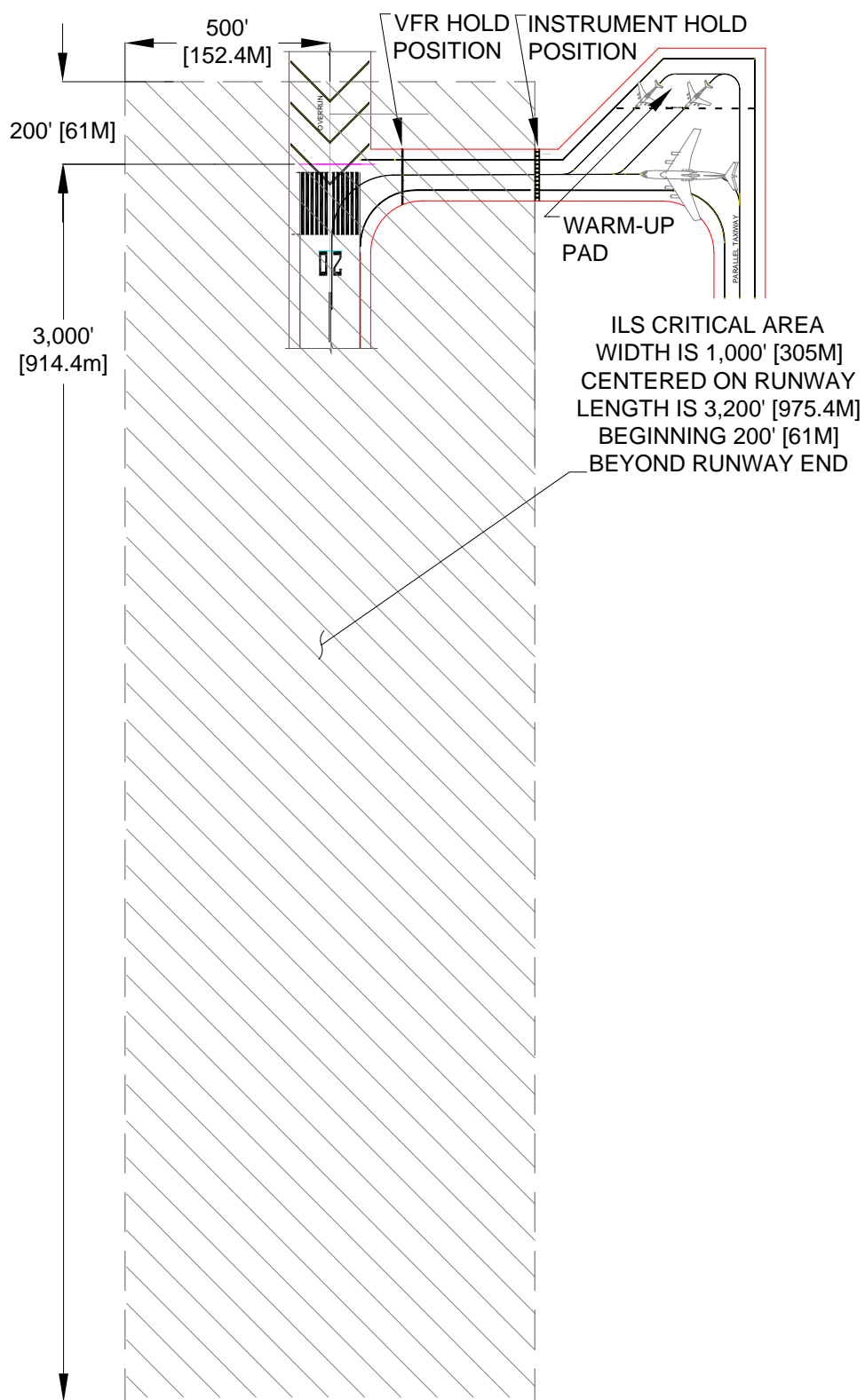
### 6-5.1.3 Locating IMC Hold Position Markings.

If the height above touchdown (HAT) is 200 feet (61 meters) or greater (ask the airfield manager), mark the instrument holding position at the edge of the glide slope critical area as shown in Figure 6-5. If the HAT is less than 200 feet (61 meters), mark the holding position at the edge of the TDZ critical area or the glide slope critical area, whichever results in a distance farther from the edge of the runway. The glide slope critical area and TDZ critical areas are shown in Figures 6-5 and 6-6. The instrument hold line is placed at least 500 feet (152.4 meters) from the runway centerline when TDZ critical area criteria apply.

**Figure 6-5. Locating Instrument Hold Position to Protect Glideslope Critical Area**



**Figure 6-6. Locating Instrument Hold Positions to Protect Touchdown Zone Critical Area**





## **6-5.2 Runway/Runway Holding Position Marking Layout and Placement.**

LAHSO for runway/runway intersections require a letter of agreement between the airfield operations authority and the air traffic control tower (ATCT) authority. When a holding position is necessary for such operations, it is marked in one of the patterns described above; however, its location is not less than 280 feet (85.3 meters) from the adjacent runway centerline. This distance is increased by 1 foot (0.3 meter) for each 100 feet (30.5 meters) of airfield elevation above MSL. Such hold lines are located further away to avoid interference with intersecting taxiway clearances and interrupts all other runway markings other than a designation marking. The runway holding position marking extends across the full width of the runway but not onto the runway shoulders or onto any intersecting taxiway fillet.

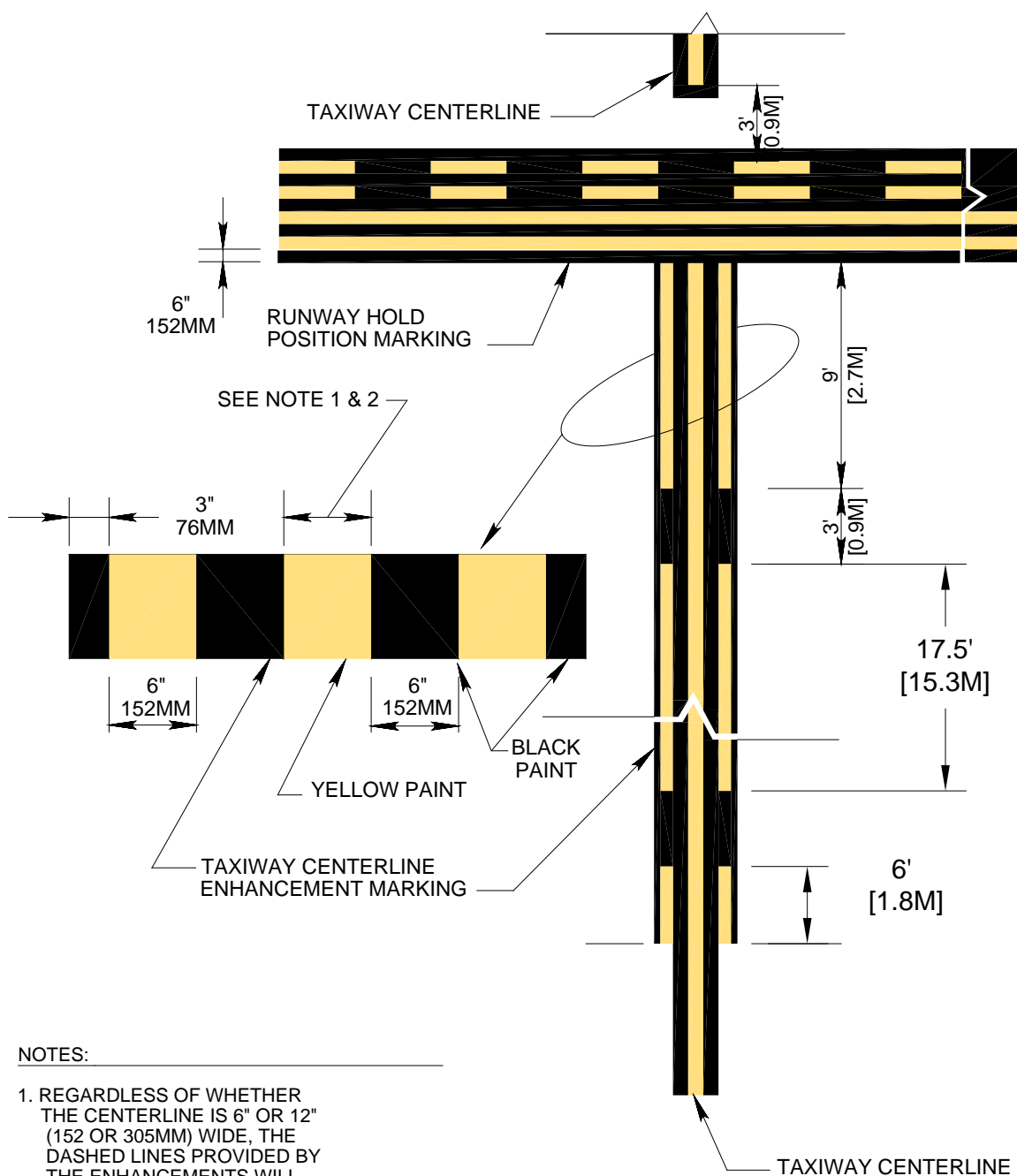
## **6-5.3 Enhanced Hold Position Marking.**

Enhanced markings are intended to be a visual precursor to an approaching runway holding position. These markings are intended to prevent runway incursion and are optionally marked at any runway intersection for any DoD installation but are required at Part 139 (14 CFR Part 139) airports. See Figure 6-7 for details. For additional guidance on marking pavements at civil-owned facilities, see FAA AC 150/5340-1.

## **6-5.4 Intermediate Hold Position Markings.**

Intermediate holding position markings identify the location for aircraft to hold short of an intersecting taxiway, or taxilane on an apron. These permissible markings are placed only where there is an operational need for aircraft to hold short of another taxiway or taxilane intersection. Intermediate holding position markings are retro-reflective yellow and are placed at a distance from the intersecting taxiway or taxilane to provide one-half the wingspan of the most demanding aircraft that uses the taxi path, plus the appropriate wingtip clearance as shown in Table 6-1 of UFC 3-260-01. When placing these markings to protect a taxiway, use the greater wingtip clearance as shown for a through taxilane. The intermediate hold position marking is a 6-inch (152-millimeter) or 12-inch (305-millimeter) -wide dashed line, where the dashes are 3 feet (0.9 meter) long and the gaps are 3 feet (0.9 meter) long; see Figure 6-8 for layout details. Interrupt taxiway or taxilane centerlines and edge lines 6 inches (152 millimeters) before and after the hold position line. Center a dash on the taxipath centerline. If the hold line crosses more than one centerline, center a dash on the path of highest use.

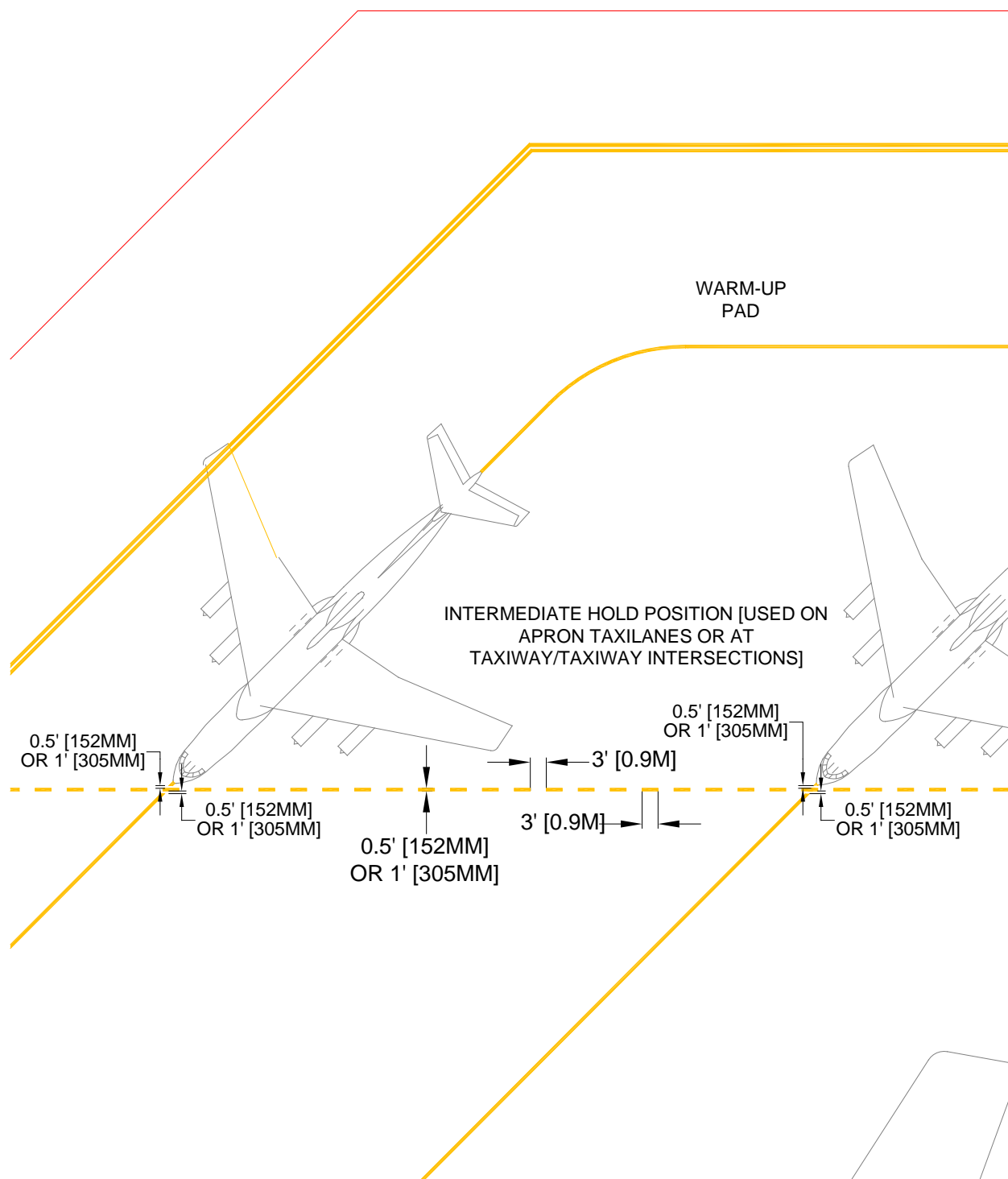
Figure 6-7. Enhanced Hold Position Markings



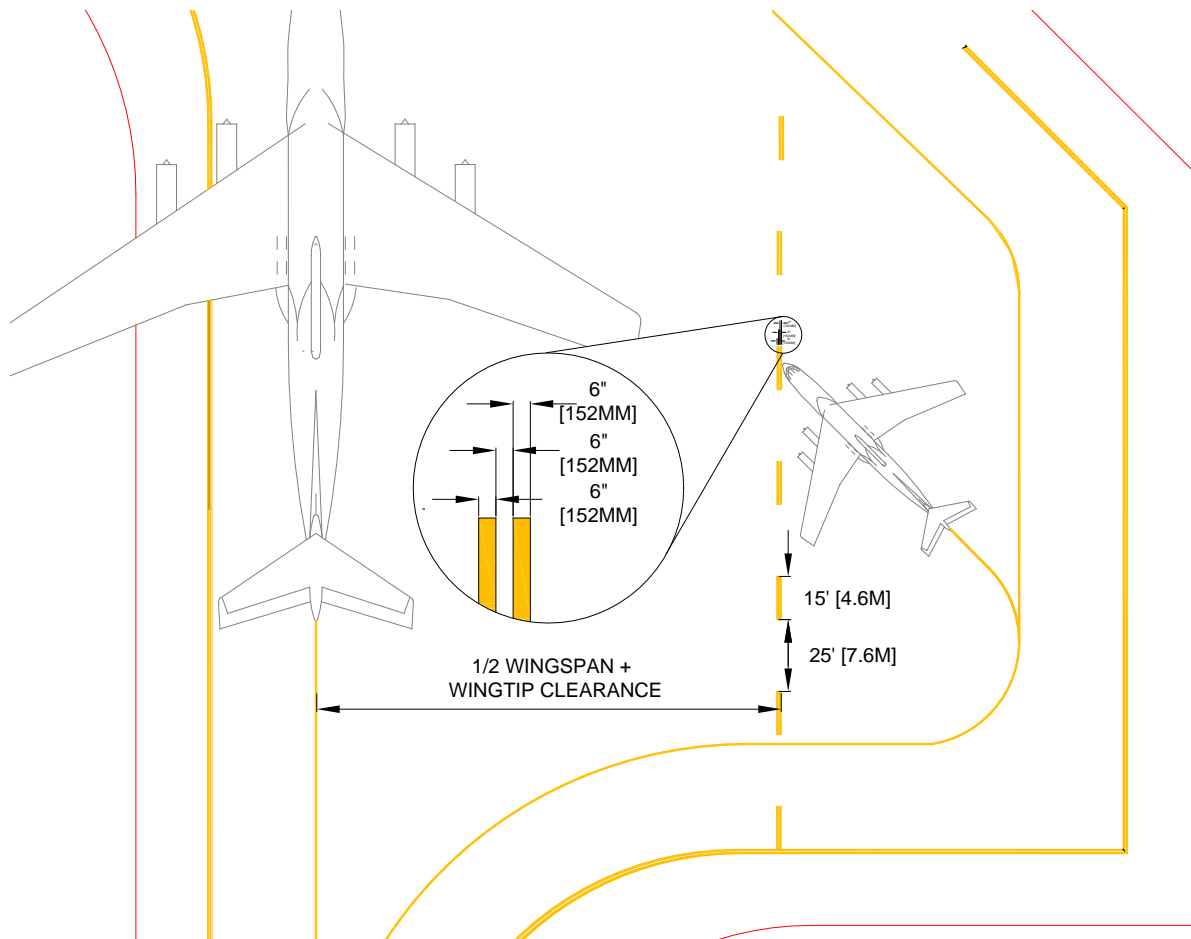
NOTES:

1. REGARDLESS OF WHETHER THE CENTERLINE IS 6" OR 12" (152 OR 305MM) WIDE, THE DASHED LINES PROVIDED BY THE ENHANCEMENTS WILL ALWAYS BE 6" (152MM)
2. IF TAXIWAY CENTERLINE LIGHTS ARE PRESENT, SHIFT THE TAXIWAY CENTERLINE EITHER RIGHT OR LEFT TO ENSURE THE ENHANCEMENT MARKINGS DO NOT COVER THE LIGHTS.

Figure 6-8. Intermediate Holding Position Marking



**Figure 6-9. Taxilane Edge Stripes**



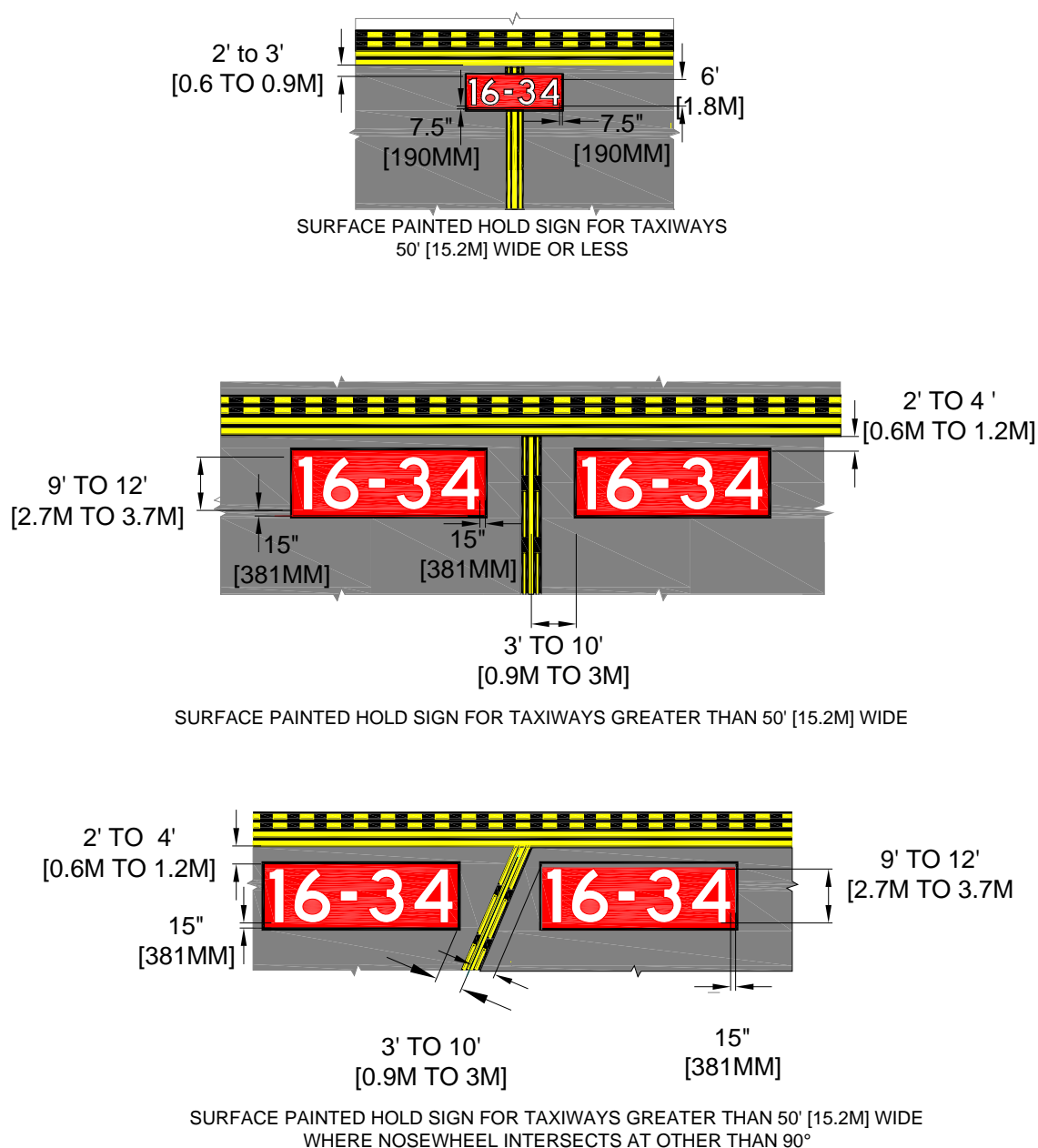
### 6-5.5 Surface Painted Signs.

Taxiway signs are described in UFC 3-535-01. Where it is desirable to furnish additional guidance at intersections or along taxiways or taxilanes, additional information is provided on the pavement surface. The most common surface-painted sign types are location, direction, and runway hold position signs. Under special circumstances, geographic position marking (GPM) signs are required. GPM signs are used repeatedly along a designated taxi route to serve as indicators of specific locations to allow pilots to confirm their position on the airfield during periods of low visibility. Low-visibility operations are defined as taxiing operations prior to takeoff or after landing that occur when the runway visual range (RVR) is below 1,200 feet (365.8 meters). See FAA AC 120-57 and both UFC 3-535-01 and FAA AC 150/5340-18 for sign requirements. See FAA AC 150/5340-1 for placement, layout, colors, and dimensions. Figures 6-10 through 6-12 show examples of typical runway hold position, location, and direction surface painted signs. The letters and numbers are formed according to the patterns shown in Figures 6-13 through 6-15.

#### **6-5.6 Surface Painted Holding Position Signs.**

The surface painted holding position sign provides supplemental visual cues that alert pilots and vehicle drivers of an upcoming holding position location and the associated runway designator(s) as a method to minimize the potential for a runway incursion, and, for certain airport geometries, wrong runway takeoffs. Several configurations of this surface painted sign are allowed to provide maximum flexibility. See Figure 6-10 for three possible layout scenarios. Inscriptions have a height of 12 feet (3.7 meters) where practicable; however, the height is reduced to a minimum height of 9 feet (2.7 meters) when necessary to appropriately fit the marking. Examples of these situations include taxiways with widths narrower than the applicable standard or taxiways that need to display multiple runway designations with directional arrows. In all cases, inscriptions follow inscription criteria shown in Figures 6-13 through 6-15. All other taxiway entrances to the same runway not needing the reduction are to maintain the 12-foot (3.7-meter) height dimension.

**Figure 6-10. Surface Painted Runway Hold Position Signs**



### **6-5.7 Surface Painted Taxiway Location Signs.**

The surface painted taxiway location sign identifies the taxiway upon which the aircraft is located and is optional when required signage is not available. When necessary, this marking is also used to supplement other signs located along the taxiway system, or where operational experience has indicated that its presence assists flight crews in better ground navigation. These type signs are normally located on the right side of the taxiway centerline in the direction of travel. The edge (excluding the border) of the surface painted taxiway location sign is placed 3 feet (0.9 meter) from the outer edge of the taxiway centerline stripe. When adequate pavement width exists, a surface painted taxiway location sign might be located on the left side of the taxiway centerline if it is co-located with a surface painted holding position sign. In this case, the two surface painted signs mimic the mandatory holding position signs, and the surface painted taxiway location sign is placed to the left of the surface painted holding position sign to be readable in the direction of taxiing toward the runway. The inscription is 12 feet (3.7 meters) in height; however, the height is reduced if necessary to a minimum height of 9 feet (2.7 meters). See Figure 6-11 for an example and detail dimensions. The inscriptions conform in appearance and proportion with the letters, numbers, and symbols in Figures 6-13 through 6-15.

### **6-5.8 Surface Painted Taxiway Direction Signs.**

The surface painted taxiway direction sign is always combined with an arrow to provide directional guidance at an intersection when it is not possible to provide an illuminated taxiway direction sign in accordance with UFC 3-535-01. An exception is where operational experience indicates the addition of a surface painted sign at a troublesome taxiway intersection assists aircrews.

**6-5.8.1** The inner edge of surface painted taxiway direction signs (excluding the border, if used) is placed 3 feet (0.9 meter) from the near edge of the taxiway or taxilane nose wheel guideline and is placed on the same side of the nose wheel guideline as the direction the aircraft turns. For example, signs indicating left turns are located on the left side of the line and signs indicating right turns are located on the right side of the line.

**6-5.8.2** The surface painted taxiway direction sign is not painted on runways, including runways sometimes used as a taxiway, between the runway VFR holding position marking and the runway, nor with surface painted hold position signs.

**6-5.8.3** For crossing taxiways, a surface painted taxiway direction sign, combined with arrows, indicates the intersecting taxiway designation at the near intersection. In such cases, a single surface painted sign is located on the left side of the taxiway centerline to accommodate the possible directions of travel.

**6-5.8.4** Locate these surface painted direction signs a longitudinal distance from crossing taxi routes at the appropriate aircraft wingtip clearance distance for the most demanding aircraft that uses the intersecting taxi route (taxiway or taxilane). These clearances are provided in UFC 3-260-01, Table 6-1, for fixed wing aircraft, and Table 6-2 for rotary wing aircraft.

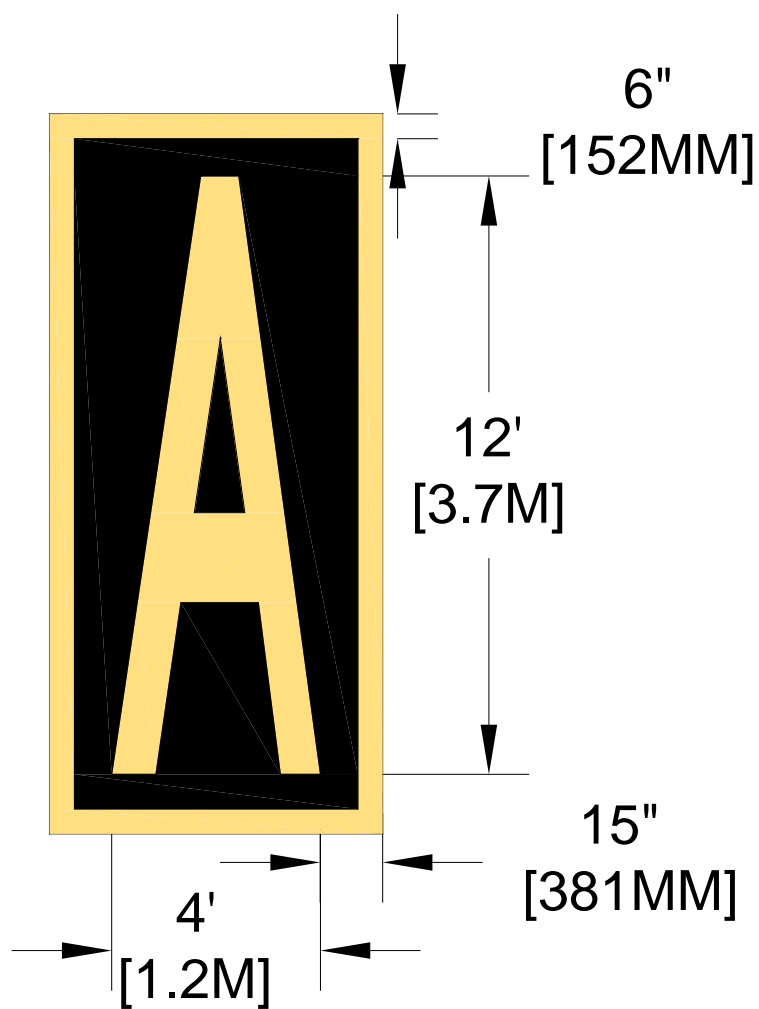
**6-5.8.5** The surface painted taxiway direction sign has a retro-reflective yellow background with a black inscription that includes one or more arrows. See paragraph 3-1.5 for recommended techniques to enhance this marking on light-colored pavements.

**6-5.8.6** The black inscription is 12 feet (3.7 meters) in height; however, the height is reduced if necessary to a minimum height of 9 feet (2.7 meters). The black inscription is accompanied by an arrow oriented to show the general direction and angle of the turn. The inscriptions and arrows conform in appearance and proportion with the letters, numbers, and symbols in Figures 6-13 through 6-15.

**6-5.8.7** The yellow background is rectangular and extends a minimum of 15 inches (381 millimeters) horizontally and vertically beyond the extremities of the black inscription, including the arrow head. A 6-inch (152-millimeter) -wide vertical black stripe separates any two black inscriptions when more than one is included on the same side of the nose wheel guideline.



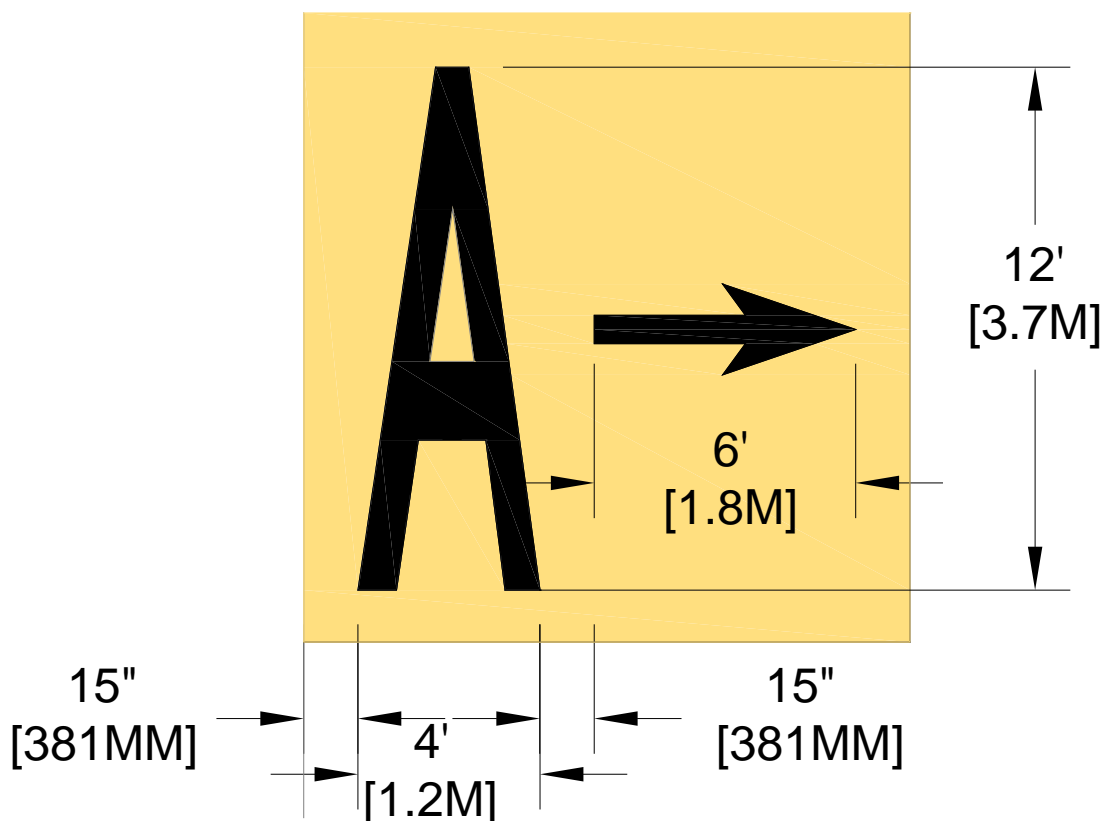
Figure 6-11. Surface Painted Taxiway Location Sign



NOTES:

1. CHARACTER HEIGHT, WIDTH, AND LENGTH MAY BE REDUCED PROPORTIONATELY BY A FACTOR OF 0.75 (12' [3.7M] HEIGHT MAY BE REDUCED TO 9' [2.7M] HEIGHT IF STROKE AND CHARACTER WIDTH ARE ALSO REDUCED PROPORTIONATELY).
2. LOCATION SIGNS ARE NOT USED BETWEEN THE VFR HOLD POSITION AND THE RUNWAY, OR ON RUNWAYS USED AS TAXIWAYS.

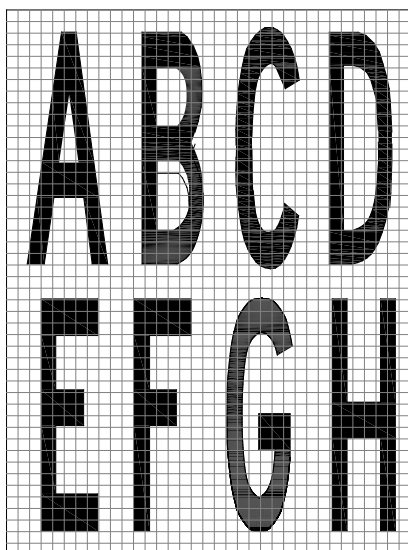
Figure 6-12. Surface Painted Taxiway Direction Sign



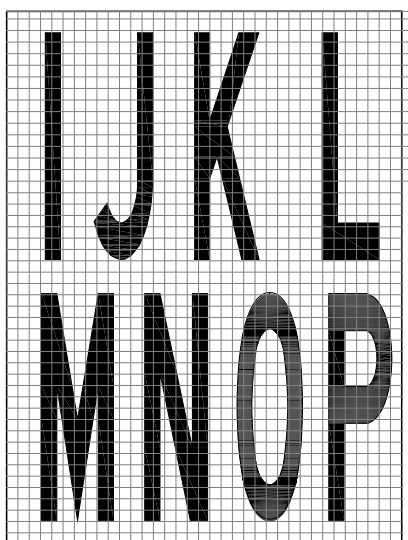
NOTES:

1. CHARACTER AND ARROW HEIGHT, WIDTH, AND LENGTH MAY BE REDUCED PROPORTIONATELY BY A FACTOR OF 0.75 (12' [3.7M] HEIGHT MAY BE REDUCED TO 9' [2.7M] HEIGHT IF STROKE AND CHARACTER WIDTH ARE ALSO REDUCED PROPORTIONATELY).
2. LOCATION SIGNS ARE NOT USED BETWEEN THE VFR HOLD POSITION AND THE RUNWAY, ON RUNWAYS USED AS TAXIWAYS, NOR ARE THEY COLLOCATED WITH SURFACE PAINTED HOLD POSITION SIGNS.

Figure 6-13. Surface Painted Sign Inscription Layout, A through P

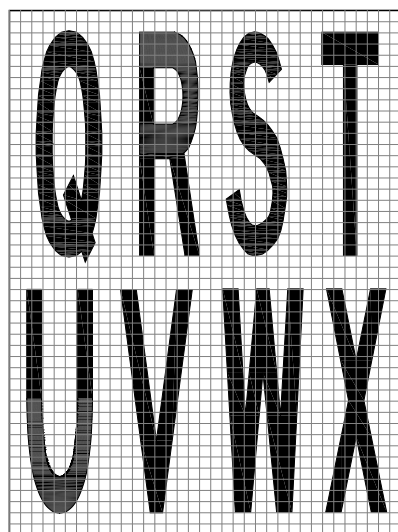


DIVIDE OVERALL DESIRED  
HEIGHT OF CHARACTER BY  
20 TO DETERMINE SIZE  
OF INDIVIDUAL SQUARES.

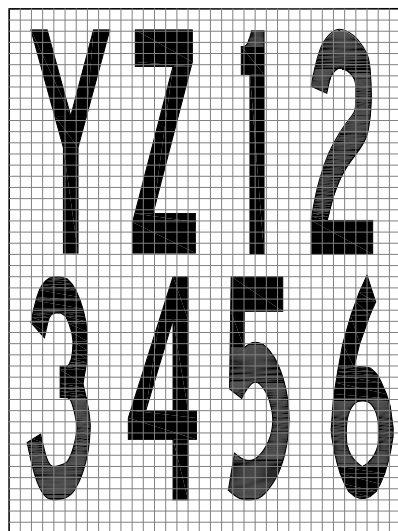


DIVIDE OVERALL DESIRED  
HEIGHT OF CHARACTER BY  
20 TO DETERMINE SIZE  
OF INDIVIDUAL SQUARES.

Figure 6-14. Surface Painted Sign Inscription Layout, Q through 6

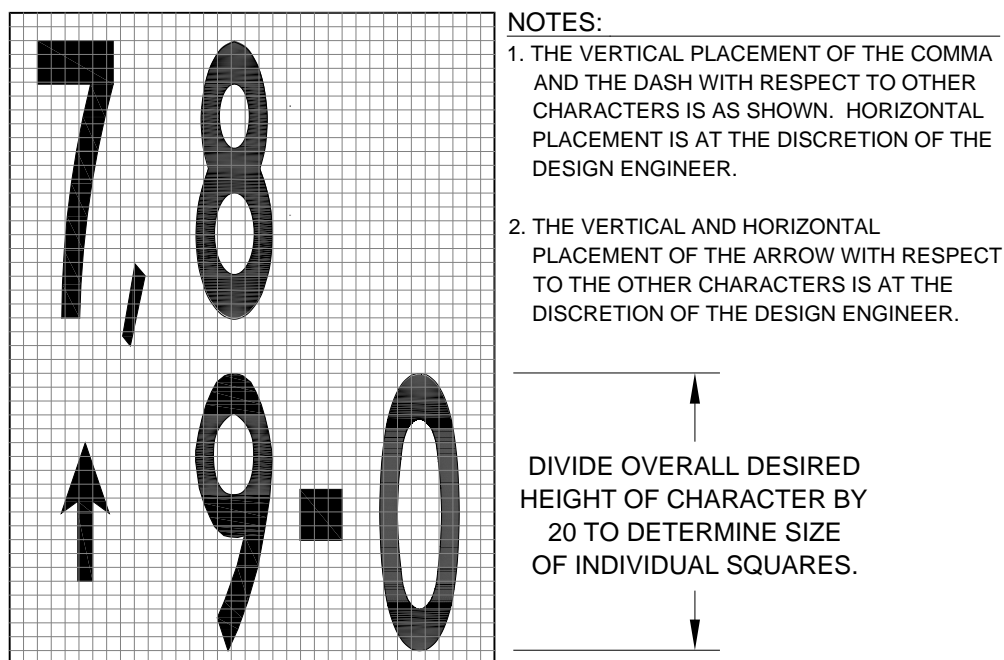


↑  
DIVIDE OVERALL DESIRED  
HEIGHT OF CHARACTER BY  
20 TO DETERMINE SIZE  
OF INDIVIDUAL SQUARES.  
↓



↑  
DIVIDE OVERALL DESIRED  
HEIGHT OF CHARACTER BY  
20 TO DETERMINE SIZE  
OF INDIVIDUAL SQUARES.  
↓

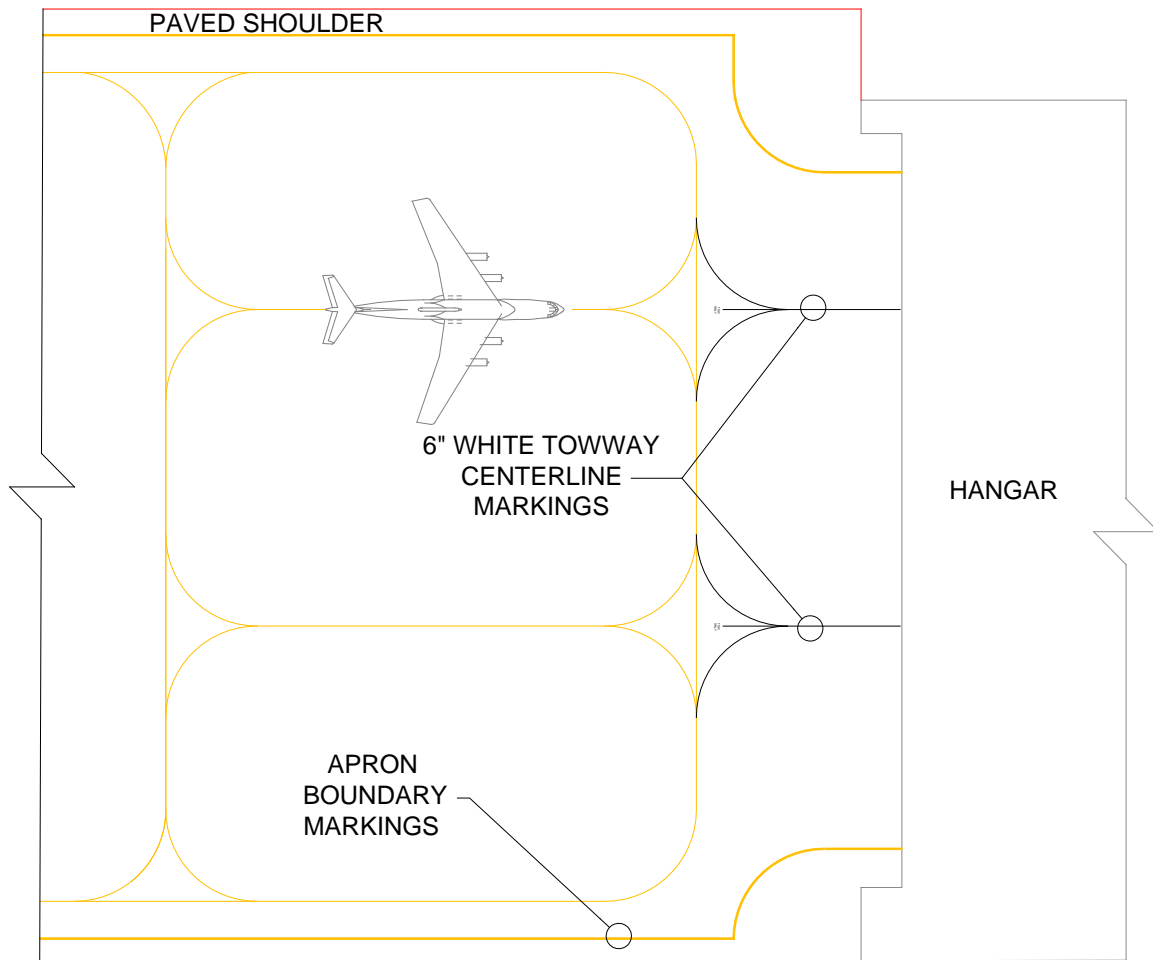
**Figure 6-15. Surface Painted Sign Inscription Layout, 7 through 0 and Directional Arrow**



#### **6-5.9 Towway Markings.**

For taxilanes where aircraft are to be towed, provide a single, solid, continuous 6-inch (152-millimeter) -wide white painted stripe. A significant gap is provided between the yellow taxilane marking and the white towway lane marking to allow the taxiing pilot to see that the towway is not a continuation of the taxilane. See Figure 6-16.

Figure 6-16 Towway Centerline Marking



NOTES:

1. TOWWAY CENTERLINES ARE 6" [152MM] WIDE WHITE LINES LAID OUT TO MAINTAIN MINIMUM CLEARANCES GIVEN WITHIN CHAPTER 5 OF UFC 3-260-01, *AIRFIELD AND HELIPORT PLANNING AND DESIGN*. USE OF RETROREFLECTIVE BEADS IS ALLOWED WHEN THESE MARKINGS MUST BE USED AT NIGHT.
2. TOWWAY CENTERLINES SHOULD NOT BE MARKED WITHIN THE AIRCRAFT OPERATING AREA OF THE APRON WHERE EXISTING TAXILANE CENTERLINES MAY BE USED FOR TOWING GUIDANCE. IF NECESSARY TO MARK THESE GUIDELINES WITHIN THE APRON BOUNDARIES, MARK THE BEGINNING OF EACH TOWWAY CENTERLINE "TOWWAY OR TOW ONLY" IN MIN 24" [610MM] HIGH LETTERS.

## 6-5.10 Restricted Area and Restricted Area Entry Control Points (ECP).

USAF AFI 31-101 and U.S. Army Regulation (AR) 190-16 prescribe signage, security force equipment, and security procedures for the protection of aircraft and the areas surrounding them. Borders and signage are necessary to identify these controlled and restricted areas. In cases where it is not practicable to establish a raised physical barrier, it is sometimes permissible to delineate such borders with a retro-reflective red, 6-inch (152-millimeter) -wide painted line surrounding the area, supplemented with ECP markings and warning signs at specific intervals. Spacing between boundary signs is usually 100 feet (30.5 meters); however, there are exceptions for areas with irregular terrain features and for abrupt changes in direction of the boundary, where the maximum distance is reduced. See UFC 3-120-01 for details necessary to mark retro-reflective signs on the pavement. See Figure 6-17 for an example of an ECP and Figure 6-18 for an example of a restricted area warning sign but refer to the specific Service component's security directives for the markings and sign legends required in each situation.

**Figure 6-17. Restricted Area Entry Control Points (ECP)**

NOTES:

1. ENTRY CONTROL POINT MARKINGS ARE 6" [152MM] WIDE BY 3' [0.9M] LONG RETROREFLECTIVE WHITE BARS SEPARATED BY 6" [152MM] GAPS.
2. THE RESTRICTED AREA BOUNDARY IS A 6" [152MM] WIDE RED BORDER AROUND THE RESTRICTED AREA. SEE AFMAN 31-101, *INTEGRATED DEFENSE*.



Figure 6-18. Typical Restricted Area Boundary Warning Sign





## **CHAPTER 7 MARKING PAVEMENTS FOR ROTARY WING OPERATIONS**

### **7-1 GENERAL.**

Marking rotary wing facilities conforms to the requirements as set forth below and govern the initial marking and re-marking of serviceable runways, taxiways, landing pads, and other areas designated for rotary wing operations.

### **7-2 MARKING WITH PAINT OR THERMOPLASTICS.**

Do not use thermoplastics to mark rotary-wing helipads, runways, landing lanes, or taxiways due to potential for FOD.

### **7-3 COLORS AND REFLECTIVITY OF MARKINGS.**

Rotary-wing runways, hoverpoints, and pads are marked with retro-reflective white except as noted below. Rotary-wing taxiways, taxi-lane and aprons are marked with retro-reflective yellow except as noted below. Hospital helipads incorporate red in the designator and borders. Rotary-wing shoulders (deceptive surfaces) and overruns are marked in non-reflective yellow durable marking materials except where noted otherwise. For Class A airfields and heliports that are not used strictly for missile security or survival school and are not trafficked by jet aircraft on a daily basis, identification markers, landing pads, and hoverpoints are marked using non-reflective white marking materials. In addition, taxiways, taxilanes, and apron markings on these Class A airfields and heliports are marked using non-reflective yellow durable marking materials except where otherwise noted.

### **7-4 PAVEMENT CURING TIME AND APPLICATION RATES.**

Durable marking materials are applied only after the pavements have been allowed to cure thoroughly. New pavement surfaces are allowed to cure for a minimum of 30 days before application of marking materials. Take care to ensure the pavement surface is dry and clean prior to application of markings. See Chapter 3 for material application rates.

#### **7-4.1 Rigid Pavements.**

When painted markings are to be applied to rigid pavements cured with a membrane-type curing compound, the surface to be painted is thoroughly cleaned and the curing compound removed by sandblasting or high-pressure water blasting. Do not allow excessive blasting of the concrete surface when using high water pressure methods. Employ removal methods sufficient only to remove curing compound, old paint, or laitance, and not expose the coarse aggregate in the concrete.

#### **7-4.2 Flexible pavements.**

Flexible pavements are allowed to cure as long as practicable before marking to prevent undue softening of the bitumen by the paint or primers, as well as to limit bleeding. The maximum drying-time requirements of the paint specifications are strictly enforced.

## **7-5 INCREASING VISIBILITY OF MARKINGS.**

A hoverpoint is a surface used as a reference or control point for arriving and departing helicopters. Mark hoverpoints with a white circle 30 feet (9.1 meter) in diameter on Class A airfields or heliports except when used for missile security or survival school or on asphalt surfaces where jet aircraft operate. On Class B airfields or Class A airfield/heliports used for missile security or survival school or on asphalt surfaces where jet aircraft operate, mark hoverpoints with a 30-foot (9.1-meter) -outside diameter circle formed with a 12-inch (305-millimeter) -wide white line. When located on a taxiway, the marking is centered on the taxiway centerline. See Figure 7-4.

## **7-6 HELICOPTER RUNWAY AND LANDING LANE MARKINGS.**

Markings on serviceable runways consist of centerline marking, runway azimuth heading numbers, and an "H" letter without a helipad border as shown in Figure 7-1. Helicopter landing lanes are also marked to delineate three equal-length segments to accommodate four equally spaced landing pads, as shown in Figure 7-7.

### **7-6.1 Rotary-Wing Runway Designator.**

The helipad "H" letter is located centered on the runway pavement centerline, 20 feet (6.1 meters) inboard from the beginning of the rotary-wing runway surface. The rotary-wing designator "H" is approximately 30 feet (9.1 meters) in length and 20 feet (6.1 meters) in width. See Figure 7-2 for placement on the runway pavement and Figure 7-3 for dimensions.

### **7-6.2 Azimuth Runway Designation Marking.**

Runway designation is the numeric azimuth heading of the paved strip rounded to the nearest 10-degree increment. Each runway end is designated by number and, where required, by letter to indicate left, right, or center. Numbers and letters assigned are determined from the approach direction and conform to the form and dimensions shown in Figure 7-3.

**7-6.2.1** The numeral(s) are retro-reflective white characters consisting of one or two numbers. The number assigned is the whole number nearest one-tenth of the magnetic azimuth of the centerline of the runway, measured clockwise from the magnetic north. Single-digit headings are not preceded by a zero (0). Lateral spacing between the numbers is 10 feet (3 meters), except for the numbers "10" and "11." Spacing between numerals for these runway designations are 7.5 feet (2.3 meters) and 12.5 feet (3.8 meters), respectively.

**7-6.2.2** In the case of parallel runways, the retro-reflective white numeric designator and a letter ("L" for left, "C" for center, or "R" for right) are marked to indicate the lateral position of the runway with respect to any others with the same numeric designator on the same airfield.

**7-6.2.3** In the case where a letter designation is required, it is placed between rotary-wing designator "H" and the numeric azimuth designator, with a 20-foot (6.1-

meter) gap between each of the characters. See Figure 7-1 for placement on the runway pavement and Figure 7-3 for letter dimensions.

### **7-6.3 Runway Centerline Marking.**

The runway centerline is marked as a solid and continuous reflective white line, 1 foot (0.3 meter) in width. The centerline stripe of each runway terminates 20 feet (6.1 meters) from the runway direction numbers as shown in Figure 7-2.

### **7-6.4 Runway Side Stripe (Edge) Marking.**

When there is little contrast between the runway and the paved shoulder or the surrounding area, the edge of the full-strength pavement is marked with a continuous 12-inch (0.3-meter) -wide stripe. This marking is used to delineate the edge of the runway from other pavements placed to prevent FOD or erosion. Such surfaces are not intended for routine use by aircraft. See Figure 7-1 for an example.

Figure 7-1. Helicopter Runway Markings

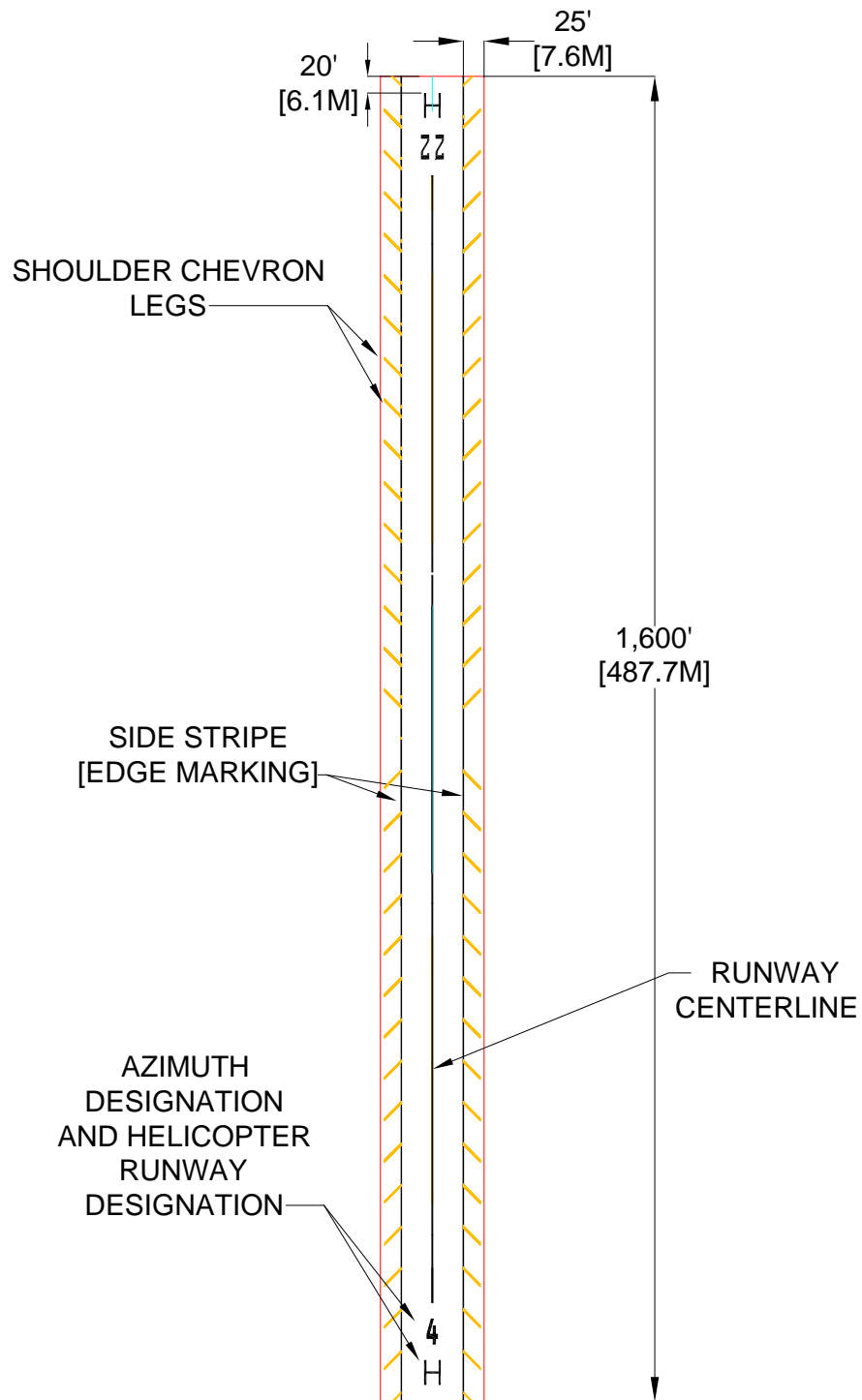


Figure 7-2. Rotary-Wing Designator and Designation Markings

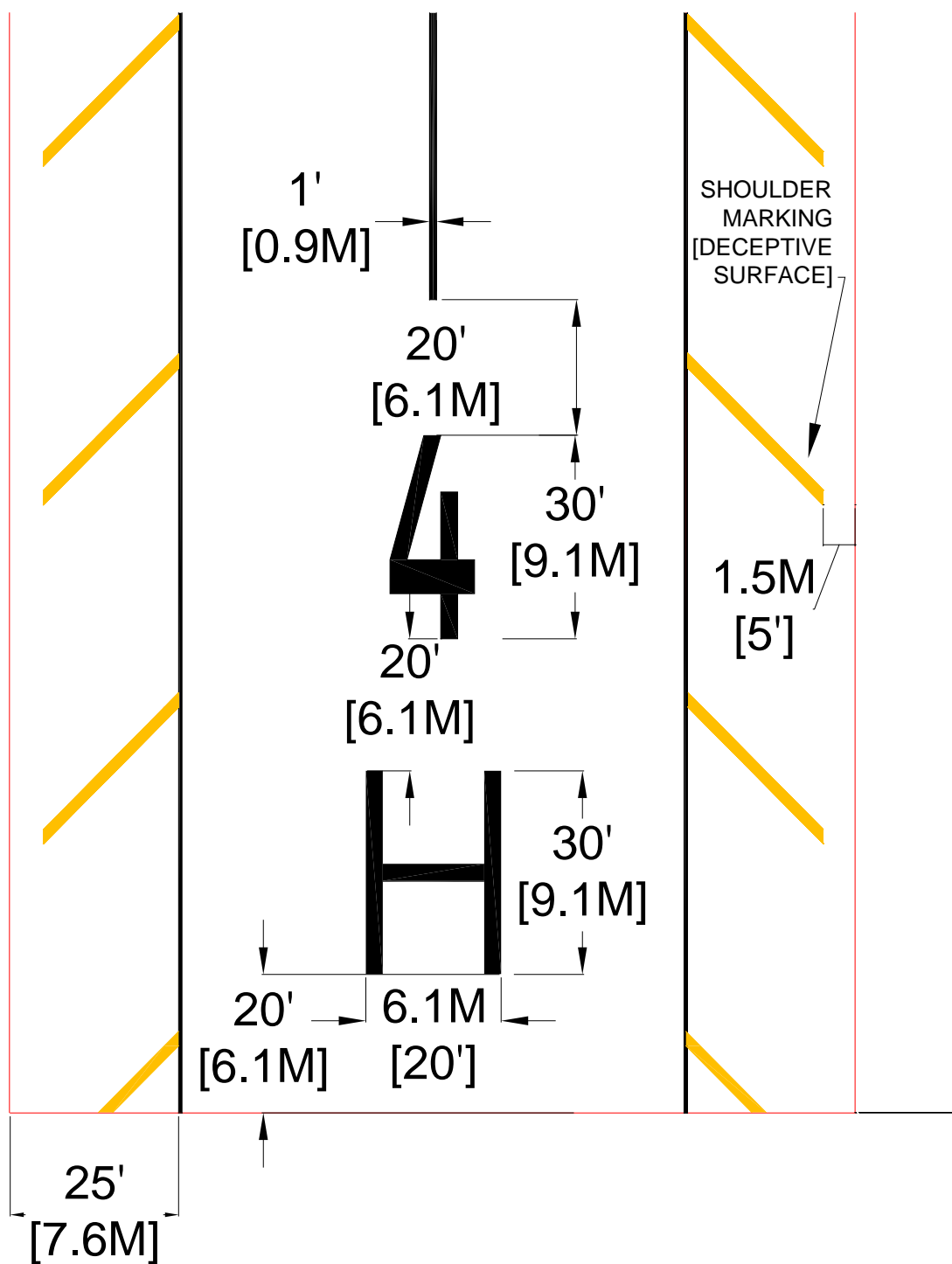
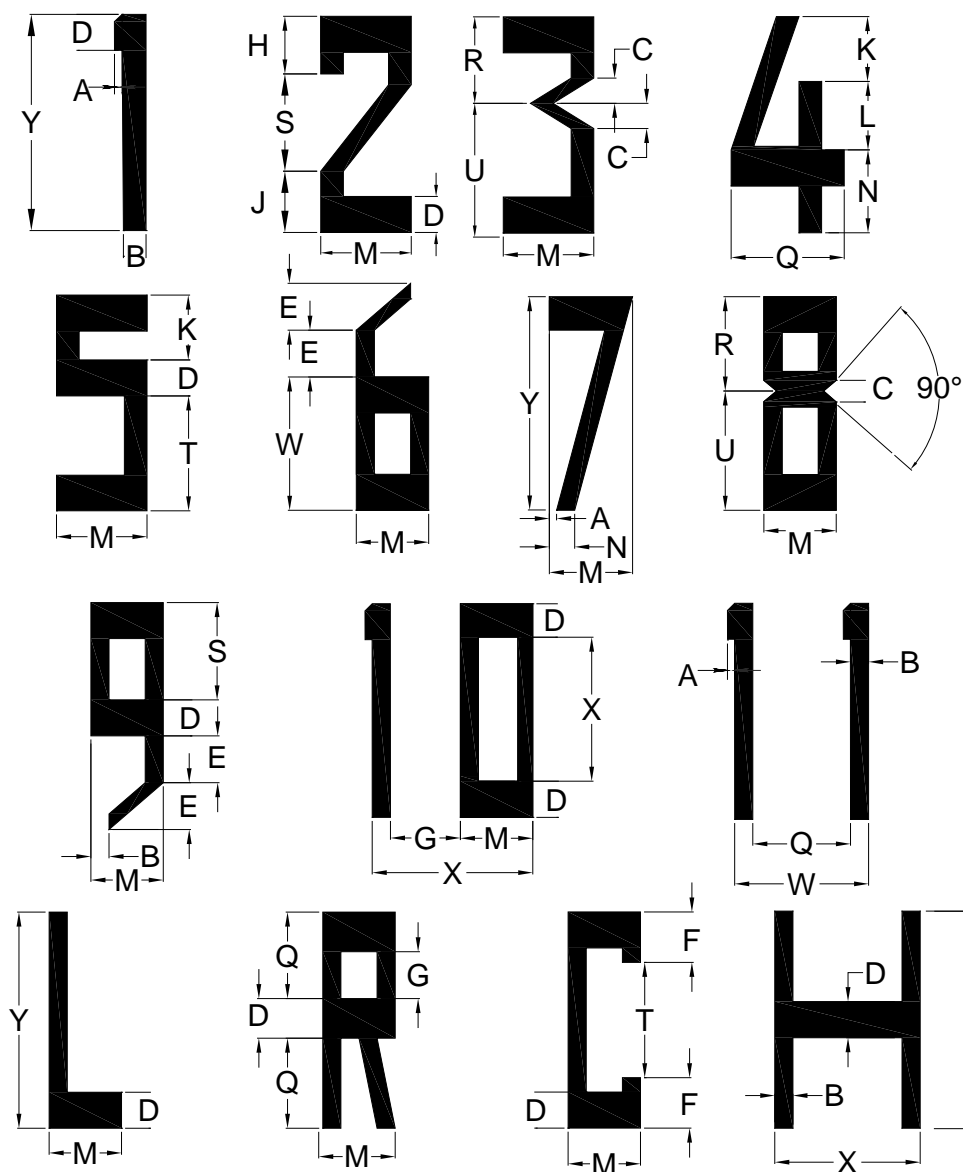


Figure 7-3. Rotary-Wing Runway Designation Numbers and Letters



DIMENSIO N	FEE T	METER S	DIMENSIO N	FEE T	METER S	DIMENSIO N	FEE T	METER S
A	1	0.3	J	8.5	2.6	R	13	4.0
B	2.5	0.76	K	9	2.7	S	13.5	4.1
C	3.5	1.1	L	9.5	2.9	T	16	4.9
D	5.0	1.5	M	10	3.0	U	17	5.2
E	6.5	2.0	N	11.5	3.5	V	18	5.5
F	7.0	2.1	O*	11	3.4	W	18.5	5.6
G	7.5	2.3	P	12	3.7	X	20	6.1
H	8.0	2.4	Q	12.5	3.8	Y	30	9.1

\* Not used.

## **7-7 TAXIWAY MARKINGS.**

### **7-7.1 Centerline Marking.**

Marking on serviceable taxiways consists of a centerline stripe and a holding line configured the same as for fixed-wing runways (see Chapter 5). The centerline stripe is a solid retro-reflective yellow line 6 inches (152 millimeters) in width. Where a taxiway and a runway have a common intersection, the centerline marking of the taxiway terminates at a point in line with the inside edge of the runway as shown in Figure 7-4.

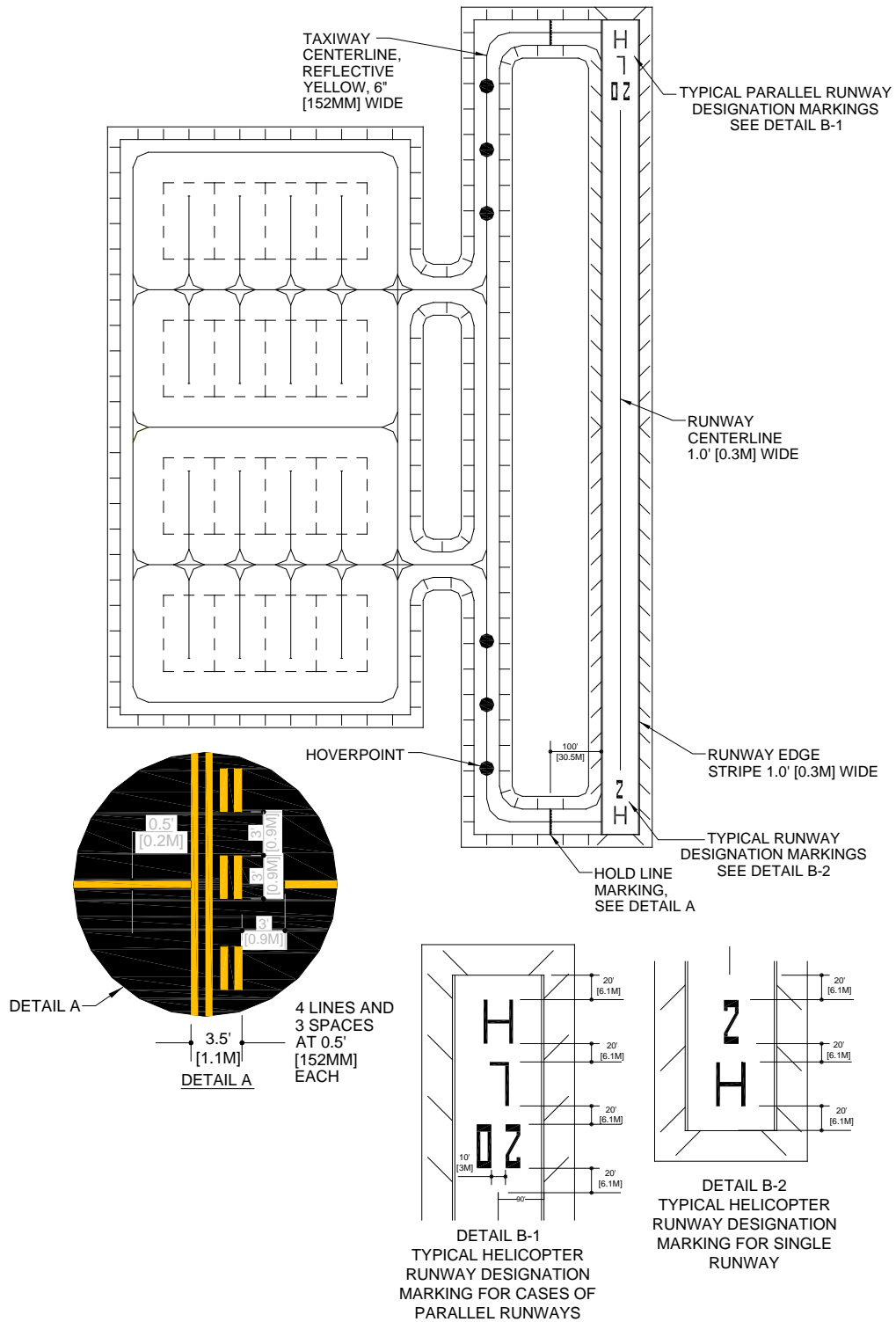
### **7-7.2 Hold-Line Marking.**

Provide hold position markings at appropriate locations to protect against incursions. The hold-line marking for VFR conditions is shown in Detail "A" of Figure 7-4 and is located 100 feet (30.5 meters) from the near edge of the adjacent runway. Also mark an instrument hold marking for runways or helipads provided with IMC landing aids. See paragraph 6-5.1.2 to determine if an instrument hold position is needed, and, if so, where. If any taxiways enter the helipad in the normal direction of approach or departure, place a holding position marking outside the clear zone so there is no potential penetration of the approach departure clearance surface by holding aircraft. See UFC 3-260-01 for applicable dimensions and imaginary surface slopes.

## **7-8 HOVERPOINTS.**

A hoverpoint is a surface used as a reference or control point for arriving and departing helicopters. Mark hoverpoints with a white circle 30 feet (9.1 meter) in diameter on class A airfields or heliports except when used for missile security or survival school or on asphalt surfaces where jet aircraft operate. On Class B airfields or Class A airfield/heliports used for missile security or survival school or on asphalt surfaces where jet aircraft operate, mark hoverpoints with a 30-foot (9.1-meter) -outside diameter circle formed with a 12-inch (305-millimeter) -wide white line. When located on a taxiway, the marking is centered on the taxiway centerline. See Figure 7-4.

Figure 7-4. Heliport Markings





## **7-9            APRON MARKINGS.**

Apron taxi centerlines are a solid yellow line 6 inches (152 millimeters) in width. Rotary wing parking positions are marked with dashed white perimeter lines 6 inches (152 millimeters) in width, and centering guidelines are 6-inch [152-millimeter] -wide solid yellow as shown in Figures 7-12, 7-13, 7-14 and 7-15. Other apron markings such as apron edge markings, deceptive surface (shoulder) markings, and closed or hazardous area markings are as shown in Figure 7-11 and Chapter 8.

## **7-10            HELIPADS.**

Mark a perimeter boundary with a capital "H" in the center to identify a pad intended for helicopter operations. Orient the "H" so it is aligned with the normal direction of approach (appears as an "H" to pilots during their approach to landing). If the facility is intended for single-direction ingress and egress, mark a bar beneath the "H" to show the intended direction of approach/departure. A bar is also placed under the "H" when it is necessary to distinguish the preferred approach direction for bi-directional helipads. The length of the bar is at least equal to the overall width of the "H" and the width equal to Dimension "C" in Figure 7-5. Provide a space between the "H" and the bar equal to half of the bar width. The perimeter boundary marking consists of a broken square marked at the corners and along the edges to delineate the limits of the safe touchdown area. The boundary is sized to accommodate the overall length of the largest helicopter using the facility. Figure 7-5 provides dimensions and layout details.

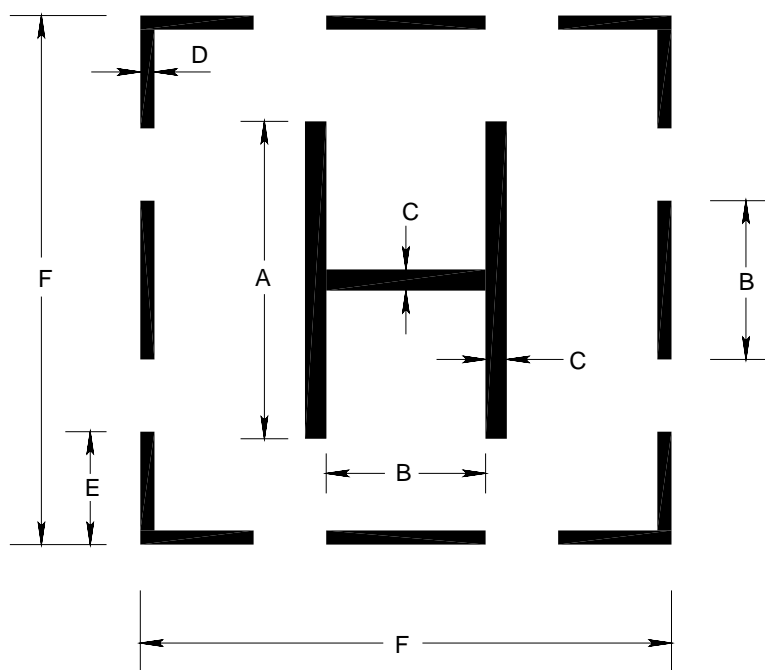
### **7-10.1          Hospital Helipad Markings.**

Medical facility helipads are marked similarly to standard helipads, with the following exceptions: the perimeter border is formed of a solid line and bordered in red, and the letter "H" is marked in red and superimposed on a white cross. Figure 7-6 shows the dimensions and colors for this marking scheme. The cross and pad boundary markings are white and outlined with a 6-inch (152-millimeter) -wide red border to improve contrast. Pad boundary markings are either a solid or segmented line as shown in Figure 7-5.

### **7-10.2          Elevated Helipad Markings.**

The markings are as shown in Figures 7-5 or 7-6, with two information boxes centered in the lower right-hand quadrant of the pad perimeter and oriented to be read in the preferred direction of ingress to the helipad. The boxes provide the maximum allowable helicopter weight expressed in thousands of pounds and the maximum allowable rotor diameter expressed in feet. Details for layout of the elevated helipad are shown in Figures 7-9 and 7-10.

Figure 7-5. Helipad Markings



IDENTIFIER DIMENSIONS

A : 0.6 F (maximum of 20 meters)

B : 0.5 A

HELIPAD SIZE (F)	PATTERN LINE WIDTH (C)	BORDER EDGE WIDTH (D)	CORNER EDGE LENGTH (E)
43.0 - 59 13.1 - 18.0	3.0 0.9	1.3 0.4	5.0 1.5
60.0 - 79.0 18.3 - 24.1	4.0 1.2	2.0 0.6	7.0 2.13
80.0 - 98.0 24.4 - 29.9	5.0 1.5	2.0 0.6	10 3.0
99 OR LARGER 30.2 OR LARGER	6.5 2.0	2.5 0.8	11.5 3.5

NOTE:

- DIMENSIONS IN TABLE ARE EXPRESSED AS;  $\frac{\text{FEET}}{\text{METERS}} \text{ e.g. } \frac{3}{10}$
- ALL COLOR IS NON-REFLECTIVE WHITE FOR U.S.ARMED FACILITIES, BUT RETRO-REFLECTIVE WHITE FOR USAF FACILITIES.

### Figure 7-6. Hospital Helipad Markings

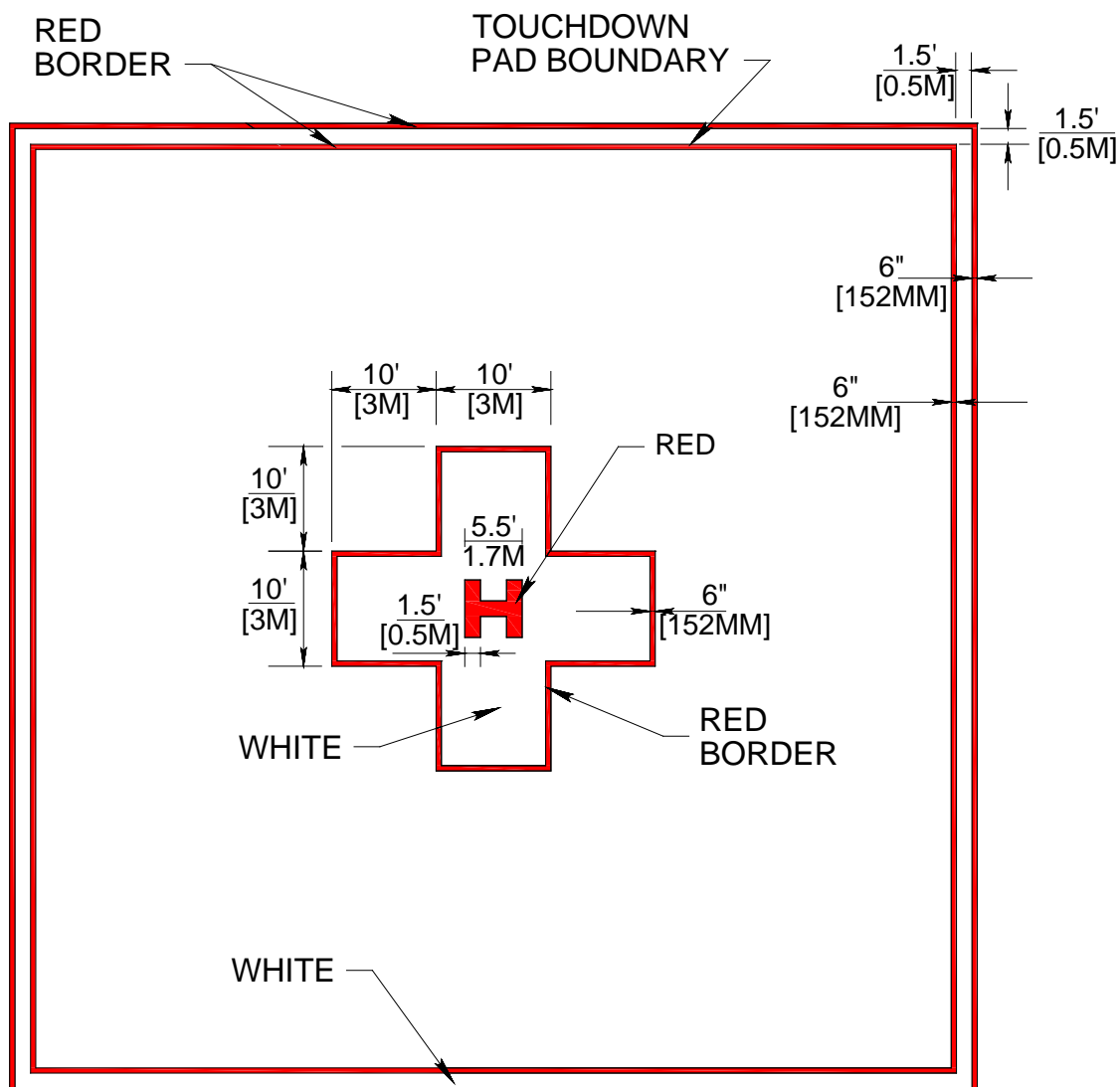


Figure 7-7. Landing Lane Layout

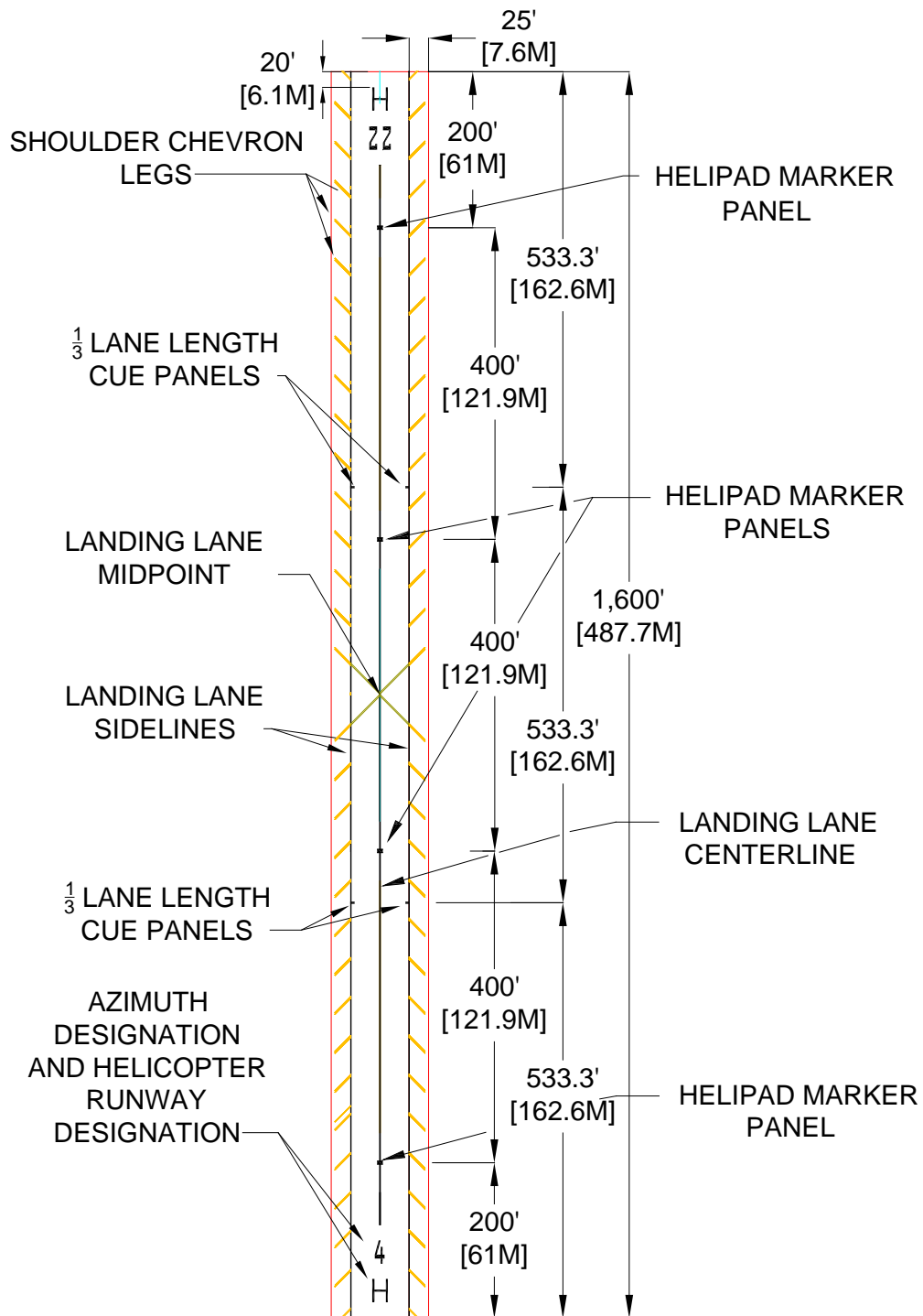


Figure 7-8. Landing Lane Helipad and 1/3rd Length Marker Panels

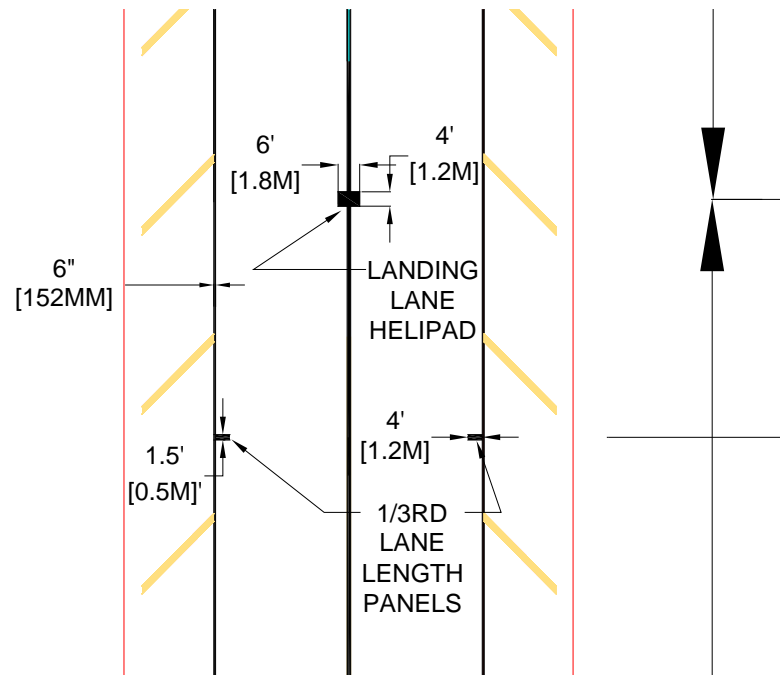


Figure 7-9. Elevated Helipad Example

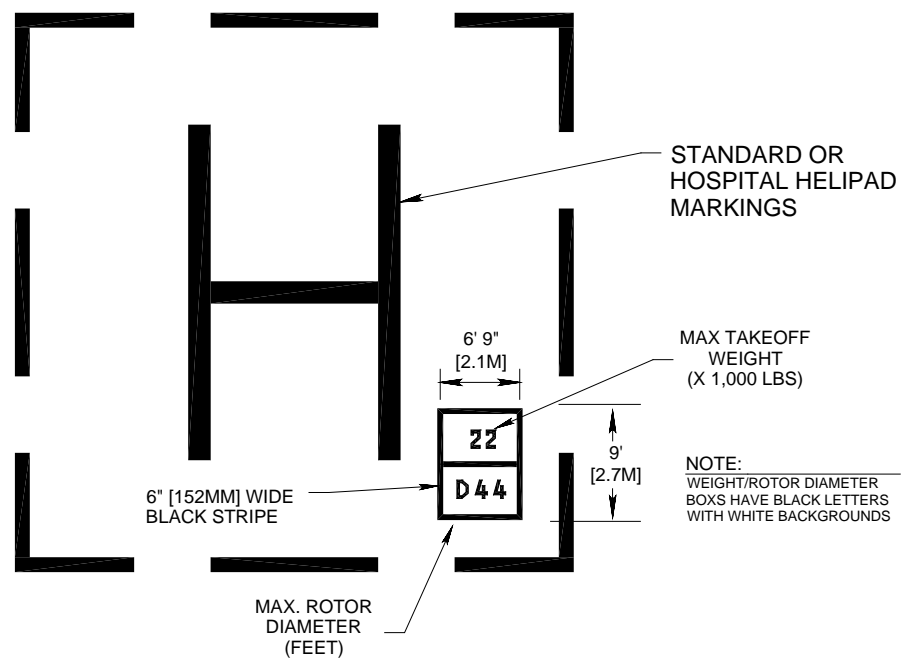
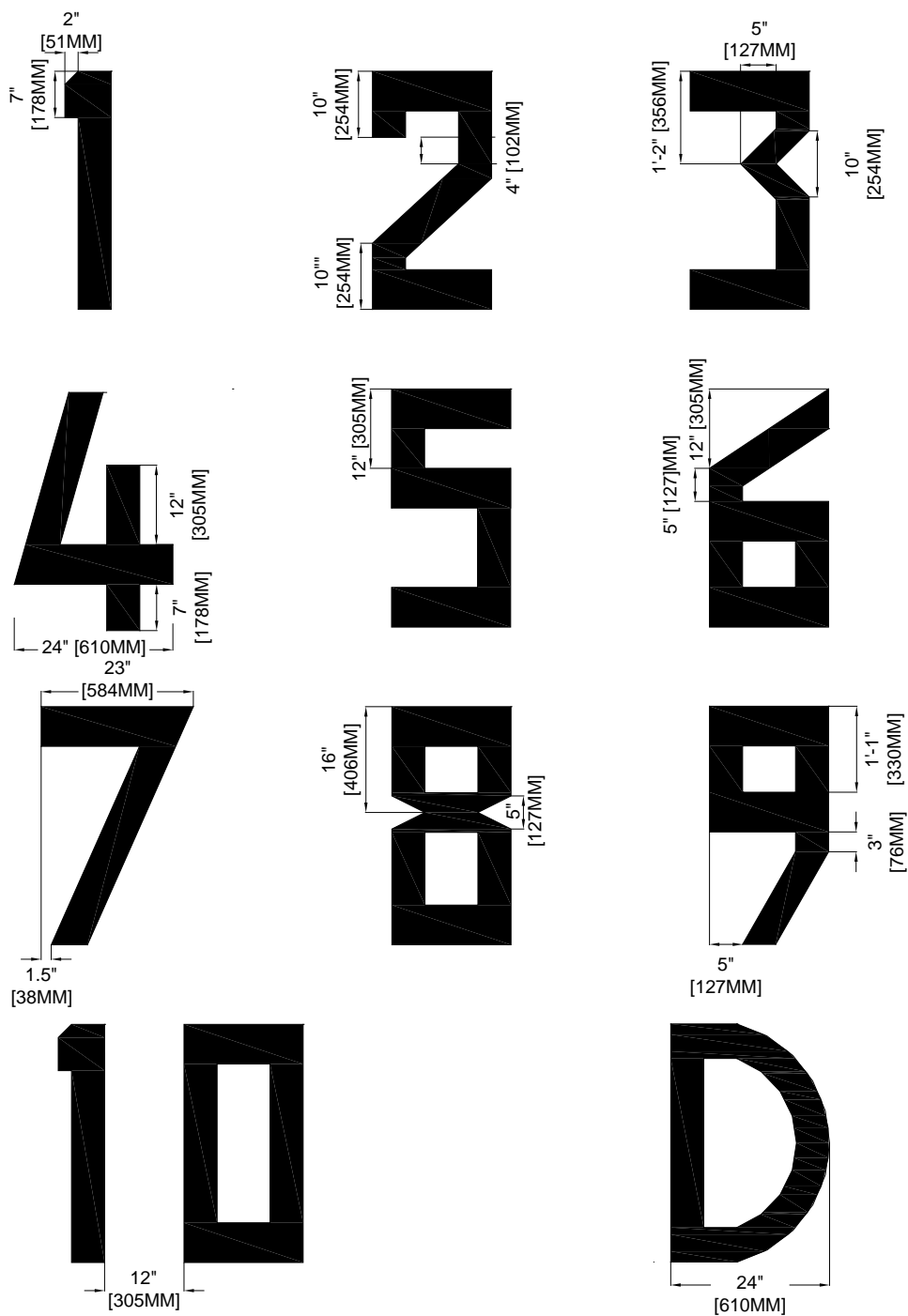


Figure 7-10. Dimensions for Supplemental Elevated Helipad Markings



ALL CHARACTERS HAVE THE FOLLOWING CHARACTERISTICS UNLESS SPECIFIED OTHERWISE:

36" [914MM] HEIGHT      VERTICAL STROKE OF 5" [127MM]  
18" [457MM] WIDTH      HORIZONTAL STROKE OF 6" [152MM]

### **7-10.3 Application.**

Rotary wing runway, landing lane, and helipad marking patterns, as appropriate, are used as an identification marker at all heliports, whether at ground level or elevated, and at helicopter takeoff and landing areas. All helicopter landing areas bearing the outdated day marker or nonstandard identification marking are re-marked with the proper identification marking as soon as practicable.

### **7-10.4 Location.**

The appropriate markings are placed in the approximate center of the touchdown area of all helicopter landing pads and on the ends of all helicopter runways and landing lanes.

## **7-11 OVERRUNS AND SHOULDER MARKINGS.**

### **7-11.1 General.**

Overrun and shoulder areas not intended for aircraft traffic are identified with overrun chevrons and shoulder (deceptive surface) markings. These markings consist of lines 18 inches (457 millimeters) wide, marked to within 5 feet (1.5 meters) of the shoulder edge, or for a total length of 25 feet (7.6 meters), whichever is less, in accordance with the requirements below. Configurations complying with these requirements are detailed in Figure 7-11.

### **7-11.2 Color.**

All heliport overrun and shoulder areas are marked with non-reflective yellow paint.

### **7-11.3 Materials.**

Non-reflective paint used in marking or re-marking overrun and shoulder areas consists of any of the materials described in Chapter 3.

### **7-11.4 Overrun Areas.**

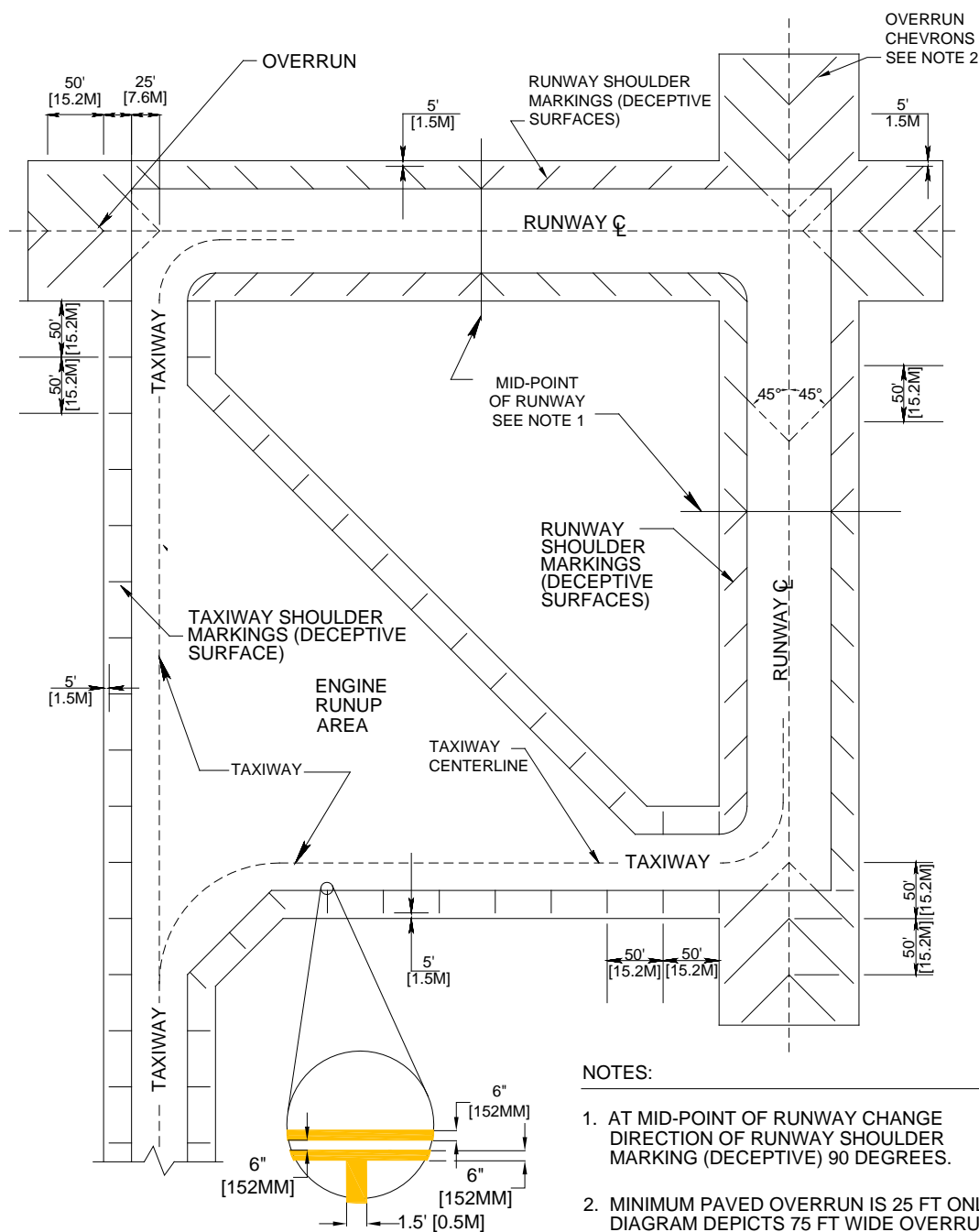
Overrun areas are identified with a chevron marking layout as shown in Figure 7-11. The index point for the layout of the chevron marking is the point of intersection of the runway centerline and the runway threshold line. The apex of the first full chevron on the approach side of the threshold is placed 25 feet (7.6 meters) outward from the index point. Subsequent chevrons are placed on 50-foot (15.2-meter) centers as shown in Figure 7-11. The portion of the partial chevron that overlaps the threshold is not painted on the full-strength pavement. The apex of each chevron is on the centerline, with each leg intersecting at an angle of 45 degrees with the runway centerline, and an unmarked extension of the runway centerline. The chevrons terminate 5 feet (1.5 meters) inside the outer paved edge of the overrun.

### **7-11.5 Runway Shoulder Areas.**

Shoulder areas are not intended for routine aircraft traffic. In cases where the surface does not provide sufficient differing contrast from the surrounding area, they are marked with shoulder (deceptive surface) markings as shown in Figure 7-11. Shoulder markings are a continuation of the chevron legs used in marking overrun areas described above. The chevrons used to form the legs are uniformly laid out from both ends of the runway as shown in Figure 7-11. Shoulder markings terminate at a length of 25 feet (7.6 meters) or at a point 5 feet (1.5 meters) inside the outer edge of the paved shoulder area.



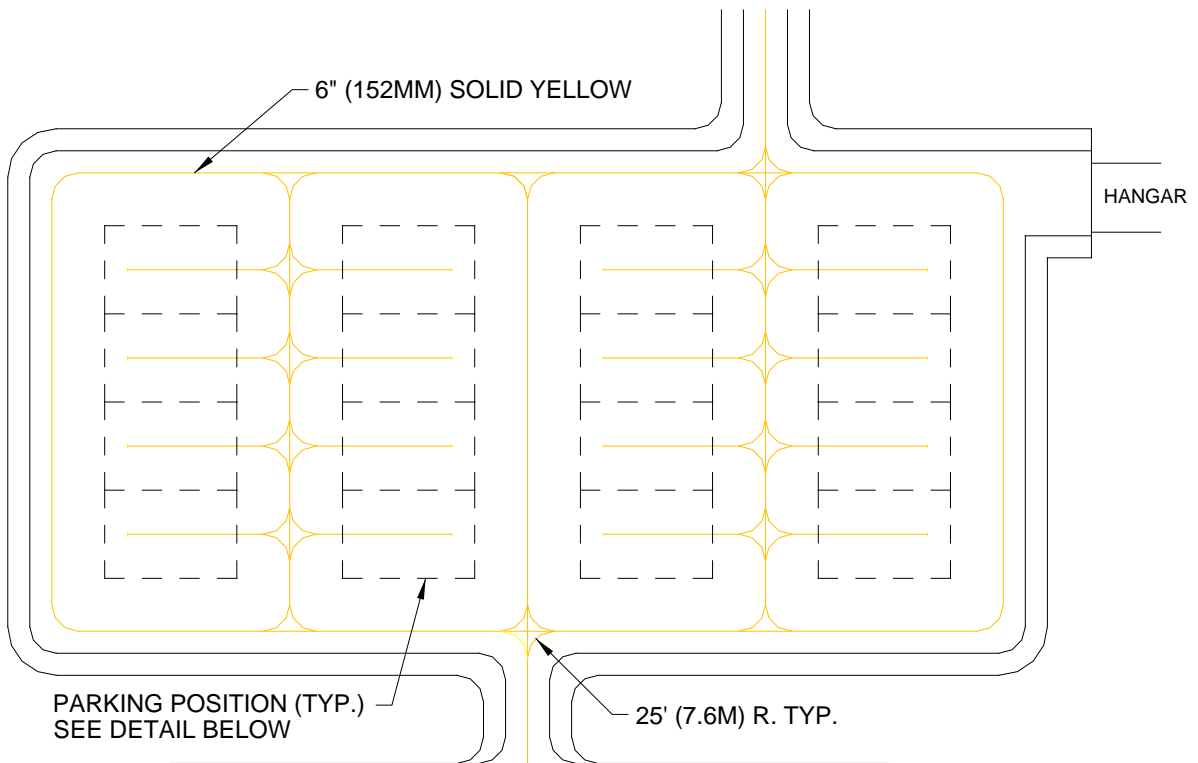
Figure 7-11. Rotary Wing Overruns and Shoulder Markings



NOTES:

1. AT MID-POINT OF RUNWAY CHANGE DIRECTION OF RUNWAY SHOULDER MARKING (DECEPTIVE) 90 DEGREES.
2. MINIMUM PAVED OVERRUN IS 25 FT ONLY. DIAGRAM DEPICTS 75 FT WIDE OVERRUN TO SHOW THAT CHEVRONS WOULD BE REQUIRED AND SPACED 15.2M [50'] BETWEEN CHEVRONS FOR OVERRUNS LARGER THAN THE MINIMUM.

Figure 7-12. Type 1 Parking for CH-47



TYPE 1 PARKING FOR CH-47

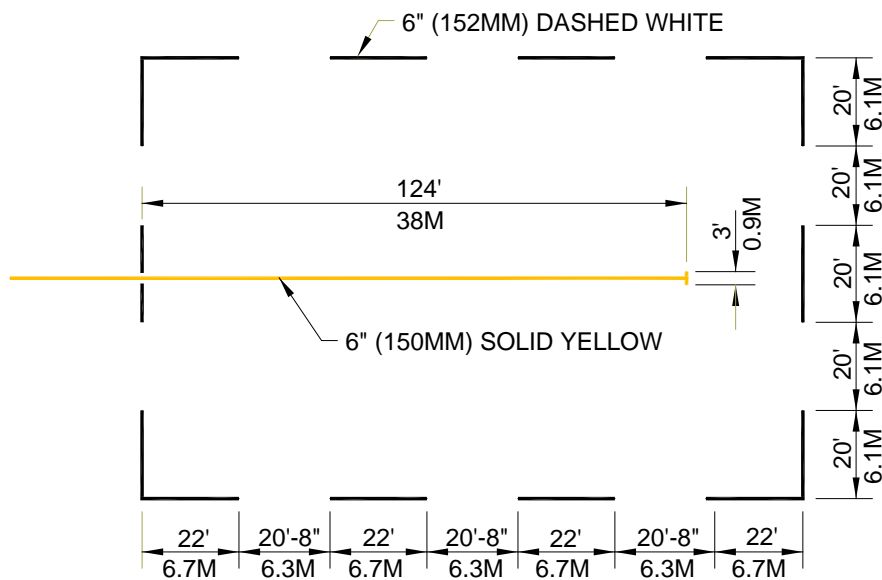
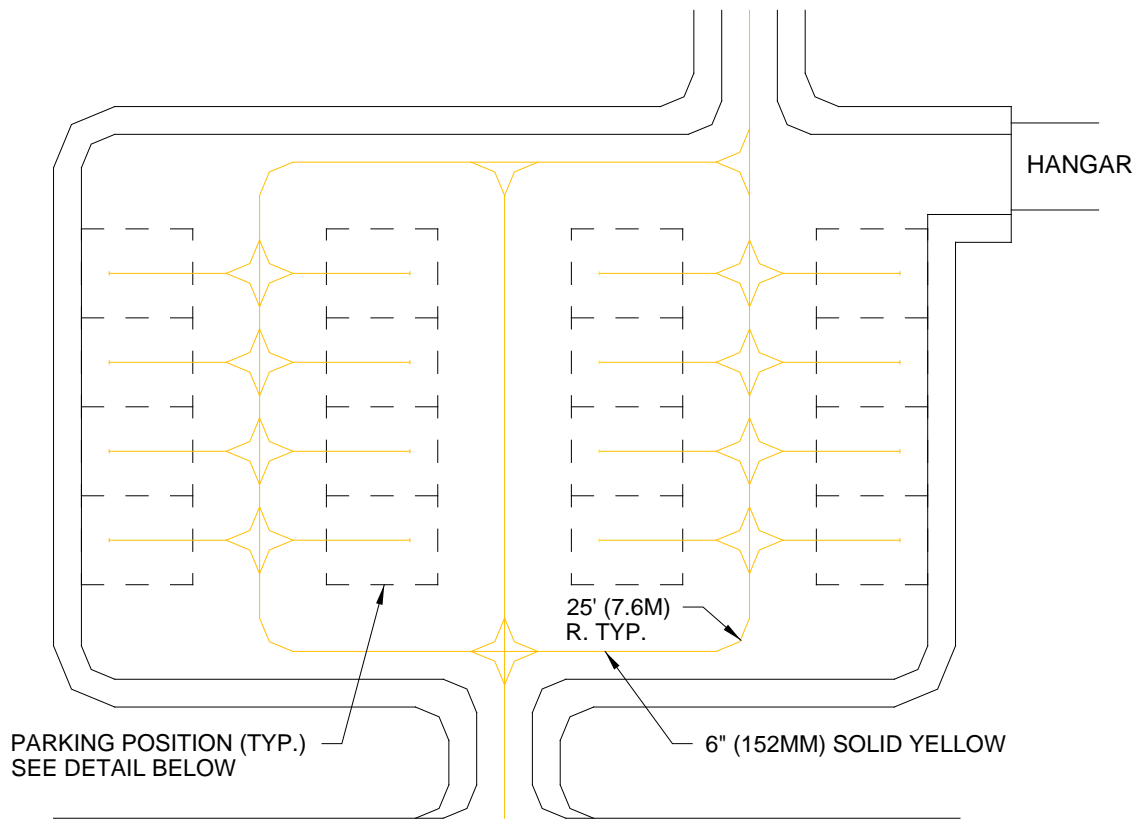
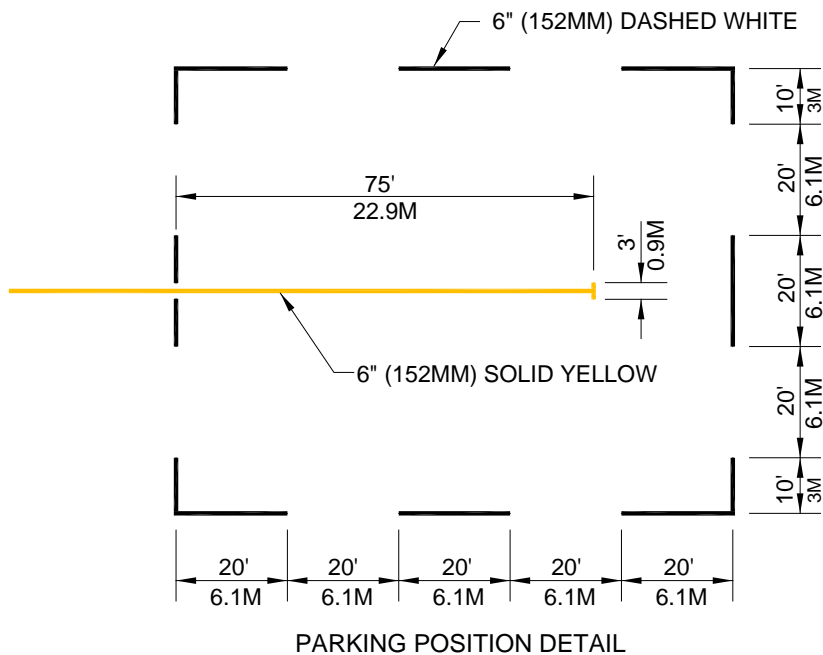


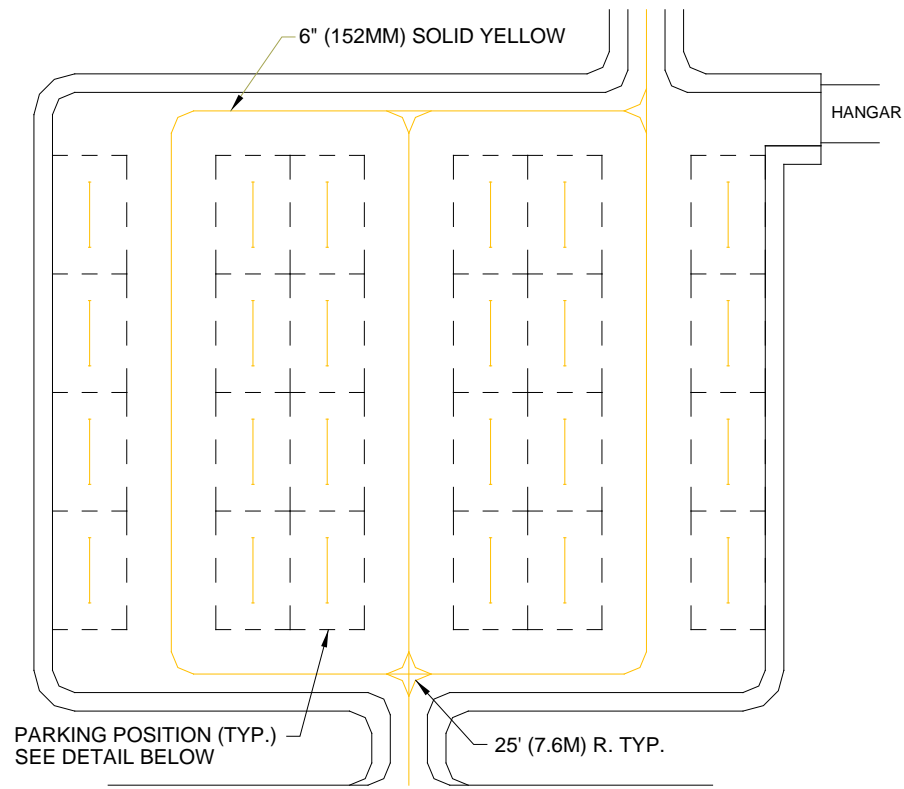
Figure 7-13. Type 1 Parking for all Rotary Wing Aircraft Except CH-47



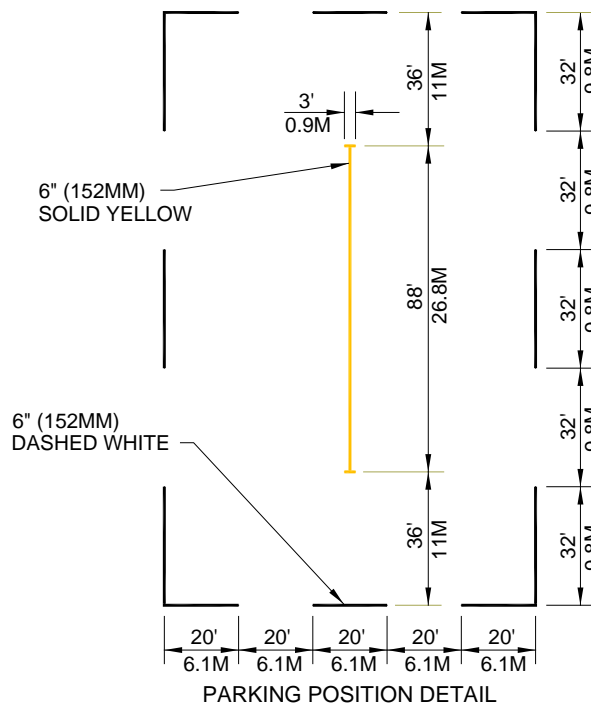
TYPE 1 PARKING FOR ALL ROTARY-WING AIRCRAFT EXCEPT CH-47



**Figure 7-14. Type 2 Parking for Wheeled Rotary Wing Aircraft**



**TYPE 2 PARKING FOR WHEELED ROTARY WING AIRCRAFT**





*This Page Intentionally Left Blank*

## CHAPTER 8 OTHER PAVEMENT MARKINGS

### 8-1 CLOSED PAVEMENT MARKINGS.

All pavements that are hazardous to aircraft traffic are marked with Xs. Larger ones are used for runways. Smaller Xs, with a slightly different angle where the two legs intersect, are used for taxiways and apron areas. Additional cones, barricades, and lights are used, or sometimes substituted for the Xs, to aid in delineation of substantially hazardous areas, areas that are only hazardous during construction, or some other special project, such as an air show. Refer to Figure 8-1 and Figure 8-2 for dimensions and layout details. The following paragraphs describe the placement of these markings and alternatives for temporarily closed areas.

### 8-2 PERMANENTLY CLOSED RUNWAYS.

Closed runways are marked to reflect their non-operational status. Ensure markings are visible to aircrew to avoid confusion and prevent mishaps that occur from attempting operations from a pavement of unknown condition or status.

#### 8-2.1 Runway Markings.

For permanently closed runways, obliterate the runway designation markings on both ends of the runway and mark a yellow "X" at each end of the runway and at 1,000-foot (305-meter) intervals along the length, centered on the runway centerline.

#### 8-2.2 Intersections.

For permanently closed runways that intersect an active runway, a solid yellow "X" marking is placed on the closed runway centerline, not more than 50 feet (15.2 meters) from the center of the X to the near paved shoulder edge of the open intersecting runway. See Figure 8-2 for an example.

### 8-3 PERMANENTLY CLOSED TAXIWAYS OR TAXILANES.

Obliterate the centerline stripe for a minimum of 200 feet (61 meters) from the nearest edge of any serviceable pavement and mark the taxiway or taxilane with an "X" within 25 feet (7.6 meters) of every intersection with any other serviceable pavement (measured from near outer paved shoulder edge of serviceable pavement to the center of the X), and along the taxiway or taxilane centerline at evenly spaced intervals not exceeding 1,000 feet (304.8 meters). Refer to Figure 8-1 for the dimensions of the Xs and Figure 8-2 for a typical layout and placement examples. Additionally, obliterate all extraneous taxiway markings from the adjacent serviceable pavements. For example, remove or hide any line or directional information signs or other markings delineating a route from an active runway to a closed taxiway.

## **8-4 PERMANENTLY CLOSED APRONS.**

When an apron is closed on an active airfield, taxilanes and taxiways leading to the closed area are marked as closed. If the closed apron area adjoins an active apron, supplemental markings are needed to indicate the division between the two areas. The separation is marked with two continuous apron edge stripes as described in Chapter 6 and shown in Figure 6-1. The letter "X," dimensioned as shown in Figure 8-1, is marked 3 feet (0.9 meter) inward toward the closed apron at intervals not exceeding 200 feet (61 meters) on the closed apron sides. Figure 8-3 shows the typical layout for these markings.

## **8-5 TEMPORARILY CLOSED AIRFIELD PAVEMENTS.**

### **8-5.1 Temporarily Closed Runways.**

Place an "X" at both ends of the runway on top of the runway designation number. For temporary purposes, the dimensions of the "X" shown in Figure 8-1 are reduced to allow use of standard 4-foot by 8-foot (1219-millimeter by 2438-millimeter) sheets of plywood.

**Note:** Runways closed for periods of five days or less do not need to be marked if a NOTAM is issued to publicize the closure. When temporarily closing a runway, Fabricate the "X" from plywood, canvas, painted picket fence sections, preformed marking tape, or other materials, such as yellow snow fencing. Anchor these materials by any suitable means, such as mechanical screw or wedge-type anchors, or sandbags. Another alternative is using lighted Xs as described in FAA AC 150/5340-1 and FAA AC 150/5345-55.

### **8-5.2 Temporarily Closed Taxiways or Taxilanes.**

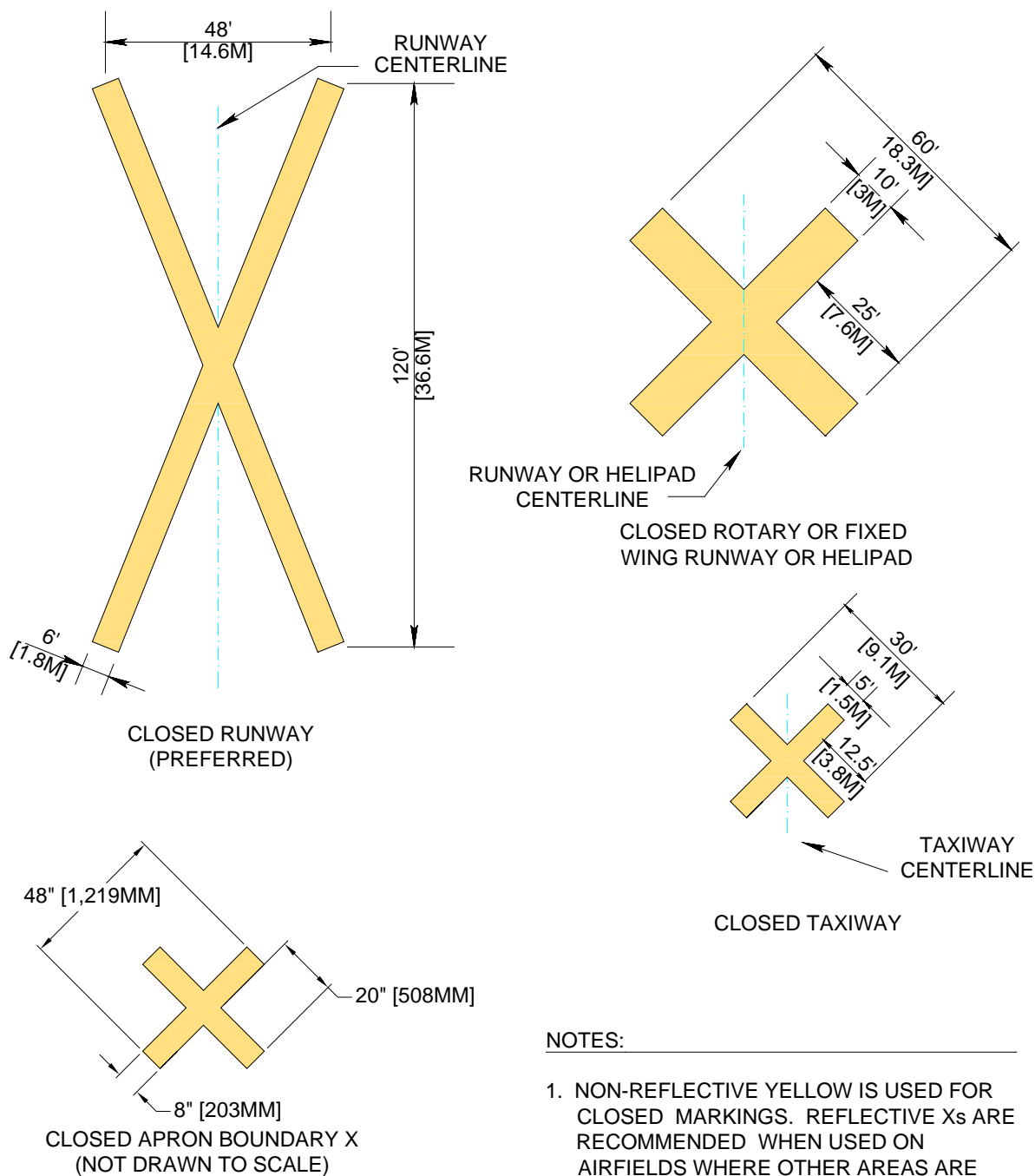
Ensure an "X" is placed at all access points to the closed pavement. In this case, it is not necessary to obliterate the existing markings. Areas used during periods of reduced visibility or darkness use lighted barricades to ensure the area is adequately marked. If lighted barricades are used to block the access point to the closed pavement, the "X" is omitted. See paragraph 8-6 and Figure 8-4. Use materials described in paragraph 8-5.1 to construct and fasten markers to the pavement.

### **8-5.3 Temporarily Closed Aprons.**

When an apron is closed on an active airfield, taxilane and taxiway centerline markings leading to the closed area are removed. However, hazardous areas on aprons caused by construction or other activities of a temporary nature are delineated using barricades or traffic cones equipped with a red light (see Figure 8-4). The lights are optionally steady burning or flashing but ensure they meet the luminance requirements of the FHWA MUTCD for safety zones. Lights are mounted on barricades and spaced at no more than 10-foot (3-meter) intervals. Lights are operated between sunset and sunrise and during periods of low visibility during operations. They are operated by photocell or manually. Solar-powered lights and light-emitting diode (LED) lights are acceptable as long as they meet the above-stated requirements.



Figure 8-1. Runway, Taxiway, and Apron Area Closure Markings



NOTES:

1. NON-REFLECTIVE YELLOW IS USED FOR CLOSED MARKINGS. REFLECTIVE Xs ARE RECOMMENDED WHEN USED ON AIRFIELDS WHERE OTHER AREAS ARE AVAILABLE FOR NORMAL OPERATIONS.
2. DIMENSIONS ARE SHOWN AS:  $\frac{\text{FEET}}{\text{METERS}}$  E.G.  $\frac{10}{3}$  EXCEPT WITHIN THE DIAGRAM FOR THE APRON BOUNDARY X.

Figure 8-2. Closed Runway, Taxiway, and Taxilane Pavement Markings

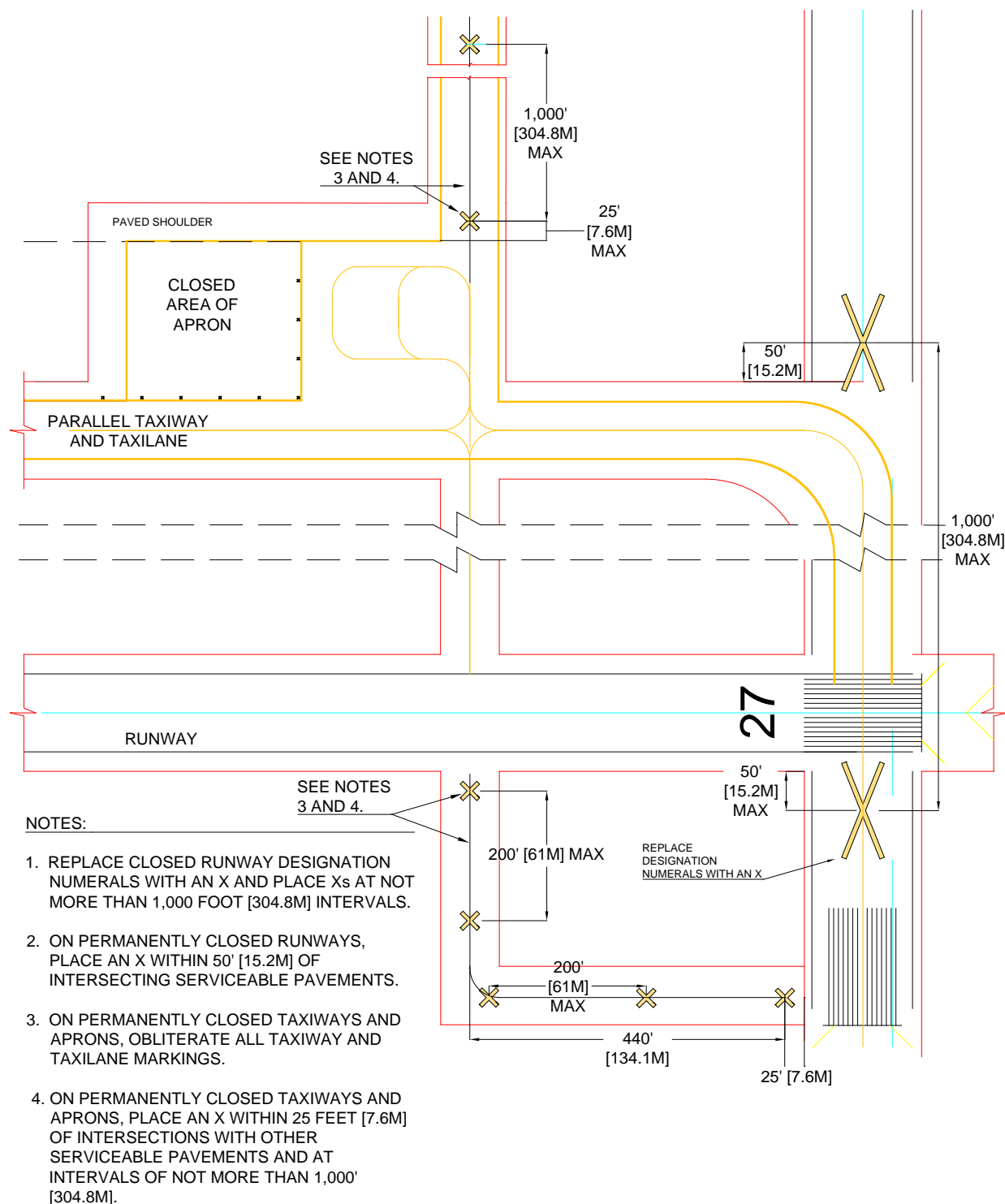
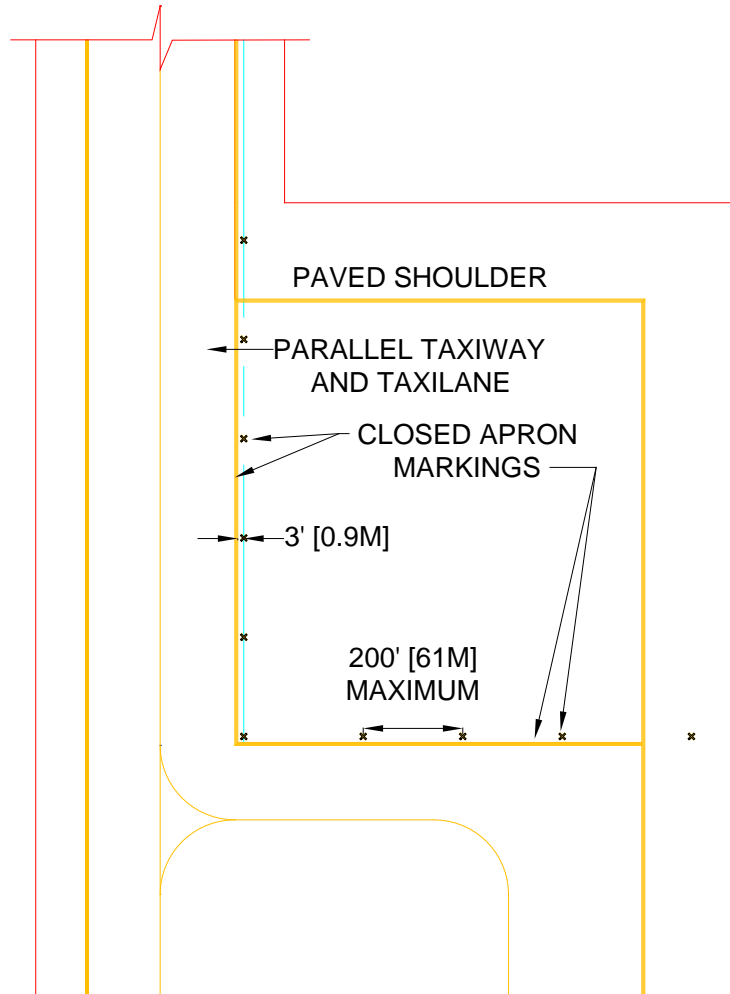


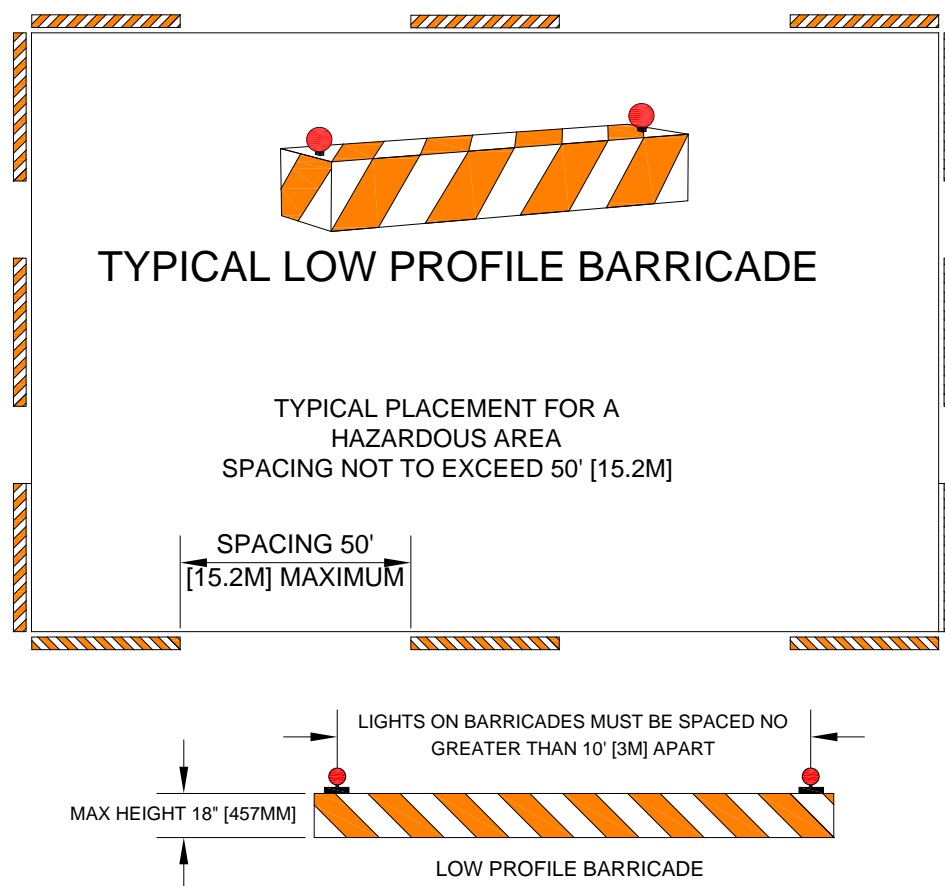
Figure 8-3. Placement of Permanently Closed Apron Pavement Markings



## 8-6 BARRICADES.

Where pavement markings do not provide adequate definitions of closed or hazardous areas, supplement the markings using retro-reflective orange and white barricades or traffic cones with securely fastened red lights aligned toward aircraft and vehicle ground traffic. All barricades and traffic cones are anchored or weighted to be heavy enough to remain in place during aircraft operations in near proximity. Ensure flashing lights are at least five candelas effective intensity and flash at a rate of from 55 to 160 flashes per minute. Ensure continuous burning lights have an effective intensity of 10 candelas. Low-profile barricades are the preferred method for marking construction areas. Examples are shown in Figure 8-4. Ensure lighted barricades used in close proximity to each other are all of the same type and colors. If flashing lights are used, ensure they have the same flash rates. Place barricades at maximum intervals of 50 feet (15.2 meters) and use dual barricades and lights on each corner and at the ends.

Figure 8-4. Low Profile Barricades



NOTES:

1. BARRICADES MAY NOT EXCEED 18" [457MM] IN HEIGHT (EXCLUSIVE OF SUPPLEMENTARY LIGHTS AND FLAGS) AND SHOULD BE SPACED TO PREVENT BREACH, BUT IN NO CASE GREATER THAN 50' [15.2M] APART. THEY MUST BE OF LOW MASS; EASILY COLLAPSIBLE UPON CONTACT WITH AN AIRCRAFT; AND WEIGHTED OR STURDILY ATTACHED TO THE SURFACE TO PREVENT DISPLACEMENT FROM JET BLAST OR OTHER WIND DISTURBANCE.
2. THE REQUIRED LIGHTS MUST BE RED AND MAY EITHER BE STEADY BURNING OR FLASHING. INTENSITIES AND LUMINANCE MUST BE AT LEAST FIVE CANDELAS EFFECTIVE INTENSITY AND FLASH AT A RATE OF FROM 55 TO 160 FLASHES PER MINUTE.
3. HAZARD LIGHTS MAY NOT BE SPACED GREATER THAN 10' [3M] APART.
4. LIGHTS MUST BE OPERATED BETWEEN SUNSET AND SUNRISE AND DURING PERIODS OF LOW VISIBILITY WHENEVER THE AIRPORT IS OPEN FOR OPERATIONS.
5. BARRICADES MAY BE SUPPLEMENTED WITH ALTERNATING ORANGE AND WHITE FLAGS AT LEAST 20" BY 20" (508MM BY 508MM) SQUARE.

## **8-7 NON-MOVEMENT AREA BOUNDARY MARKING.**

Non-movement area boundary markings are used to delineate the air traffic or ground radio-controlled movement area from the non-controlled movement area. This marking is used only when there is a need specified in the AOI or the letter of agreement between the airport operator and airport traffic control tower since they are sometimes misinterpreted as a holding position marking.

### **8-7.1 Location.**

Locate the non-movement area boundary marking on the boundary between the movement and non-movement area. To avoid confusing this marking with a VFR hold or intermediate hold position, do not place this marking to coincide with the edge of a taxiway.

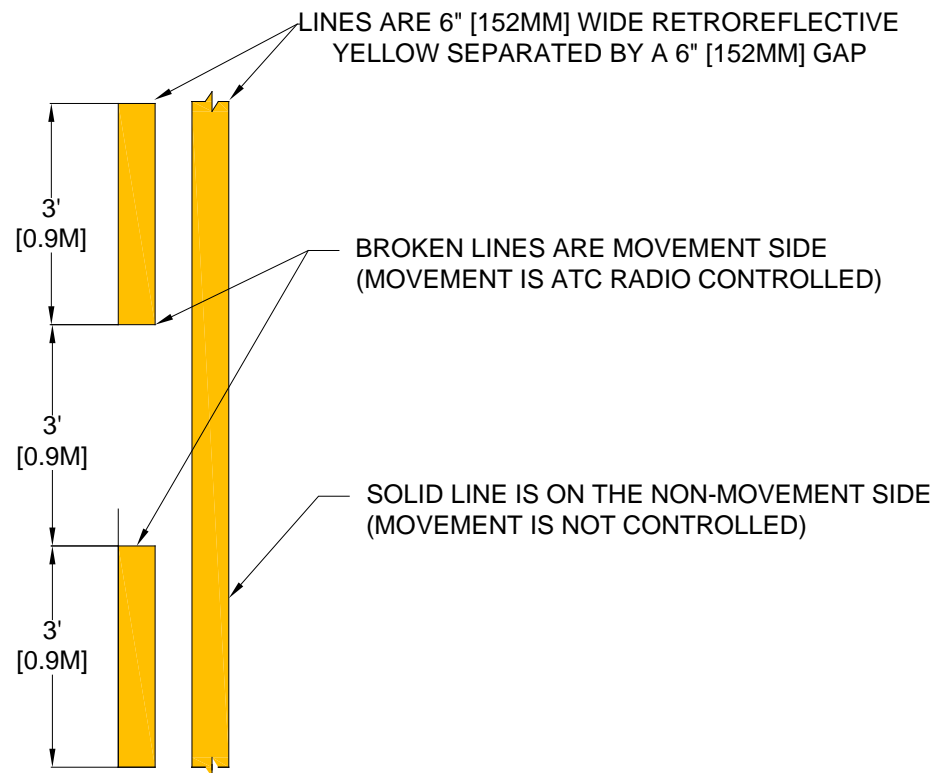
### **8-7.2 Layout.**

The non-movement area boundary marking consists of two retro-reflective yellow lines, one solid and one dashed, as shown in Figure 8-5. The solid yellow line is located on the non-movement (or non-radio controlled) area side; the dashed yellow line is located on the movement (air traffic control/ground control-supervised and radio-controlled) area side. Each line is 6 inches (152 millimeters) in width, with a 6-inch (152-millimeter) gap between the lines. The width of the lines and spaces are optionally doubled to 12 inches (305 millimeters). The dashes are 3 feet (0.9 meter) in length with a 3-foot (0.9-meter) gap between dashes. If a taxiway centerline intersects a non-movement area boundary marking, the taxiway centerline is interrupted 6 inches (152 millimeters) from the solid line (movement area side) and 3 feet (0.9 meter) from the dashed line (non-movement area) side.

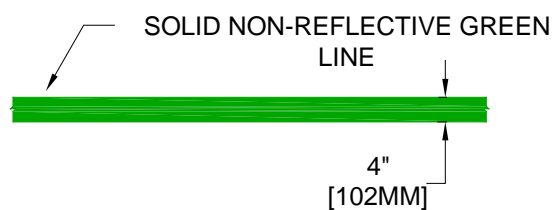
## **8-8 OBSTRUCTION CLEARANCE LINE.**

On Class A airfields, heliports, or aprons servicing only rotary wing aircraft, and where needed, an obstruction clearance line is marked to delineate an apron lateral clearance area as defined by UFC 3-260-01. The line is placed to prevent fixed and mobile objects (e.g., maintenance vehicles, equipment, and storage bins) from being located where they encroach into the required apron lateral clearance distance. The obstruction clearance line consists of a single solid green non-reflective line 4 inches (102 millimeters) wide. The obstruction clearance line is not painted within the usable portion of the apron or on portions of the airfield traversed by aircraft under their own power such as runways, vertical landing pads, helipads, overruns, hoverpoints, taxiways, taxi-lanes, warm-up pads, arm/de-arm pads, hot cargo pads, hot refueling areas, forward arming and refueling pads, compass calibration pads, trim pads, engine run-up or engine check pads; however, it might be painted at or near hangar entrances and exits. See Figure 8-5 for obstruction clearance line details. An obstruction clearance line is not required at installations which ensure the apron lateral clear areas are accessed only by personnel trained on proper placement and movement of equipment, materials, and structures on active airfield pavements and which do not bring or leave such materials, equipment, or structures unattended or without informing the airfield managers and controllers and restricting aircraft movement in the area.

**Figure 8-5. Non-Movement Area Boundary and Obstruction Clearance Line Markings**



## NON-MOVEMENT AREA MARKING



## OBSTRUCTION CLEARANCE LINE

## **8-9 DECEPTIVE SURFACES (SHOULDER MARKINGS).**

Shoulders and other areas of airfield pavements that are not intended for aircraft traffic but have the appearance of operational pavement are marked as deceptive surfaces. Use deceptive surface markings when the paved shoulder width exceeds the standard dimension given in UFC 3-260-01 or if experience shows there is a lack of definition between the full-strength pavement and shoulders. **Note:** If there is a significant gap between the deceptive surface markings and the runway side stripe (such as occurs when side stripes are spaced at a 144-foot [43.9-meter] separation on a 300-foot [91.4-meter] -wide runway), double 6-inch (152-millimeter) -wide yellow stripes separated by a 6-inch (152-millimeter) -wide gap are optionally added to the inner ends of the deceptive surface markings to longitudinally delineate the limit of the load-bearing pavement. Place the outer edge of the outermost stripe to coincide with the outer edge of the full-strength pavement and the inner end of the deceptive surface marking. These stripes are curved to follow the outer radius of fillets and terminated at the intersecting taxiway edge, or joined to taxiway edge markings, where used.

## **8-10 RUNWAY SHOULDERS.**

Mark deceptive surfaces on the edges of runways with diagonal stripes as shown in Figure 8-6. The stripes are uniformly laid out from each end of the runway to the midpoint, reversing direction at the midpoint. Begin the measurement for spacing at the initial overrun chevron apex. Stripes are located so the inner edge of the marking is coincident with the edge of the full-strength pavement and the stripe extends to within 5 feet (1.5 meters) of the outer pavement edge or for a length of 25 feet (7.6 meters), whichever results in the shorter length line.

## **8-11 TAXIWAY AND APRON SHOULDERS.**

Mark deceptive surfaces on the edges of taxiways and aprons with perpendicular stripes as shown in Figure 8-7. These markings consist of a series of 3-foot (0.9-meter) -wide stripes positioned perpendicular to the edge markings. On curves, a stripe is placed at each point of tangency and intermediate stripes are spaced uniformly up to 30 feet (9.1 meters) apart. Stripes are placed so the inner edge of the marking is coincident with the edge of the full-strength pavement.

## **8-12 VEHICULAR ACCESS MARKING.**

Mark vehicular access routes according to the FHWA MUTCD. Additionally, ensure all vehicular access roads leading to a movement area or taxiway/taxilane are marked with a white "stop" bar. See paragraph 4.5.

## **8-13 INERTIAL NAVIGATION SYSTEM (INS) CHECKPOINT MARKINGS.**

INS checkpoint markings are provided to allow data input or calibration of the aircraft INS. Contrasting colors are used for the border, numerals, and letters. A record of actual coordinates is normally maintained by base operations flight data, transient alert, and maintenance control. Figure 8-8 shows a typical layout scheme. Suggested locations are nose wheel parking spots on aprons and ramps; engine run-up areas

adjacent to runway ends; hammerheads; or taxiway and apron holding positions. **Note:** For Air Force installations, survey support for NAVAIDs and INS checkpoints are coordinated with base and MAJCOM mapping, charting, and geodesy offices, according to AFI 14-205.

#### **8-14 GROUND RECEIVER CHECKPOINT MARKINGS.**

Identify instrument navigation checkpoint markings such as VHF omni range (VOR) and tactical air navigation (TACAN) markings as shown in Figure 8-8. Where directional alignment of the aircraft is required, paint a 6-inch (152-millimeter) -wide line through the center of the circle that extends outside the circle aligned toward the transmitter. Terminate the line with an arrowhead. Black or white paint is used to contrast this marking, as required. If the checkpoint marking conflicts with a taxiway centerline, interrupt the taxiway centerline 3 feet (0.9 meter) on either side of the checkpoint marking. A supplemental sign is required for the checkpoint marking; see UFC 3-535-01 for size, lettering, and placement. **Note:** For Air Force installations, survey support for NAVAIDs and INS points are coordinated with base and MAJCOM mapping, charting, and geodesy offices, according to AFI 14-205.



Figure 8-6. Runway Shoulder Markings (Deceptive Surfaces)

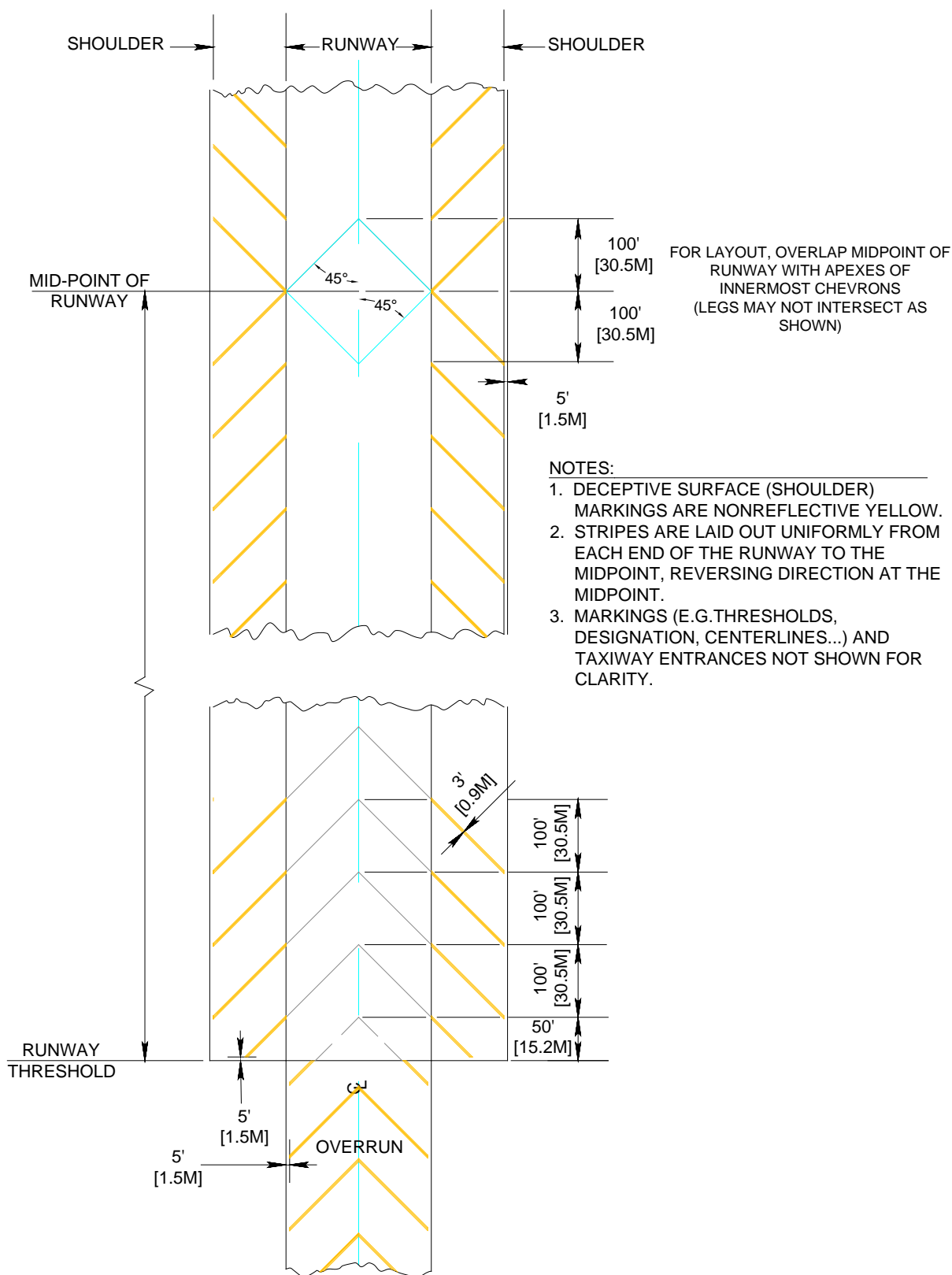


Figure 8-7. Taxiway and Apron Shoulder Markings (Deceptive Surfaces)

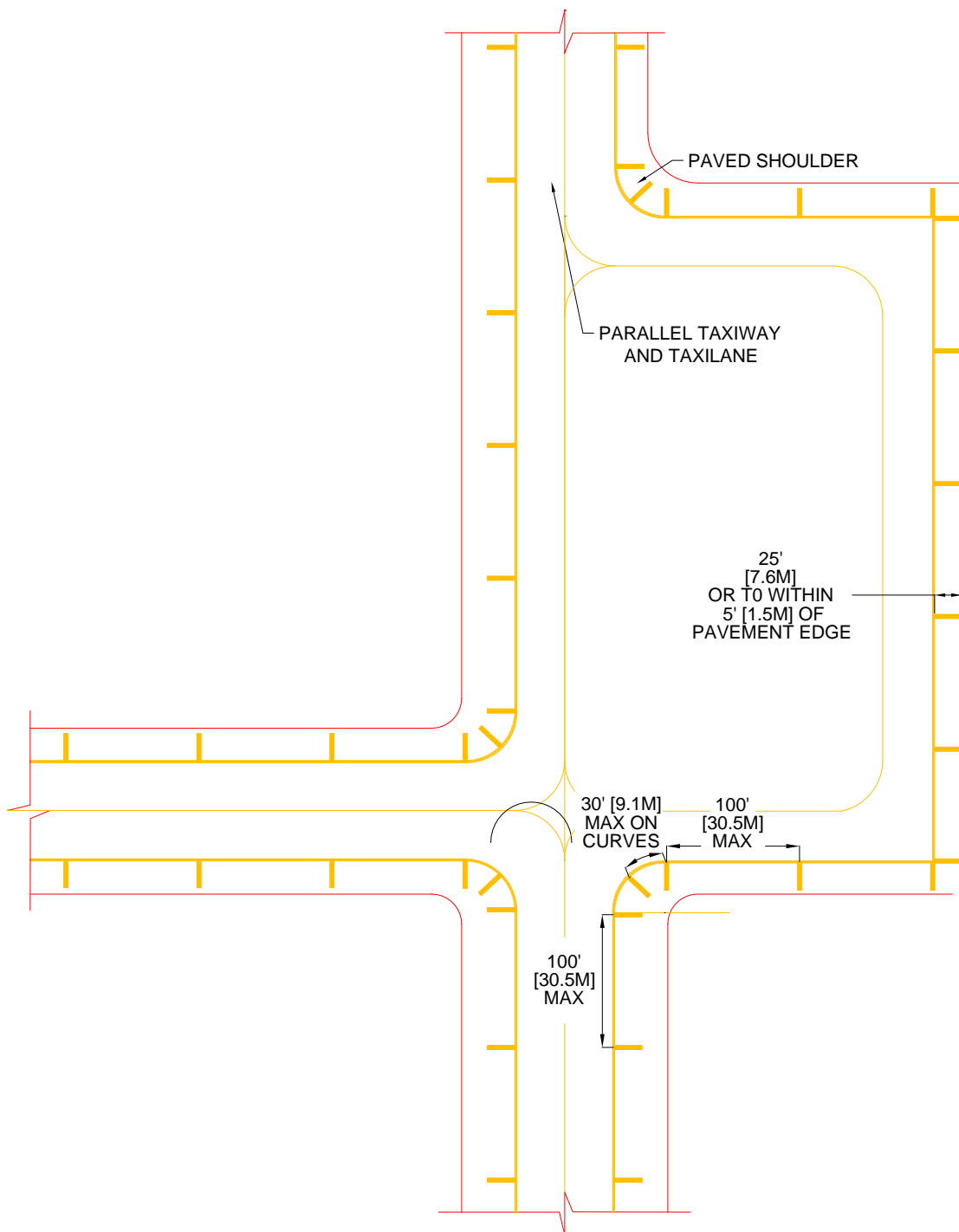
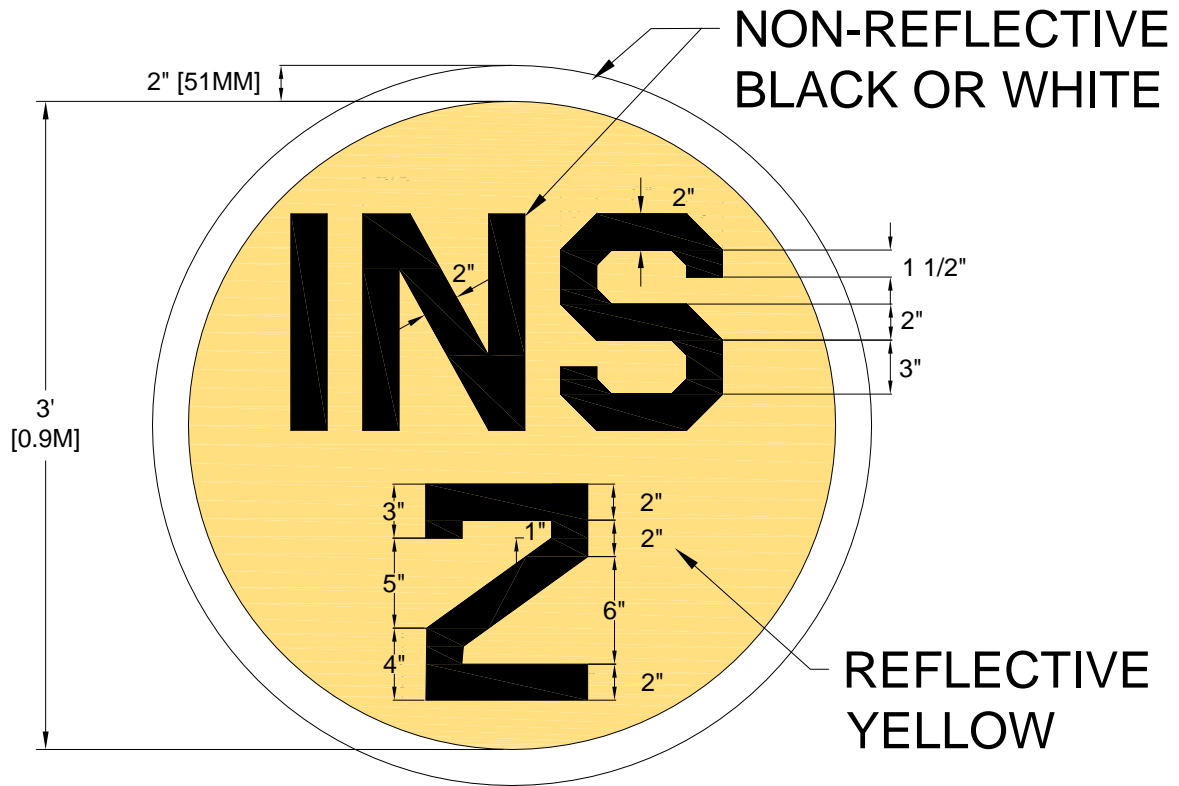
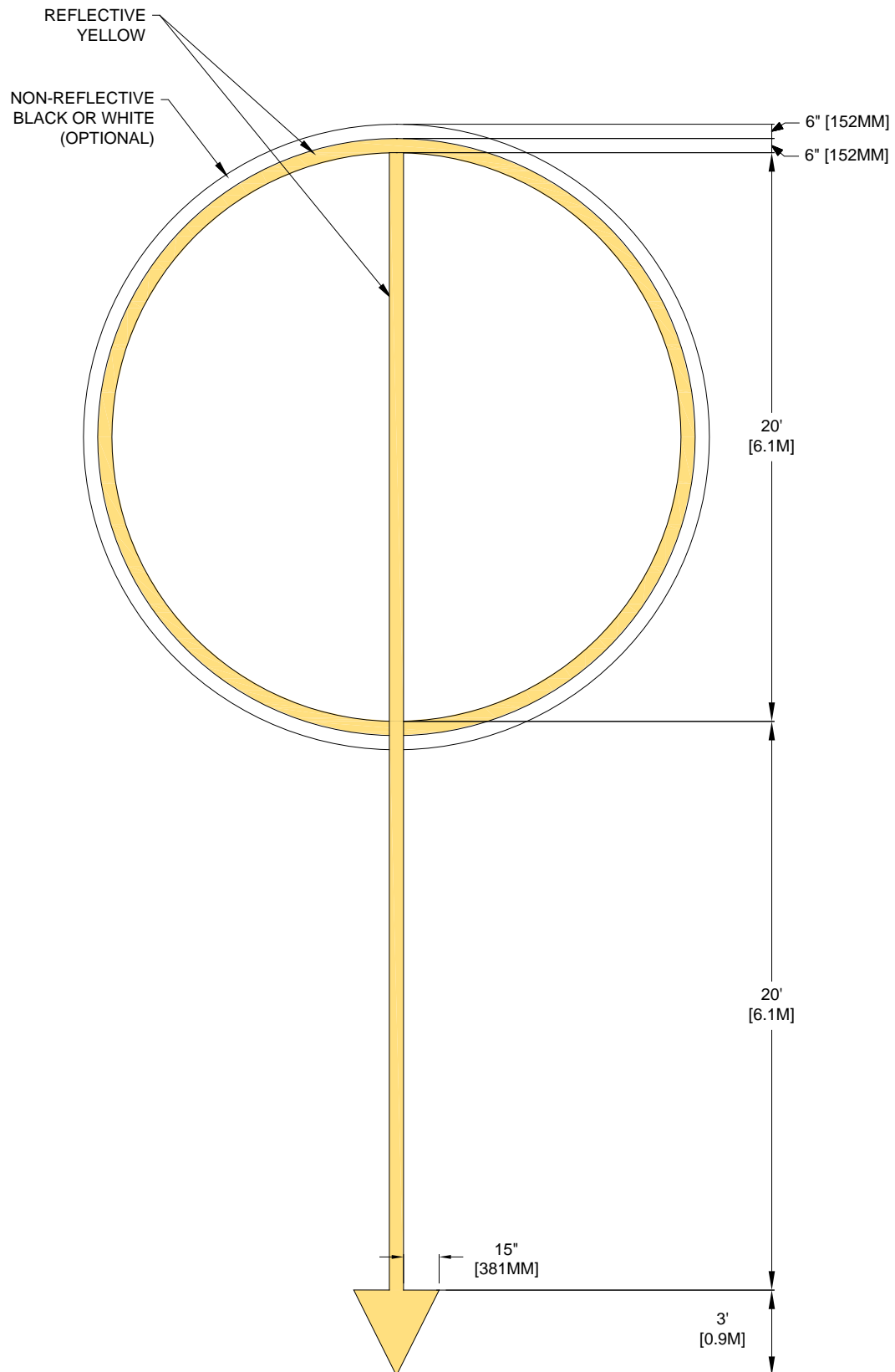


Figure 8-8. Typical Inertial Navigation System Marking



MULTIPLY BY 25.4 TO CONVERT INCHES TO MILLIMETERS

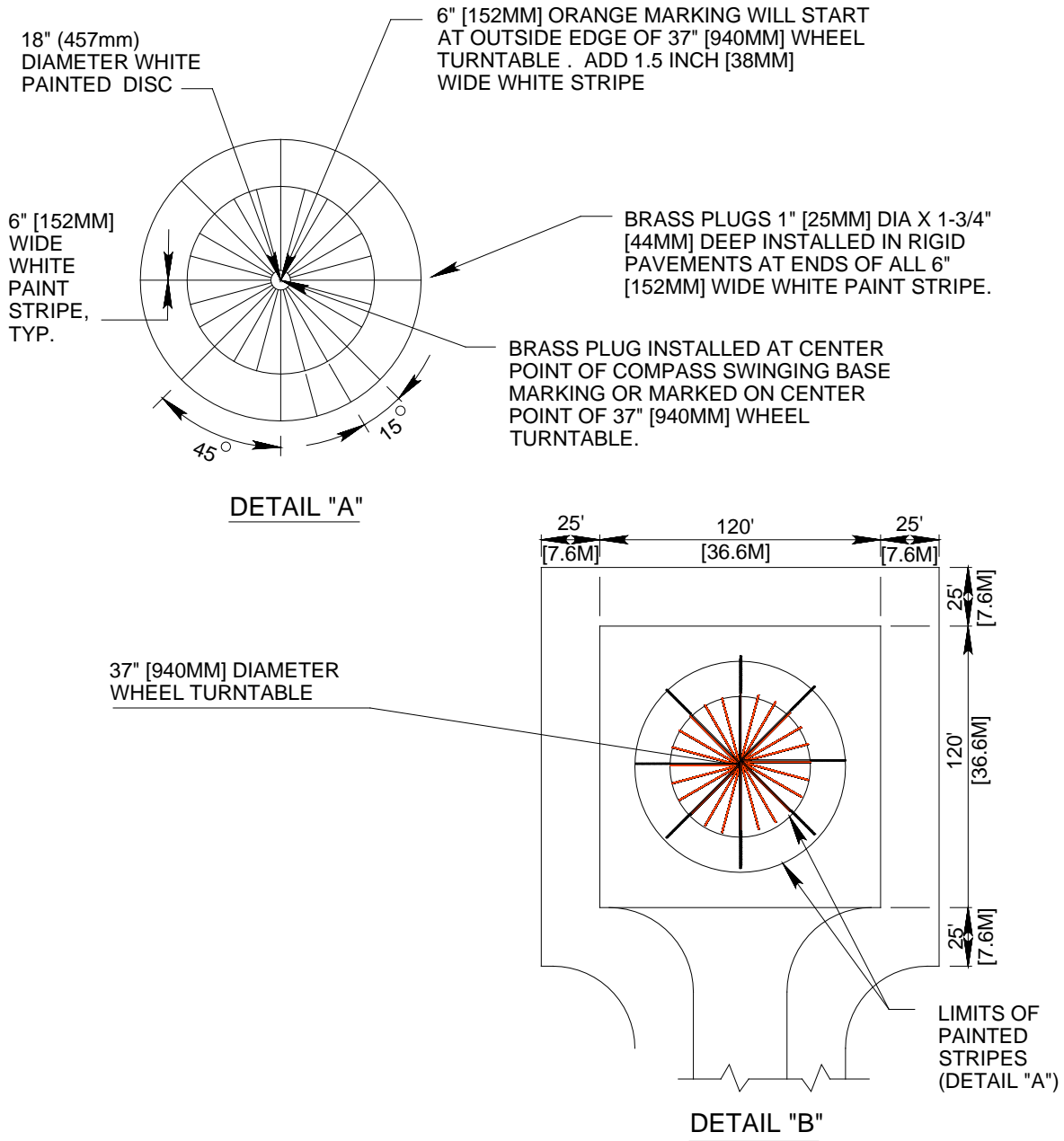
**Figure 8-9. Ground Receiver Checkpoint (Directional)**



**8-15 COMPASS CALIBRATION PAD (CCP) MARKINGS.**

Compass swinging bases are established in accordance with UFC 3-260-01, Chapter 6 and Appendix B10. Mark CCPs in accordance with the applicable aircraft maintenance Technical Order (T.O.), considering primarily the most demanding aircraft that are serviced on the apron. If aircraft are serviced which do not require a specific marking within the T.O., optionally use either the more restrictive criteria provided in UFC 3-260-01 and described below or the general guidelines for compass calibration pads in FAA AC 150/5300-13 for Class B airfields; otherwise, use the criteria described below. Swinging bases for aligning aircraft for the precise calibration of all types of air navigation equipment are marked as shown in Figures 8-10 and 8-11. The stripes are set at magnetic directions from the corresponding true compass rose control point at every 15 degrees (15°). A 6-inch (152-millimeter) -wide orange stripe is painted for each of the 24 compass rose control points. These stripes begin at the center of the pad and extend outward for a minimum length of 25 feet (7.6 meters). Border each stripe with a 1.5-inch (38-millimeter) -wide white stripe. At a distance of 27 feet (8.2 meters) from the center of the pad, identify the azimuth of each stripe as measured from magnetic north with 24-inch (610-millimeter) -high by 15-inch (381-millimeter) -wide orange block numerals (Figure 8-11). All azimuth numbers contain three numerals (e.g., 045). The stroke of each numeral is a minimum of 3.5 inches (89 millimeters) wide. Each azimuth number is painted on a solid white background formed from a rectangle 26 inches (660 millimeters) high by 51 inches (1,295 millimeters) wide.

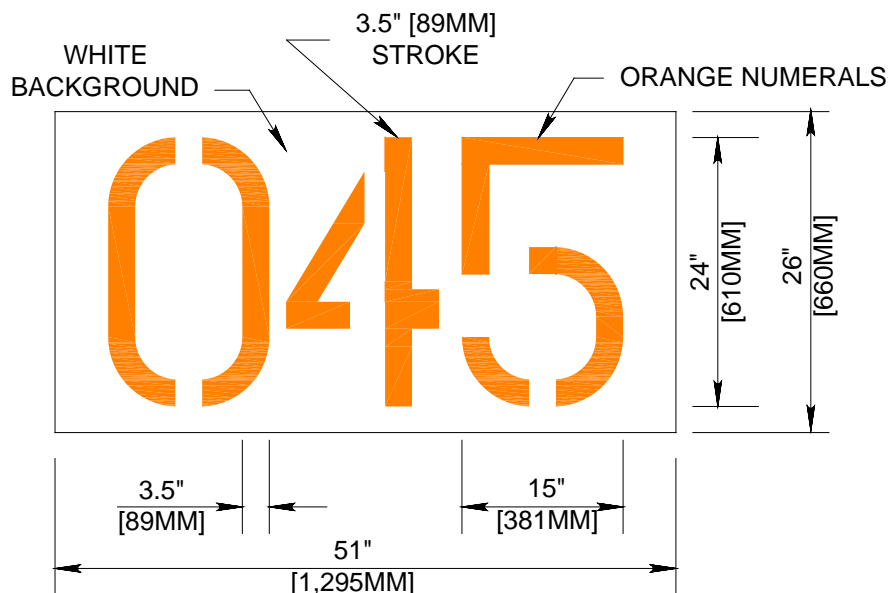
**Figure 8-10. Compass Calibration Pad Markings**



**NOTES:**

1. UNITS ARE EXPRESSED AS  $\frac{\text{FEET}}{\text{METERS}}$  (e.g.  $\frac{10}{3}$ ).
2. SEE UFC 3-260-01 FOR SURVEY REQUIREMENTS AND UFC 3-260-02 FOR PAVEMENT AND SUBGRADE DESIGN REQUIREMENTS.

**Figure 8-11. Compass Calibration Pad Numerals**



#### **8-16 T-6 PROPELLER HAZARD PAVEMENT MARKINGS.**

In an effort to reduce the hazard caused by T-6 propellers, T-6 parking positions are marked in accordance with Figure 8-12.

#### **8-17 F-16 ENGINE INLET DANGER AREA PAVEMENT MARKINGS.**

In an effort to reduce the hazard caused by F-16 engine inlet suction, F-16 parking positions are optionally marked in accordance with Figure 8-13; however, aircraft maintenance personnel determine whether the radius is established at 15 feet (4.6 meters) for idle thrust or 25 feet (7.6 meters) for mil-thrust.

#### **8-18 HYDRANT FUEL PIT LID MARKING.**

If needed to alert pilots, vehicle operators, or maintenance personnel, hydrant fuel pit covers and/or adjacent pavement is optionally marked as shown in Figure 8-14. In areas where snow is not a factor, these pits do not necessarily require markings of this type.

#### **8-19 STATIC GROUND MARKINGS.**

See UFC 3-575-01, *Lightning and Static Electricity Protection Systems*, and Army Techniques Publication (ATP) 4-43, *Petroleum Supply Operations*, for static grounding, testing, and marking requirements.

**8-20 C-12 PROP HAZARD WARNING MARKING.**

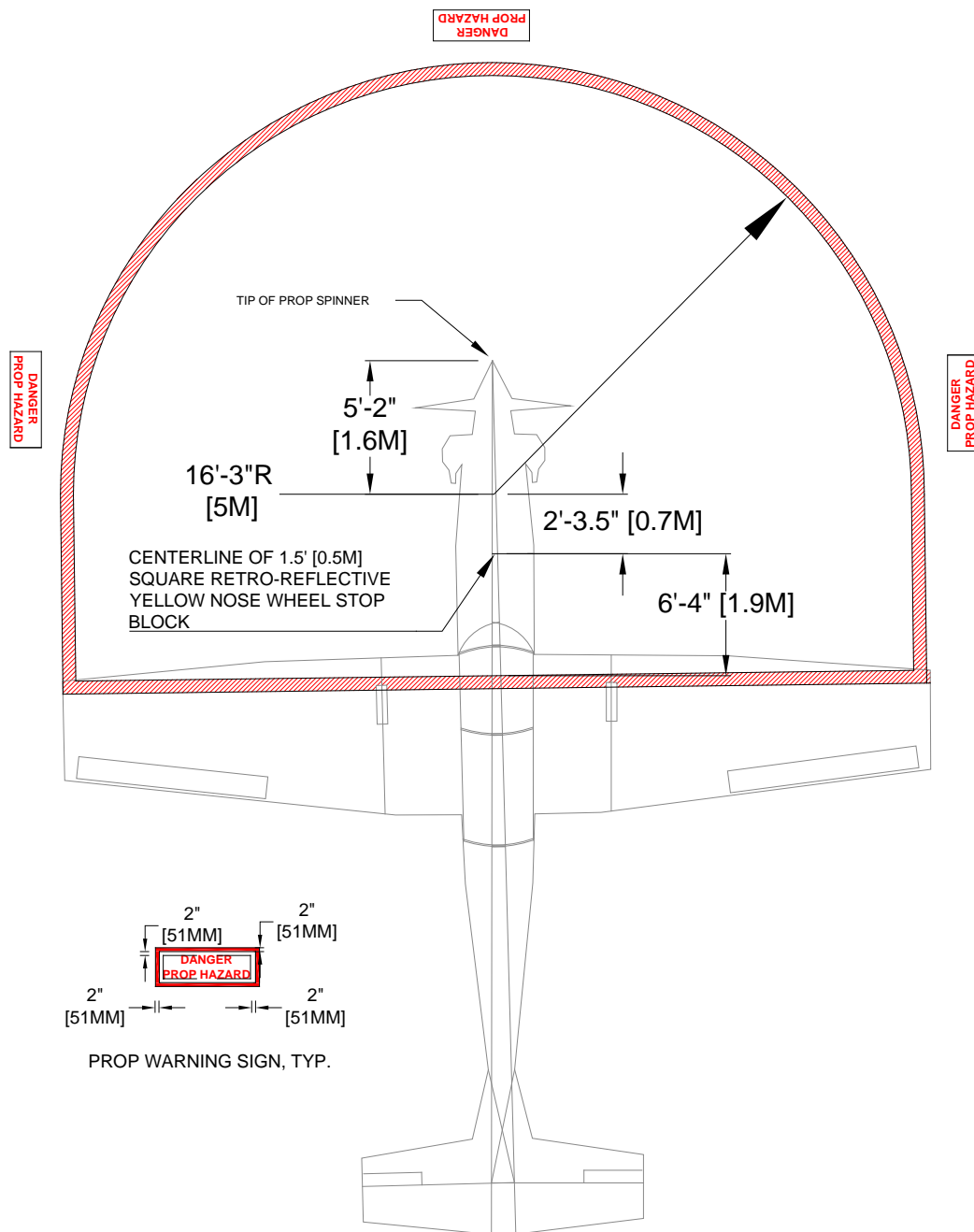
In an effort to reduce the hazard caused by C-12 propellers and exhaust, C-12 parking positions are marked in accordance with Figure 8-15.

**8-21 EXPEDIENT AIRFIELD MARKINGS.**

There are two VFR types of expedient airfields: the landing zone (LZ) (formerly called shortfields or assault landing zones) and the minimum operating strip (MOS). They are rapidly developed to support operations due to an urgent need but support different types of operations. LZs are developed to support airlift operations for C-130 and C-17 aircraft and the MOS is developed for base recovery after an attack to allow the launch and recovery of fighter aircraft. The schemes for marking an MOS are described in T.O. 35E2-6-1, *Minimum Airfield Operating Surface Marking System*. The schemes for marking an LZ are provided in TM 3-34.48-2, *Theater of Operations: Roads, Airfields, and Heliports – Airfield and Heliport Design*, Volume II.



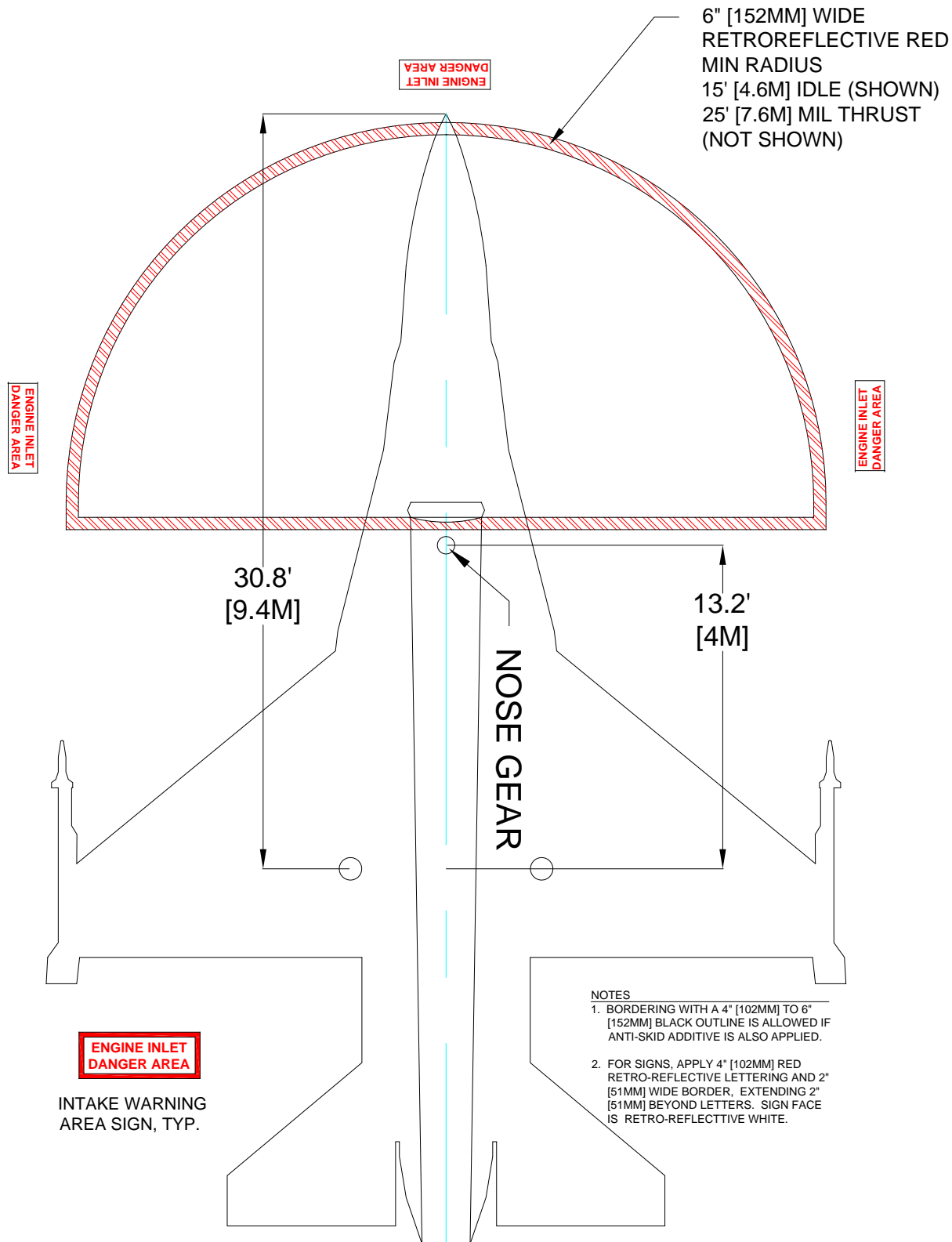
Figure 8-12. T-6 Propeller Hazard Area Pavement Markings



NOTES:

1. WARNING SIGNS WILL BE 4" [102MM] HIGH RED LETTERS ON A WHITE BACKGROUND THAT EXTENDS AT LEAST 2' [51MM] BEYOND THE EXTREMITIES OF THE LETTERS. PLACEMENT SHALL BE AT MINIMUM, AS SHOWN ABOVE.
2. PROP WARNING ARC AND OTHER BOUNDARIES WILL BE A 6" [152MM] CONTINUOUS RED LINE WITH RETRO-REFLECTIVE BEADS EMBEDDED. AN ANTI-SKID MATERIAL SHOULD ALSO BE INCORPORATED ACCORDING TO THE MANUFACTURERS RECOMMENDATIONS.
3. PAINT AND GLASS BEADS SHALL BE IN ACCORDANCE WITH STANDARDS PROVIDED IN CHAPTER 3 OF THIS MANUAL.

Figure 8-13. F-16 Engine Inlet Danger Area Pavement Markings for Idle Thrust



**Figure 8-14. Hydrant Fuel Pit Markings**

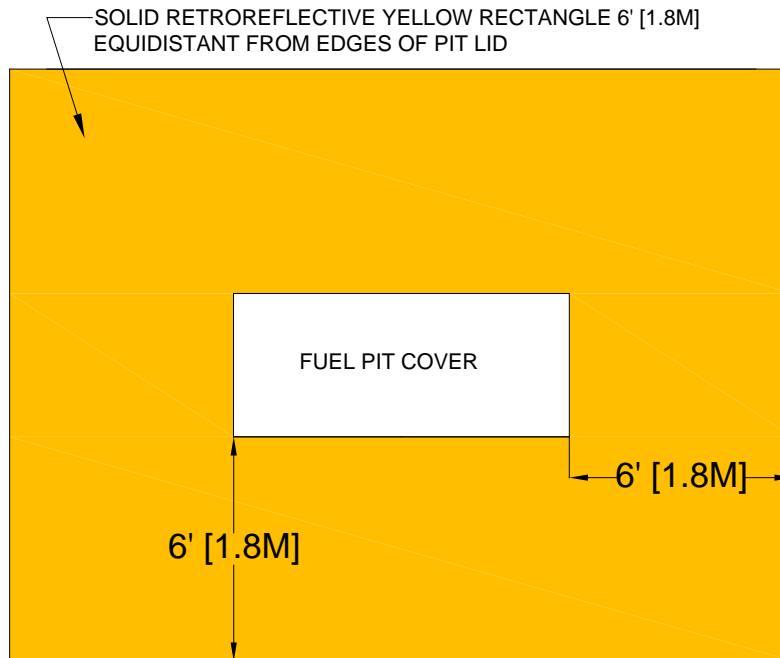
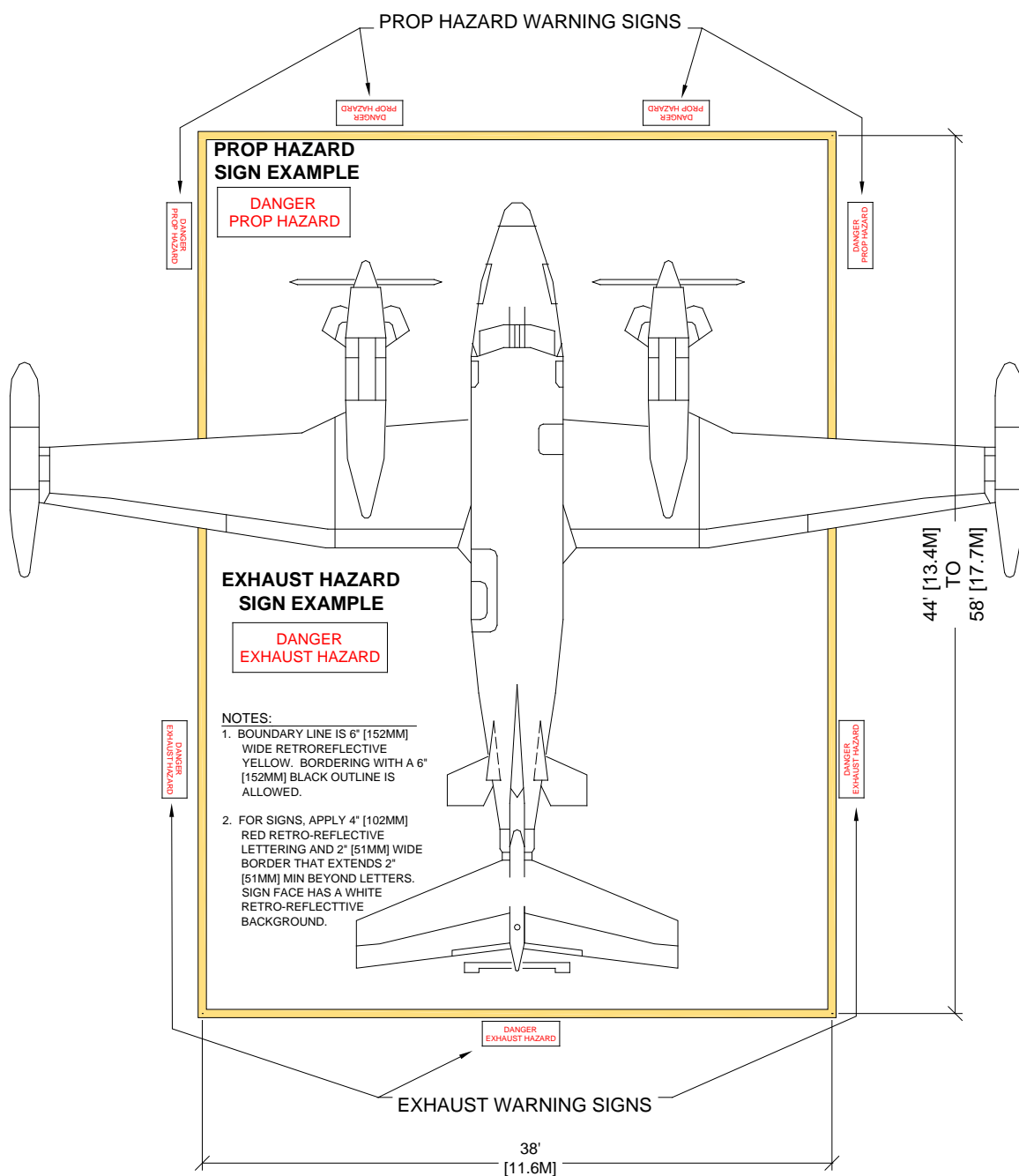


Figure 8-15. C-12 Propeller and Exhaust Hazard Area Pavement Markings



## APPENDIX A REFERENCES

### AIR FORCE

AFI 13-217, *Drop Zone and Landing Zone Operations*, <http://www.e-publishing.af.mil/>

AFI 14-205, *Geospatial Information and Services (GI&S)*, <http://www.e-publishing.af.mil/>

AFI 31-101, *Integrated Defense* (FOUO)

AFI 32-1044, *Visual Air Navigation Systems*, <http://www.e-publishing.af.mil/>. (This AFI gives information on aircraft arresting system locations and lighted signs required for runway, taxiway, and instrument hold positions.)

T.O. 35E2-6-1, *Minimum Airfield Operating Surface Marking System*

ETL 09-6, *C-130 and C-17 Landing Zone (LZ) Dimensional, Marking, and Lighting Criteria* (FOUO), [https://www.wbdg.org/ccb/browse\\_cat.php?c=125](https://www.wbdg.org/ccb/browse_cat.php?c=125)

### ARMY

AR 190-16, *Physical Security*,  
<https://armypubs.army.mil/Search/ePubsSearch/ePubsSearchDownloadPage.aspx?docID=0902c8518001047d>

ATP 4-43, *Petroleum Supply Operations*,  
<http://www.apd.army.mil/ProductMaps/PubForm/ATP.aspx>

SDDCTEA Pamphlet 55-14, *Traffic Engineering for Better Signs and Markings*,  
[https://www.sddc.army.mil/sites/TEA/Functions/SpecialAssistant/TrafficEngineeringBranch/Pamphlets/SDDCTEA\\_Pamphlet\\_55-14.pdf](https://www.sddc.army.mil/sites/TEA/Functions/SpecialAssistant/TrafficEngineeringBranch/Pamphlets/SDDCTEA_Pamphlet_55-14.pdf)

SDDCTEA Pamphlet 55-17, *Better Military Traffic Engineering*,  
[https://www.sddc.army.mil/sites/TEA/Functions/SpecialAssistant/TrafficEngineeringBranch/Pamphlets/SDDCTEA\\_Pamphlet\\_55-17\\_2011.pdf](https://www.sddc.army.mil/sites/TEA/Functions/SpecialAssistant/TrafficEngineeringBranch/Pamphlets/SDDCTEA_Pamphlet_55-17_2011.pdf)

TM 3-34.48-2, *Theater of Operations: Roads, Airfields, and Heliports – Airfield and Heliport Design*, Vol. II,  
[https://armypubs.us.army.mil/epubs/DR\\_pubs/DR\\_a/pdf/web/tm3\\_34x48\\_2.pdf](https://armypubs.us.army.mil/epubs/DR_pubs/DR_a/pdf/web/tm3_34x48_2.pdf)

USACE TSC 13-2, *Aircraft Characteristics for Military Aircraft*,  
<https://transportation.erdc.dren.mil/tsmcx/criteria.aspx>

## NAVY

NAVAIR 51-50AAA-2, *General Requirements for Shore Based Airfield Marking and Lighting*. Download a copy at <http://www.wbdg.org/ffc/dod/supplemental-technical-criteria> (designated TSEWG NAVAIR 51-50111-2, *General Requirements for Shorebased Airfield Marking and Lighting*) or contact the management authority for NAVAIR 51-50-AAA-2 at: Commanding Officer Naval Air Warfare Center Aircraft Division, Lakehurst Logistics, Code 6.8.5.1, Lakehurst, NJ, 08733, phone (732) 323-5073.

## JOINT PUBLICATIONS

TSPWG Manual 3-260-04.18-01, *Life-Cycle Cost Analysis of Retroreflective Glass Beads*, <http://www.wbdg.org/ffc/dod/supplemental-technical-criteria/>

TSPWG Manual 3-260-04.18-02, *Airfield Marking Waiver Procedures*, <http://www.wbdg.org/ffc/dod/supplemental-technical-criteria/>

UFC 1-200-01, *DoD Building Code (General Building Requirements)*, [https://www.wbdg.org/ccb/browse\\_cat.php?c=4](https://www.wbdg.org/ccb/browse_cat.php?c=4)

UFC 3-120-01, *Design: Sign Standards*, [https://www.wbdg.org/ccb/browse\\_cat.php?c=4](https://www.wbdg.org/ccb/browse_cat.php?c=4)

UFC 3-201-01, *Civil Engineering*, [https://www.wbdg.org/ccb/browse\\_cat.php?c=4](https://www.wbdg.org/ccb/browse_cat.php?c=4)

UFC 3-260-01, *Airfield and Heliport Planning and Design*, [https://www.wbdg.org/ccb/browse\\_cat.php?c=4](https://www.wbdg.org/ccb/browse_cat.php?c=4)

UFC 3-260-02, *Pavement Design for Airfields*, [https://www.wbdg.org/ccb/browse\\_cat.php?c=4](https://www.wbdg.org/ccb/browse_cat.php?c=4)

UFC 3-535-01, *Visual Air Navigation Facilities*, [https://www.wbdg.org/ccb/browse\\_cat.php?c=4](https://www.wbdg.org/ccb/browse_cat.php?c=4)

UFC 3-575-01, *Lightning and Static Electricity Protection Systems*, [https://www.wbdg.org/ccb/browse\\_cat.php?c=4](https://www.wbdg.org/ccb/browse_cat.php?c=4)

UFGS 32 17 23, *Pavement Markings*, [https://www.wbdg.org/ccb/browse\\_cat.php?c=3](https://www.wbdg.org/ccb/browse_cat.php?c=3)

## FEDERAL AVIATION ADMINISTRATION (FAA)

FAR Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace*, <http://www.ecfr.gov/cgi-bin/text-idx?SID=c957224f6e2b4fb1f2fc236f5da09558&node=pt14.2.77&rgn=div5>

AC 70/7460-1, *Obstruction Marking and Lighting*, [http://www.faa.gov/regulations\\_policies/advisory\\_circulars/index.cfm/go/document.information/documentID/1028657](http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1028657)

AC 120-57, *Surface Movement Guidance and Control System*,  
[http://www.faa.gov/regulations\\_policies/advisory\\_circulars/index.cfm/go/document.information/documentID/23193](http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/23193)

AC 150/5300-13, *Airport Design*,  
[http://www.faa.gov/regulations\\_policies/advisory\\_circulars/index.cfm/go/document.information/documentID/1020359](http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1020359)

AC 150/5340-1, *Standards for Airport Markings*,  
[http://www.faa.gov/regulations\\_policies/advisory\\_circulars/index.cfm/go/document.information/documentID/1022266](http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1022266)

AC 150/5340-18, *Standards for Airport Sign Systems*,  
[http://www.faa.gov/regulations\\_policies/advisory\\_circulars/index.cfm/go/document.information/documentID/321003](http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/321003) AC 150/5345-55, *Specification for L-893, Lighted Visual Aid to Indicate Temporary Runway Closure*,  
[http://www.faa.gov/regulations\\_policies/advisory\\_circulars/index.cfm/go/document.information/documentID/22296](http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/22296)

## **FEDERAL HIGHWAY ADMINISTRATION (FHWA)**

*Manual on Uniform Traffic Control Devices (MUTCD)*, <http://mutcd.fhwa.dot.gov/>

## **FEDERAL SPECIFICATIONS AND STANDARDS**

TT-P-1952, *Paint, Traffic and Airfield Marking, Waterborne*,  
[http://quicksearch.dla.mil/qsDocDetails.aspx?ident\\_number=51859](http://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=51859)

TT-B-1325, *Beads (Glass Spheres), Retroreflective*,  
[http://quicksearch.dla.mil/qsDocDetails.aspx?ident\\_number=51830](http://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=51830)

## **AIR STANDARDIZATION COORDINATING COMMITTEE (ASCC)**

Air Standard 90/28, *Aerodrome Pavement Markings*

## **INNOVATIVE PAVEMENT RESEARCH FOUNDATION (IPRF)**

Project 05-1, *Develop and Publish a Best Marking Practices Handbook*,  
<http://www.iprf.org/products/main.html>

## **INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO)**

Annex 14, Volume I, *Aerodromes*, <http://www.icao.int/>

Annex 14, Volume II, *Heliports*, <http://www.icao.int/>

## **NORTH ATLANTIC TREATY ORGANIZATION (NATO)**

STANAG 3111, *Airfield Marking Tone-Down*

**SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) INTERNATIONALE**

SAE-AMS-STD-595, *Colors Used in Government Procurement*, [www.sae.org](http://www.sae.org)



## APPENDIX B BEST PRACTICES

### B-1 PAVEMENT MARKING.

#### B-1.1 DEVELOPMENT SPONSORSHIP.

The FAA funded, and the American Concrete Pavement Association (ACPA), in cooperation with the Innovative Pavement Research Foundation (IPRF), executed Project 05-1, *Develop and Publish a Best Marking Practices Handbook*. The products were delivered in September 2008 and are available for download:

<http://www.iprf.org/products/main.html>

#### B-1.2 CONTENTS.

The manual is composed of the following products:

- Airfield Marking Handbook (pdf format)
- PowerPoint Presentation
- Instructional video (The instructional video requires the DivX codec, which is downloadable from the same website.)

**Note:** Printed copies of this report are available at no cost; however, a nominal shipping and handling fee applies.

#### B-1.3 EXCEPTIONS.

The practices, methods, and recommended materials provided within the report do not necessarily comply with the mandatory policies established within this UFC or individually by the Services. In cases where there are conflicts, this UFC, as well as Service, MAJCOM, and MACOM-specific policies, govern.

## **B-2 PREVIOUS AIRFIELD MARKING PATTERN STANDARDS.**

### **B-2.1 PATTERN SIZES AND LAYOUTS.**

Previous pavement marking standards called for smaller and differently spaced marking schemes from those standardized by the FAA or ICAO. This UFC attempts to standardize marking standards and practices across DoD in an effort to enable uniform recognition of surface painted markings and better promote aviation safety, regardless of the geographic location of the airfield.

#### **When to Implement New Marking Patterns/Layouts.**

Due to the potentially significant budgetary impact caused by arbitrary implementation of new standards, continue marking current patterns until renovation of the pavement (reconstruction or overlay) or at least 50 percent of the individual pavement feature (e.g., a runway, a taxiway system, or individual aprons and taxilanes). This allows a phased approach to replacing obsolete patterns or marking schemes.

#### **Exceptions to Civil Standards on DoD-Owned Facilities.**

Note that not all FAA-promulgated size requirements and enhancements have been made mandatory requirements in this UFC. This is because military missions, needs, and funding constraints are different from those of civil operational interests. Where FAA or ICAO standards differ from those within this UFC, these standards govern unless waived by the appropriate authority.

### **B-2.2 PREVIOUS STANDARDS.**

#### **Obsolete USAF Standards.**

- AFI 32-1042, *Standards for Marking Airfields*, 14 January 2015, is downloadable at <https://www.my.af.mil/gcss-af/USAF/ep/contentView.do?contentType=EDITORIAL&contentId=cE3494DD0577CE8B5015790ED79F400C1&programId=t2D8EB9D6386BFB8B01394F5729351F52&channelPageId=s2D8EB9D637283B5601377B2CE4030666>
- ETL 04-2, *Standard Airfield Pavement Marking Schemes*, 19 July 2004, is downloadable at <https://www.my.af.mil/gcss-af/USAF/ep/contentView.do?contentType=EDITORIAL&contentId=cE3494DD0577CE8B5015790ED79F400C1&programId=t2D8EB9D6386BFB8B01394F5729351F52&channelPageId=s2D8EB9D637283B5601377B2CE4030666>

**Obsolete U.S. Army Standards.**

- U.S. Army Technical Letter No. 1110-3-512, *Army Airfield and Heliport Markings*, is downloadable at <http://www.publications.usace.army.mil/USACE-Publications/Engineer-Technical-Letters/>
- UFC 3-260-05A, *Marking of Army Airfield Heliport Operational and Maintenance Facilities*, 16 January 2004, is downloadable at [https://www.wbdg.org/ccb/browse\\_cat.php?c=4&a=1](https://www.wbdg.org/ccb/browse_cat.php?c=4&a=1)
- Engineering and Construction Bulletin 2012-28, *Marking of Army Airfields and Heliports*, is downloadable at [http://www.wbdg.org/ccb/browse\\_cat.php?c=268&a=1](http://www.wbdg.org/ccb/browse_cat.php?c=268&a=1)

**B-3 METRICATION OF DIMENSIONS.**

**B-3.1 METRIC VALUES TO USE.**

The technologies addressed in this UFC when developed were based on the inch-pound system used in the United States. Because DoD operates in many foreign countries, and because it is beneficial and necessary to use SI units when developing and constructing projects in those theaters, rational conversions are shown here for cases where NATO or ICAO standards are not called out. In an effort to maintain compliance with both U.S. civil standards and international civil aviation standards, imperial and metric dimensions are provided where practicable within the text. The following table was developed to reduce crowding of dimensions and improve clarity and readability in some of the figures within the document. If necessary, use these values to validate the values provided in the figures.

**Table B-1 Inches to Millimeters**

<b>Inch-Pound Dimension (Inches)</b>	<b>SI Dimension (Millimeters)</b>
2.00 inches	51 millimeters
3.00 inches	76 millimeters
3.50 inches	89 millimeters
4.00 inches	102 millimeters
5.00 inches	127 millimeters
6.00 inches	152 millimeters
7.00 inches	178 millimeters
7.50 inches	191 millimeters
8.00 inches	203 millimeters
10.00 inches	254 millimeters
12.00 inches	305 millimeters
13.00 inches	330 millimeters
14.00 inches	356 millimeters
15.00 inches	381 millimeters
16.00 inches	406 millimeters
18.00 inches	457 millimeters
20.00 inches	508 millimeters
23.00 inches	584 millimeters
24.00 inches	610 millimeters
26.00 inches	660 millimeters
36.00 inches	914 millimeters
37.00 inches	940 millimeters
48.00 inches	1219 millimeters
51.00 inches	1,295 millimeters

**Table B-2 Feet to Meters**

<b>Inch-Pound Dimension (Feet) [Nominal Tolerance Dimension]</b>	<b>Metric Used (rounded to nearest tenth of meter)</b>
0.5 foot	0.2 meter
1 foot	0.3 meter
1.3 feet	0.4 meter
1.5 feet	0.5 meter
2 feet	0.6 meter
2.29 feet	0.7 meter
2.5 feet	0.8 meter
3 feet	0.9 meter
3.5 feet	1.1 meters
4 feet	1.2 meters
4.5 feet	1.4 meters
5 feet	1.5 meters
5.17 feet	1.6 meters
5.5 feet	1.7 meters
5.75 feet	1.75 meters
6 feet	1.8 meters
6.33 feet	1.9 meters
6.5 feet	1.98 meters
6.6 feet	2.0 meters
6.75 feet	2.1 meters
7 feet	2.13 meters
7.5 feet	2.3 meters
8 feet	2.4 meters
8.4 feet	2.56 meters
8.5 feet	2.6 meters
9 feet	2.7 meters
9.5 feet	2.9 meters
10 feet	3 meters
11 feet	3.4 meters
11.5 feet	3.5 meters
12 feet	3.7 meters
12.5 feet	3.8 meters
13 feet	3.96 meters
13.2 feet	4.0 meters
13.5 feet	4.1 meters
14 feet	4.3 meters
15 feet	4.6 meters

Inch-Pound Dimension (Feet) [Nominal Tolerance Dimension]	Metric Used (rounded to nearest tenth of meter)
16 feet	4.9 meters
16.25 feet	5.0 meters
17 feet	5.2 meters
17.5 feet	5.3 meters
18 feet	5.5 meters
18.5 feet	5.6 meters
19 feet	5.8 meters
20 feet	6.1 meters
20.66 feet	6.3 meters
22 feet	6.7 meters
24 feet	7.3 meters
24.5 feet	7.5 meters
25 feet	7.6 meters
26 feet	7.9 meters
27 feet	8.2 meters
28 feet	8.5 meters
30 feet	9.1 meters
30.8 feet	9.4 meters
32 feet	9.8 meters
35 feet	10.7 meters
36 feet	11.0 meters
37 feet	11.3 meters
37.5 feet	11.4 meters
40 feet	12.2 meters
43 feet	13.1 meters
44 feet	13.4 meters
45 feet	13.7 meters
48 feet	14.6 meters
50 feet	15.2 meters
59 feet	18.0 meters
60 feet	18.3 meters
63 feet	19.2 meters
72 feet	21.9 meters
75 feet	22.9 meters
79 feet	24.1 meters
80 feet	24.4 meters
88 feet	26.8 meters
98 feet	29.9 meters
99 feet	30.2 meters

Inch-Pound Dimension (Feet) [Nominal Tolerance Dimension]	Metric Used (rounded to nearest tenth of meter)
100 feet	30.5 meters
120 feet	36.6 meters
124 feet	38.0 meters
125 feet	38.1 meters
144 feet	43.9 meters
150 feet	45.7 meters
171 feet	52.1 meters
175 feet	53.3 meters
194 feet	59.1 meters
200 feet	61.0 meters
205 feet	62.5 meters
250 feet	76.2 meters
280 feet	85.3 meters
300 feet	91.4 meters
400 feet	121.9 meters
440 feet	134.1 meters
500 feet	152.4 meters
520 feet	158.5 meters
533.3 feet	162.5 meters
1000 feet	304.8 meters
1200 feet	365.8 meters
1300 feet	396.2 meters
1600 feet	487.7 meters
3000 feet	914.4 meters
3200 feet	975.4 meters
4000 feet	1,219.2 meters

*This Page Intentionally Left Blank*



## APPENDIX C GLOSSARY

### C-1 ACRONYMS AND ABBREVIATIONS

AAS	Aircraft Arresting System
AC	Advisory Circular
AFI	Air Force Instruction
AFMAN	Air Force Manual
AOI	Airfield Operating Instruction
ATP	Army Techniques Publication
CCP	Compass Calibration Pad
CONUS	Continental United States
DoD	Department of Defense
ECP	Entry Control Point
ETL	Engineering Technical Letter
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FCIF	Flight Crew Information File
FHWA	Federal Highway Administration
FLIP	Flight Information Publication
FOD	Foreign Object Damage
HAT	Height Above Touchdown
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rule
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
INS	Inertial Navigation System

IPRF	Innovative Pavement Research Foundation
LAHSO	Land And Hold Short Operations
LZ	Landing Zone
m	Meter
MACOM	U.S. Army Major Command
MAJCOM	USAF Major Command
MILS	Thousandths of an Inch Film Measurement (0.000")
MIN	Minimum
mm	Millimeters
MOS	Minimum Operating Strip
MSL	Mean Sea Level
MUTCD	Manual on Uniform Traffic Control Devices
NATO	North Atlantic Treaty Organization
NAVAID	Navigational Aid
NAVAIR	Naval Air Systems Command
NDAA	National Defense Authorization Act
NOTAM	Notice To Airmen
OCONUS	Outside Continental United States
PCC	Portland Cement Concrete
POFZ	Precision Obstacle Free Zone
SDDCTEA	Military Surface Deployment and Distribution Command Transportation Engineering Agency
SOFA	Status of Forces Agreement
STANAG	Standardization Agreement
TDZ	Touchdown Zone
TM	Technical Manual

T.O.	Technical Order
TSC	Technical Services Center
U.S.	United States
UAS	Unmanned Aircraft System
UFC	Unified Facilities Criteria
UFGS	Unified Facilities Guide Specification
USACE	U S Army Corps of Engineers
USAF	United States Air Force
VFR	Visual Flight Rules

## C-2 TERMS

**Precision Approach Runway Category I**—A runway served by an instrument landing system (ILS), microwave landing system (MLS), or precision approach radar (PAR) and visual aids intended for operations down to 60 meters (200 feet) decision height, and down to a runway visual range (RVR) on the order of 720 meters (2,400 feet).

**Precision Approach Runway Category II**—A runway served by ILS or MLS and visual aids intended for operations down to 30 meters (100 feet) decision height and down to an RVR on the order of 360 meters (1,200 feet).

**Precision Approach Runway Category III**—A runway served by ILS or MLS (no decision height being applicable) and:

**Category IIIa:** By visual aids intended for operations down to an RVR on the order of 210 meters (700 feet).

**Category IIIb:** By visual aids intended for operations down to an RVR on the order of 45 meters (150 feet).

**Category IIIc:** Intended for operations without reliance on external visual reference. (The RVR is 0).

**Entry Control Point**—A marked location on the periphery of a controlled and restricted area for accessing and exiting the designated area.

**Index of Refraction**—The ratio of the speed of radiation (as light) in one medium (as a vacuum) to that in another medium—also called *refractive index*.

**Taxilane**—Designated path marked through parking, maintenance, or hangar aprons, or on the perimeter of such aprons, to permit the safe ground movement of aircraft operating under their own power.

**Taxitrak**—A specially prepared or 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.

**Taxiway**—A specially prepared or designated path, on an airfield or heliport other than apron areas, on which aircraft move under their own power to and from landing, service, and parking areas.

**Towway**—Paved surface over which an aircraft is towed.



**RAE Products & Chemicals Corporation**

---

~ A reputation for excellence since 1976 ~

**Federal Spec. TT-P-1952(E)**

**PAINT, TRAFFIC AND AIRFIELD MARKING, WATERBORNE**

**[www.raepaint.com](http://www.raepaint.com)**

**11638 South Mayfield Ave. ~ (708) 396-1984 ~ Alsip, IL 60803**

INCH-POUND  
TT-P-1952E  
06 August 2007  
SUPERSEDING  
TT-P-1952D  
January 7, 1994

## FEDERAL SPECIFICATION

### PAINT, TRAFFIC AND AIRFIELD MARKING, WATERBORNE

The General Services Administration has authorized the use of this federal specification by all federal agencies.

#### 1. SCOPE AND CLASSIFICATION.

1.1 Scope. This specification covers three types of low VOC (volatile organic compounds), ready-mixed, one-component, 100% acrylic waterborne airfield and traffic marking paint. The paint is suitable for application on such traffic-bearing surfaces as Portland cement concrete, bituminous cement concrete, asphalt, tar, and previously painted areas of these surfaces. The paint may be used either alone or to bind reflective beads.

##### 1.2 Classification.

1.2.1 Types. The paint shall be furnished in the following types, as specified (see 6.2):

Type I - For use under normal conditions

Type II - For use under adverse conditions (see 6.1)

Type III - For increased durability

1.2.2 Color. Traffic paint shall be furnished in white and any Federal Standard 595 color, as specified (see 3.2.7 and 6.3).

2. APPLICABLE DOCUMENTS. The following documents, of the issues in effect on date of invitation for bids or request for proposal, form a part of this description to the extent specified herein.

2.1 Government Publications. The issues of the following documents, in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

Beneficial comments, recommendations, additions, deletions, clarifications, etc. and any data which may improve this document should be sent to: HQ AFCESA/CESC, 139 Barnes Drive, Suite 1, Tyndall AFB FL 32403-5319.

FSC 8010

Distribution Statement A. Approved for public release. Distribution is unlimited.

TT-B-1325 - Beads (Glass Sphere), Retro-reflective

FED-STD-595 - Colors Used in Government Procurement

(Single copies of this specification, and other federal specifications and commercial item descriptions required by activities outside the Federal Government for bidding purposes are available without charge from the General Services Administration, Federal Supply Service, Specification Section, Suite 8100, 470 L'Enfant Plaza, SW, Washington, DC, 20407)

## 2.2 Federal Regulations.

40 CFR Part 60, Appendix A

29 CFR Part 1910.1200

(The Code of Federal Regulations (CFR) is available online at <http://www.gpoaccess.gov/cfr/index.html> or for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

2.3 Other publications. The following documents form a part of this description to the extent specified herein. Unless a specific issue is identified, the issue in effect on the date of invitation for bids or request for proposal shall apply.

### 2.3.1 American Society for Testing and Materials (ASTM) Standards.

- D 522 - Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
- D 562 - Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer
- D 711 - Standard Test Method for No-Pick-Up-Time of Traffic Paint
- D 968 - Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasives
- D 969 - Standard Test Method for Laboratory Determination of Degree of Bleeding of Traffic Paint
- D 1210 - Standard Test Method for Fineness of Dispersion of Pigment-Vehicle Systems by Hegman-Type Gage
- D 1394 - Standard Test Methods for Chemical Analysis of White Titanium Pigments
- D 1640 - Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature
- D 1729 - Standard Practice for Visual Appraisal of Colors and Color Differences of Diffusely Illuminated Opaque Materials
- D 1849 - Standard Test Method for Package Stability of Paint

- D 2243 - Standard Test Methods for Freeze-Thaw Resistance of Water-Borne Coatings
- D 2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
- D 2369 - Standard Test Method for Volatile Content of Coatings
- D 2486 - Standard Test Methods for Scrub Resistance of Wall Paints
- D 2697 - Standard Test Method for Volume Nonvolatile Matter in Clear or Pigmented Coatings
- D 2805 - Hiding Power of Paints by Reflectometry
- D 3335 - Standard Test Method for Low Concentrations of Lead, Cadmium and Cobalt in Paint by Atomic Absorption Spectroscopy
- D 3718 - Standard Test Method for Low Concentrations of Chromium in Paint by Atomic Absorption Spectroscopy
- D 3723 - Standard Test Method for Pigment Content of Water-Emulsion Paints by Low-Temperature Ashing
- E-1347 - Standard Test Method for Color and Color-Difference Measurement by Tristimulus (Filter) Colorimetry.
- G 154 - Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, (610) 832-9500, [www.astm.org](http://www.astm.org).)

### 3. REQUIREMENTS.

#### 3.1 Composition.

3.1.1 Materials. The non-volatile portion of the vehicle for all types shall be composed of a 100% acrylic polymer as determined by infrared spectral analysis. The acrylic resin used for Type III shall be a 100% cross-linking acrylic as evidenced by infrared peaks at wavelengths 1568, 1624, and 1672 cm<sup>-1</sup> with intensities equal to those produced by an acrylic resin known to be 100% cross-linking.

3.1.2 Prohibited material. The manufacturer shall certify that the product does not contain mercury, lead, hexavalent chromium, toluene, chlorinated solvents, hydrolysable chlorine derivatives, ethylene-based glycol ethers and their acetates, nor any carcinogen, as defined in 29 CFR 1910.1200. When tested as specified in 4.3.1, the lead content shall not exceed 0.06 percent by weight of the dry film and the test for chromium content shall be negative.

#### 3.2 Qualitative requirements.

3.2.1 Condition in the container. When tested, as specified in 4.3.2, the paint, as received, shall show no evidence of biological growth, corrosion of the container, livering, or hard settling. The paint shall be dispersible by hand stirring for 5 minutes to a



smooth and homogenous consistency, exempt of gel structures, persistent foam or air bubbles.

3.2.2 Appearance. When tested as specified in 4.3.3, the paint shall produce a film which is smooth, uniform, and free from grit, undispersed particles, craters, and pinholes.

3.2.3 Accelerated package stability. After storage as specified in 4.3.4, the sample shall conform to the requirements of 3.2.1 and 3.2.2. The sample shall show no change in consistency greater than 5 KU (Krebs Unit) from the value in Table 1.

3.2.4 Flexibility. When tested as specified in 4.3.6, the paint film shall not crack, chip or flake after the test panel is bent 180 degrees over a 13 mm (1/2 in) mandrel.

3.2.5 Water resistance. When tested as specified in 4.3.5, the paint film shall not soften, blister, wrinkle, lose adhesion, change color, or show other evidence of deterioration.

3.2.6 Freeze-thaw stability. When tested as specified in 4.3.8, the paint shall show no coagulation or flocculation, change in consistency greater than 10 KU from the value in Table 1, or a decrease in scrub resistance by more than 10 percent of the requirement in 3.2.13.

3.2.7 Color requirements.

3.2.7.1 Color match. For all colors except white and yellow, when tested as specified in 4.3.9.3, the paint shall match the specified Federal Standard 595 color number within a  $\Delta E$  or 6.0 CIELAB units.

3.2.7.2 Daylight directional reflectance. When tested as specified in 4.3.9.2, the white paint shall have the daylight directional reflectance specified in Table 1.

3.2.7.3 Yellow color match. The yellow traffic paint shall be an appropriate color match to Federal Standard 595 color number 33538 when tested in accordance with 4.3.9.4.

3.2.8 Heat-shear stability. When tested as specified in 4.3.13, the sample shall not show signs of gelling or other instability. The consistency shall be in compliance with Table 1.

3.2.9 Skinning. The paint shall not skin when tested as specified in 4.3.14.

3.2.10 Dry-through (early washout). For Type II only, the paint when tested as specified in 4.3.15 shall have a dry-through time less than 120 minutes.

3.2.11 Abrasion resistance. When tested as specified in 4.3.7, both baked and weathered paint films shall require not less than 150 liters of sand to abrade the paint film through to the substrate.

3.2.12 Accelerated weathering. When tested as specified in 4.3.10, the colored samples after weathering shall be in conformance with 3.2.7. The directional reflectance of white paint shall meet the requirement in Table 1. After performing the scrub resistance test in accordance with 4.3.12, the paint shall be in conformance with 3.2.13.

3.2.13 Scrub resistance. When tested as specified in 4.3.12, it shall not take less than 500 cycles to remove the paint film.

3.2.14 Titanium dioxide content. When tested in accordance with 4.3.16, the yellow, green, and blue colored paint shall contain a maximum of 23.7 g/L (0.2 lb/gal) rutile titanium dioxide. The white paint shall contain a minimum of 120 g/L (1 lb/gal) rutile titanium dioxide.

3.3 Quantitative requirements. The paint shall meet the quantitative requirements specified in Table 1.

Table I. Quantitative Requirements.

Characteristics	Min	Max
Consistency	80	90
Volatile organic content (VOC), grams/liter	---	150
Solids by volume <sup>1</sup>		
Yellow or white	60	---
Other colors	58	---
Pigment, percent by weight	60	62
Dry opacity - White and colors	0.92	---
Black	1.00	
Directional reflectance of white paint, percent	85	---
Drying time for no pick up, min.	---	10
Fineness of dispersion, Hegman	3.0	---
Heat-shear stability, consistency, KU	68	105
Bleeding ratio	0.95	---

<sup>1</sup> Manufacturers may calculate this requirement from batch card data, but in case of dispute the method specified in Table 2 must be used.

3.4 Material Safety Data Sheet. A Material Safety Data Sheet (MSDS) shall be submitted in accordance with FED-STD-313 (see 6.2).

#### 4. QUALITY ASSURANCE PROVISIONS.

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified

herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the government. The government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 Classification of inspections. Inspections shall be classified as follows: (a) inspection of preparation for delivery (see 4.2.1); (b) acceptance testing (see 4.2.2).

4.2.1 Inspection in preparation for delivery. Prior to shipment, containers shall be examined for compliance with Section 5.

4.2.2 Acceptance testing. Testing for acceptance of individual lots shall be done in accordance with section 1000 of FED-STD-141 and shall consist of test and inspections as indicated in Table 2.

4.3 Test methods. Samples shall be tested as specified in Table 2. Unless otherwise specified, tests shall be performed at standard conditions, which are  $25^{\circ} \pm 1^{\circ}\text{C}$  and  $50\% \pm 5\%$  relative humidity. All test reports shall contain the individual values used in expressing the final result. Test results shall be evaluated for conformance to requirements. The sample shall be unacceptable if any test result is not in conformance with the corresponding requirement in section 3.

Table II. Index

Characteristic	Acceptance Testing	Requirement Paragraph	ASTM Method	Test Paragraph
Lead content		3.1.2	D 3335	4.3.1.1
Chromium content		3.1.2	D 3718	4.3.1.2
Condition in container	Yes	3.2.1	---	4.3.2
Appearance	Yes	3.2.2	---	4.3.3
Accelerated package stability		3.2.3	D 1849	4.3.4
Flexibility	Yes	3.2.4	D 522	4.3.5
Water resistance	Yes	3.2.5	---	4.3.6
Freeze-thaw stability	Yes	3.2.6	D 2243	4.3.8
Color	Yes	3.2.7	D 2244	4.3.9
Directional reflectance	Yes	3.2.7.2	E 1347	4.3.9.2
Yellow color match	Yes	3.2.7.3	D 1729	4.3.9.4
Heat-shear stability	Yes	3.2.8	---	4.3.13
Skinning	Yes	3.2.9	---	4.3.14
Dry-through (early washout)	Yes	3.2.10	D 1640	4.3.15
Abrasion resistance	Yes	3.2.11	D 968	4.3.7

Accelerated weathering		3.2.12	G 154	4.3.10
Scrub resistance	Yes	3.2.13	D 2486	4.3.12
Volatile organic content		Table 1	D 2369	---
Consistency	Yes	Table 1	D 562	---
Solids by volume	Yes	Table 1	D 2697	---
Dry opacity	Yes	Table 1	D 2805	4.3.11
Dry time (no pick up)	Yes	Table 1	D 711	---
Fineness of dispersion	Yes	Table 1	D 1210	---
Bleeding ratio		Table 1	D 969	---
Pigment (percent by weight)		Table 1	D 3723	---
Titanium dioxide		3.2.14	D 1394	4.3.16

#### 4.3.1 Prohibited materials.

4.3.1.1 Lead content. Determine lead in accordance with ASTM D 3335 or by the use of an X-ray fluorescence spectrometer in accordance with the manufacturer's manual. The X-ray method shall be used in case of dispute. Evaluate for compliance with 3.1.2.

4.3.1.2 Chromium (hexavalent) content. Add 5 ml of 25 percent aqueous KOH (potassium hydroxide) to 0.5 g of the extracted pigment contained in a centrifuge tube. Agitate by shaking and centrifuge. A yellow color in the supernatant liquid indicates the presence of hexavalent chromium. If the results of the above test are inconclusive, then use the procedure in ASTM D 3718 to test for chromium content. Evaluate results for compliance with 3.1.2.

4.3.2 Condition in the container. Before stirring the contents of the container in which the material was originally packaged, check for evidence of biological growth and corrosion. Then lower a spatula into the container and determine whether the paint has livered or developed hard settling. Disperse the paint with the spatula for 5 minutes and examine for compliance with 3.2.1.

4.3.3 Appearance. Draw down the paint on a clear glass panel to a wet film thickness of 0.33 mm (0.013 in), and allow to dry for 24 hours at standard conditions. Evaluate for conformance with 3.2.2.

4.3.4 Accelerated package stability. Fill a 550 mL (1 pint) resin-lined friction-top can with the sample. Ensure that the bulk sample from which the cans are filled is well stirred and uniform, that the containers used are clean, and that the lids are applied promptly to the cans to prevent evaporation losses. Store at a temperature of 52°C for 2 weeks. Evaluate following the procedure in ASTM D 1849, except allow hand stirring for

5 minutes to ensure uniform distribution. Evaluate the consistency for conformance with Table 1. Draw down the paint as described in 4.3.3. Evaluate for conformance with 3.2.3.

4.3.5 Flexibility. Determine flexibility in accordance with Method B of ASTM D 522. Draw down the paint to a wet film thickness of 0.13 mm (0.005 in) on a clean, bare, cold-rolled steel panel. Air-dry the panel for 24 hours at standard conditions, then bake for 5 hours at  $105^{\circ}\text{C} \pm 2^{\circ}\text{C}$ , and finally condition the panel for 30 minutes at standard conditions. Bend over a 13 mm (0.5 in) diameter cylindrical mandrel and examine under a magnification of 7 diameters for compliance with 3.2.4.

4.3.6 Water resistance. Prepare a 10 by 15 cm concrete panel as specified in Method 2051 Procedure B of FED-STD-141. Draw down to a wet film thickness of 0.33 mm (0.013 in) and allow it to dry in a horizontal position at standard conditions for 72 hours. Immerse one-half of the painted panel in distilled water at  $25^{\circ}\text{C} \pm 1^{\circ}\text{C}$ . After 18 hours, remove the panel from the water and allow it to dry for 2 hours at standard conditions. Evaluate for conformance with 3.2.5.

#### 4.3.7 Abrasion resistance.

4.3.7.1 Sample preparation. Draw down the paint on four glass panels measuring approximately 100 by 200 mm to a dry film thickness of 0.102 mm to 0.107 mm.

4.3.7.2 Baked films. Air-dry two of the panels for 24 hours at standard conditions and then bake for 5 hours at  $105^{\circ}\text{C} \pm 2^{\circ}\text{C}$ . After baking, condition the panels for 30 minutes at standard conditions and then run the abrasion test as specified in 4.3.7.4.

4.3.7.3 Weathered films. Air-dry the other two panels for 48 hours at standard conditions then subject the panels to accelerated weathering in accordance with 4.3.10. Remove the panels and condition for 24 hours at standard conditions, then run the abrasion test as specified in 4.3.7.4.

4.3.7.4 Test. Subject the panels to the abrasion test in accordance with ASTM D 968, Method A, except that the inside diameter of the metal guide tube shall be from 18.97 to 19.05 mm. Five liters of unused sand shall be used for each test panel. The test shall be run on two test panels. (Note: Five liters of sand weigh 7.94 kg.) Evaluate for compliance with 3.2.11.

4.3.8 Freeze-thaw stability. Test in accordance with ASTM D 2243 for three freeze-thaw cycles. Perform the consistency test in accordance with ASTM D 562 and the scrub resistance test as described in 4.3.12. Check for conformance with 3.2.6.

#### 4.3.9 Color.

4.3.9.1 Sample preparation. Use the test panels prepared for the accelerated weathering test (4.3.10.1).

4.3.9.2 Daylight directional reflectance. For the white paint, determine the directional reflectance before and after weathering in accordance with ASTM E 1347 using the 45/0 illumination. Evaluate for conformance with Table 1.

4.3.9.3 Color match. For colors other than white and yellow, determine the color difference of the paint before and after weathering in accordance with ASTM D 2244 using CIE Illuminant D65 with the 10 degree standard observer. Evaluate for conformance with 3.2.7.

4.3.9.4 Yellow color match. Determine the color match for yellow paint before and after weathering in accordance with ASTM D 1729 with the daylight illumination represented by CIE Illuminant D75 or D65. Evaluate for conformance with 3.2.7.3.

#### 4.3.10 Accelerated weathering.

4.3.10.1 Sample preparation. Apply the paint at a wet film thickness of 0.33 mm (0.013 in) to four 8 by 15 cm solvent-cleaned aluminum panels. Air-dry the sample for 48 hours under standard conditions.

4.3.10.2 Testing conditions. Test in accordance with ASTM G 154 using both ultraviolet light (UV-B PS-40) and condensate exposure, 300 hours total, alternating 4 hours of UV exposure at 60°C and 4 hours of condensate exposure at 40°C.

4.3.10.3 Evaluation. Remove the samples and condition for 24 hours under standard conditions. Determine the directional reflectance and color match using the procedures in 4.3.9.2 and 4.3.9.3. Evaluate for conformance with the color requirements in 3.2.7. Using the procedure described in 4.3.12, run the scrub resistance test. Evaluate for conformance with 3.2.13.

4.3.11 Dry opacity. Use the procedure of ASTM 2805, calculate the contrast ratio of the paint applied at a wet film thickness of 0.13 mm (0.005 in). Evaluate for conformance with Table 1.

4.3.12 Scrub resistance. Using the procedure of ASTM D 2486 modified to use the 8 by 15 cm test panels from the accelerated weathering test (4.3.10), evaluate for conformance with 3.2.13.

4.3.13 Heat-shear stability. One pint of the paint is sheared in a kitchen blender at high speed to 65°C. The blender should have a tight-fitting lid and taped to minimize volatile loss. When the paint reaches 65°C, stop the blender, immediately can and apply

a cover. Let cool a minimum of 12 hours and examine for gelling or other signs of instability. Evaluate for compliance with 3.2.8.

4.3.14 Skinning. Place 188 mL of the paint in a 250 mL container and seal. Invert the container momentarily and then place upright in a dark environment at 22.2–26.7°C (70–80°F) for 48 hours. Examine for compliance with 3.2.9.

4.3.15 Dry-through (early washout) (For Type II only). Draw down the paint on a glass panel to a wet film thickness of 0.33 mm (0.013 in). Immediately place in a humidity chamber maintained at 23°C ± 2°C and 90% ± 3% relative humidity. Test in accordance with ASTM D 1640, except that the pressure exerted will be the minimum needed to maintain contact with the thumb and film. Check for compliance with 3.2.10.

4.3.16 Titanium dioxide content. Determine the titanium dioxide content using the aluminum reduction method of ASTM D 1394. Evaluate for conformance with 3.2.14.

## 5. PACKAGING.

5.1 Packaging, packing and marking. The paint shall be packaged in containers as required by the procurement documents. Unless otherwise specified, each container shall be labeled with the following information:

Name: PAINT, TRAFFIC AND AIRFIELD MARKING, WATERBORNE  
 Specification: TT-P-1952E, Type:  
 Color:  
 Batch Number:  
 Date of Manufacture:  
 Quantity of Paint in Container:  
 Information and Warnings as may be required by Federal and State Laws:  
 Manufacturer's Name and Address:

### 5.2 Special marking.

5.2.1 Shipping container markings. Each shipping container shall be marked:

“PROTECT FROM FREEZING - STORE ABOVE 2°C (35°F)”

5.2.2 Unit container markings. Each unit container shall be marked as follows:

“PROTECT FROM FREEZING - STORE ABOVE 2°C (35°F)”

“After opening, maintain a thin layer of water on surface of paint during storage to prevent skinning.”

“Use only in equipment designed for water-based paints.”

“This paint may be reflectorized by dropping glass beads conforming to TT-B-1325 onto the wet paint. The surface to be coated shall be free from dirt, oil, grease, curing compounds, or other contaminants, and loose, peeling, or poorly bonded paint. The paint shall be applied to the surface at a wet film thickness of 0.33 mm (0.013 in), while air and surface temperatures are above 10°C (50°F) and rising.”

## 6. NOTES.

INFORMATION FOR GUIDANCE ONLY. (This section contains information of a general or explanatory nature that is helpful, but is not mandatory.)

6.1 Intended use. (This paragraph is non-mandatory and shall not supersede specific use requirements in contract documents.) These paints are intended for use on concrete, bituminous, brick, or stone surfaces of airfields, highways, bridges, tunnels, streets, or parking lots when applied at a wet film thickness of 0.33 mm (0.013 in) by traffic-striping equipment designed for water-based paints. The white and yellow paint stripes should preferably be reflectorized for night visibility by adding glass beads conforming to TT-B-1325. A wet film thickness of 0.457–0.635 mm (0.018–0.025 in) is commonly specified when Type IV A beads are used and 0.381–0.457 mm (0.015–0.018 in) is commonly specified when Type IV B beads are used. The black paint is intended for use as a border around markings on light-colored pavements and as an obliterating paint for painting out existing markings to permit remarking in a different manner.

Type I - For use under normal weather conditions, i.e., 50% relative humidity, moderate temperatures and slight breezes. Not for use at the greater thickness required for the larger diameter Type IV beads.

Type II - For use under adverse conditions, i.e., night striping, higher humidity (around 80%), low air movement and lower surface temperatures, down to 10°C (50°F). Not for use at the greater thickness required for the larger diameter Type IV beads.

Type III - For use under normal weather conditions where higher durability and greater adhesion to glass beads is desired. Minimum application temperature should be 12.8°C (55°F) and rising. Low temperature will result in greater dry time, especially when specifying increased thickness as required when using Type IV beads.

6.2 Ordering data. Purchasers should select the preferred options permitted herein, and include the following information in procurement documents:

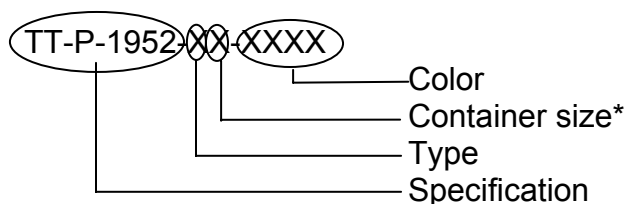


- a. Title and date of this specification.
- b. Type required (see 1.2).
- c. Color required (see 1.2.2 and 6.3).
- d. Size and requirements for containers (see 5.1).
- e. Packaging and packing level.
- f. Marking required (see 5.1 and 5.2).
- g. Requirements for Material Safety Data Sheets.

6.3 Colors. The most common colors and their FED-STD-595 color chip numbers are:

- a. Yellow – 33538
- b. Green – 34108
- c. Black – 37038
- d. Blue -- 35180
- e. Red – 31136
- f. White -- 37925

6.4 Part Identification number (PIN). Part numbers for cataloging purposes under this specification may be coded as follows:



\*Container size codes:

- 1 - 3.78 liters (1 gallon)
- 2 - 18.9 liters (5 gallons)
- 3 - 113.4 liters (30 gallons)
- 4 - 207.9 liters (55 gallons)

6.5 Key Word Listing.

- a. Paint
- b. Reflective beads
- c. Traffic
- d. Airfield

MILITARY INTERESTS

Custodian  
Air Force -- 99  
Navy – YD  
  
Reviewing Activity  
Air Force – 50

CIVIL AGENCY  
COORDINATING ACTIVITIES:

FAA – AAS – 100

Preparing Activity  
Air Force-84

Agent activity  
Air Force-99

Project 8010-2007-011

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <http://assist.daps.dla.mil>.

INCH-POUND  
TT-B-1325D  
06 August 2007  
SUPERSEDING  
TT-B-1325C  
June 1, 1993

## FEDERAL SPECIFICATION

### BEADS (GLASS SPHERES) RETRO-REFLECTIVE

The General Services Administration has authorized the use of this federal specification by all federal agencies.

#### 1. SCOPE AND CLASSIFICATION.

1.1 This specification covers three types of retro-reflective beads used to reflectorize traffic and airfield marking paints.

##### 1.2 Classification.

###### 1.2.1 Type I - Low Index of Refraction recycled glass (fire-polished process)

Gradation A (Coarse, Drop-on)

Gradation B (Fine, Premix)

Type II - Deleted

Type III - High Index of Refraction

Type IV - Low Index of Refraction direct melt glass (molten glass kiln process)

Gradation A (Large Coarse, Drop-on)

Gradation B (Medium Coarse, Drop-on)

#### 2. APPLICABLE DOCUMENTS.

2.1 Government Publications. The issues of the following documents, in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

##### FEDERAL LANDS, HIGHWAY

T 520-93 – Determining the Roundness of Large Glass Beads

##### FEDERAL STANDARDS

Beneficial comments, recommendations, additions, deletions, clarifications, etc. and any data which may improve this document should be sent to: HQ AFCESA/CESC, 139 Barnes Drive, Suite 1, Tyndall AFB FL 32403-5319.

FSC 8010

Distribution Statement A. Approved for public release. Distribution is unlimited.

FED-STD-141 - Paint, Varnish, Lacquer, and Related Materials; Methods of Inspection, Sampling and Testing

FED-STD-313 – Material Safety Data Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities

(Single copies of this specification, and other federal specifications and commercial item descriptions required by activities outside the Federal Government for bidding purposes are available without charge from the General Services Administration, Federal Supply Service, Specification Section, Suite 8100, 470 L'Enfant Plaza, SW, Washington, DC, 20407)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on the date of invitation for bids or request for proposal shall apply.

American Society for Testing and Materials (ASTM) Standards:

D 1155 - Standard Test Method for Roundness of Glass Spheres

D 1214 - Standard Test Method for Sieve Analysis of Glass Spheres

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, (610) 832-9500, [www.astm.org](http://www.astm.org).)

National Motor Freight Traffic Association, Inc. Agent:

National Motor Freight Classification

(Application for copies should be addressed to the ATA, Inc., Traffic Department, 2200 Mill Road, Alexandria, VA 22314, [www.nmfta.org](http://www.nmfta.org).)

National Railroad Freight Committee, Agent:

Uniform Freight Classification

(Application for copies should be addressed to G.F. Earl, Tariff Publishing Officer, Suite 1120, 222 South Riverside Plaza, Chicago, IL 60606-5945)

### 3. REQUIREMENTS.

3.1 Composition. The Type I beads shall be manufactured entirely from reclaimed scrap glass (soda lime cullet). No specific ingredients are required for the Type III beads. The Type IV beads shall be manufactured by a direct-melt process resulting in no visible carbon residue.

### 3.2 Physical properties.

3.2.1 Appearance. When tested as specified in 4.3.1, the beads shall be transparent, clean, dry, free-flowing, and free from bubbles and foreign matter.

3.2.2 Roundness. When tested as specified in 4.3.2, Type I and Type III beads shall contain not less than 80 percent by weight of true spheres. The Type IV beads shall contain not less than 85 percent by weight of true spheres.

3.2.3 Index of refraction. When tested as specified in 4.3.3, the index of refraction shall be as follows: For Type I and Type IV beads 1.50 to 1.55; for Type III beads 1.90 to 1.93.

3.2.4 Specific gravity. When tested as specified in 4.3.4, the specific gravity shall be as follows: For Type I and Type IV beads 2.30 to 2.50; for Type III beads 4.00 to 4.50.<sup>1</sup>

3.2.5 Gradation. When tested as specified in 4.3.5, the beads shall pass each sieve series, as specified in Table I.

Table I. Gradation, percent by weight, passing.

U.S. Sieve #	Microns	Type I				Type III		Type IV			
		A		B				A		B	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
12	1700	---	---	---	---	---	---	100	---	100	---
14	1400	---	---	---	---	---	---	95	100	---	---
16	1180	---	---	---	---	100	---	80	95	95	100
18	1000	---	---	---	---	---	---	10	40	---	---
20	850	100	---	---	---	95	100	0	5	35	70
30	600	80	100	---	---	55	75	---	---	0	5
40	425	---	---	---	---	15	35	---	---	---	---
50	300	18	35	---	---	0	5	---	---	---	---
70	212	---	---	100	---	---	---	---	---	---	---
80	180	---	---	85	100	---	---	---	---	---	---
100	150	0	10	---	---	---	---	---	---	---	---
140	106	---	---	15	55	---	---	---	---	---	---
200	75	0	2	---	---	---	---	---	---	---	---
230	63	---	---	0	10	---	---	---	---	---	---

<sup>1</sup> For field verification, the mass of Type I and Type IV beads should be 1570 grams per liter and Type III should be 2670 grams per liter.

3.2.6 Resistance to acid. When tested as specified in 4.3.6, the beads shall not develop any surface haze or dulling.

3.2.7 Resistance to calcium chloride. When tested as specified in 4.3.7, the beads shall not develop any surface haze or dulling.

3.2.8 Resistance to sodium sulfide. When tested as specified in 4.3.8, the sodium sulfide should not darken the beads.

3.2.9 Water resistance. When tested as specified in 4.3.9, the water shall not produce haze or dulling of the beads, and not more than 4.5 mL of 0.1 N hydrochloric acid shall be used in the titration.

3.3 Material Safety Data Sheet. A Material Safety Data Sheet (MSDS) shall be submitted in accordance with FED-STD-313 (see 6.2).

#### 4. QUALITY ASSURANCE PROVISIONS.

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the government. The government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

##### 4.2 Quality conformance inspection.

4.2.1 Lot. A lot shall consist of all beads of one type offered for inspection at one time.

4.2.2 Inspection of preparation for delivery. An inspection shall be made to determine that the packing and marking comply with Section 5 of this specification. The sample unit shall be one filled shipping container for each ten ordered, randomly selected from the lot.

4.2.3 Sampling of the end item. Sampling shall be random in the ratio of 45 kg (100 lb) sample (in full bags) per 4,535 kg (10000 lb) shipped. Upon delivery, the material shall be reduced in a sample splitter to a size of approximately 1 kg (2.2 lb). The sample shall be submitted to the laboratory for testing.

4.2.4 Certificate of compliance. When Type I or Type IV beads are offered for inspection, the manufacturer shall certify that the beads conform to the requirements of 3.1.

4.3 Test procedure. The beads shall be tested in accordance with the methods specified in Table II and as otherwise specified herein to determine compliance with the requirements of section 3. Unless otherwise specified all tests shall be conducted at conditions specified in Section 9 of FED-STD-141. All test reports shall contain the individual values used in expressing the final results. Failure to pass any tests, or noncompliance with any requirement, shall be cause for rejection of the sample.

Table II. Tests and methods.

Characteristics	Requirement Paragraph	ASTM Method	Test Method Paragraph
Appearance	3.2.1	--	4.3.1
Roundness	3.2.2	D 1155	4.3.2
Index of refraction	3.2.3	--	4.3.3
Specific gravity	3.2.4	--	4.3.4
Gradation	3.2.5	D 1214	4.3.5
Resistance to acid	3.2.6	--	4.3.6
Resistance to calcium chloride	3.2.7	--	4.3.7
Resistance to sodium sulfide	3.2.8	--	4.3.8
Water resistance	3.2.9	--	4.3.9

TT-B-1325D

4.3.1 Appearance. Spread thinly 10 g of sample on white bond paper and examine visually for compliance with 3.2.1.

4.3.2 Roundness. The roundness of the Type I and Type III beads shall be determined in accordance with ASTM method D 1155. Use Procedure A for Type III beads and Procedure B for Type I beads. The roundness of the Type IV beads shall be determined in accordance with FLH Designation T 520-93. Evaluate for compliance with the requirements in 3.2.2.

4.3.3 Index of refraction. The index of refraction shall be determined by the immersion method. A microscope capable of a minimum of 100x magnification, equipped with a light source and certified immersion oils shall be used. Place crushed beads on a microscope slide and immerse in a refractive index immersion oil at standard conditions. (The immersion oil shall have a refractive index within 0.02 units of that of the beads to be tested.) Cover with a microscope slide and determine the refractive index of the beads to the nearest one-hundredth of a unit. Evaluate for compliance with the requirements of 3.2.3.

4.3.4 Specific gravity. Place 100 g of the beads in an oven at  $105^{\circ}\text{C} \pm 2^{\circ}\text{C}$  and dry to constant weight. Remove the beads and place in a desiccator until the sample is cool. Remove 60 g of beads from the desiccator and weigh the sample accurately. Pour the beads slowly into a 100 mL graduated cylinder containing 50 mL of reagent-grade xylene. Make certain that air is not entrapped among the beads. Calculate the specific gravity as follows:

$$\text{Specific gravity} = \frac{M}{V - 50}$$

$M$  = Mass of sample

$V$  = total volume (xylene level after addition)

Evaluate for compliance with 3.2.4.

4.3.5 Gradation. Determine the gradation of the beads in accordance with ASTM method D 1214 for compliance with 3.2.5.

4.3.6 Resistance to acid. Place 10 g of the beads in a 100 mL beaker and cover with a 1N sulfuric acid. Let soak for 5 minutes. Rinse the beads 3 times with distilled water. Dry, then examine the beads under a microscope and compare with the untreated sample. Evaluate for compliance with 3.2.6.

4.3.7 Resistance to calcium chloride. Place 10 g of the beads in a 100 mL beaker and cover with a 1N calcium chloride solution. Let soak for 3 hours. Rinse the beads 3 times with distilled water. Dry, then examine the beads under a microscope and compare with the untreated sample. Evaluate for compliance with 3.2.7.

4.3.8 Resistance to sodium sulfide. Place 10 g of the beads in a glass stopper bottle and cover with a solution containing by weight 50% sodium sulfide, 48% distilled water, and 2% of an anionic wetting agent. Soak the beads for one hour and then rinse the beads 3 times with distilled water. Dry, then examine the beads under a microscope and compare with untreated sample. Evaluate for compliance with 3.2.8.

4.3.9 Water resistance. Place 10 g of the beads in a 20 x 80 mm extraction thimble. Place the thimble in a large (No. 3) Soxhlet extractor with a 125 mL boiling flask. Add 100 mL of distilled water, and reflux for two hours. Rinse the beads 3 times with distilled water. Remove the beads, dry, then examine the beads under a microscope and compare with untreated beads. Add five drops of one percent phenolphthalein indicator to the content of the boiling flask and titrate with 0.1N hydrochloric acid to the phenolphthalein indicator end point. Evaluate for compliance with 3.2.9.

## 5. PACKAGING.

5.1 Preservation. The glass beads shall be furnished in lots as specified by the purchaser and packaged in moisture-proof containers. Containers shall be in accordance with the supplier's normal commercial practice, provided that there will be no interaction chemically or physically with the contents so as to damage the containers or alter the strength, quality, or purity of the contents. Containers are to be guaranteed to furnish dry and undamaged beads. The container shall be securely closed to prevent accidental opening or loss of the glass beads, and sufficiently strong to prevent



accidental rupture during multiple shipments, handling and storage. The shipping containers shall also comply with the National Motor Freight Classification or Uniform Freight Classification requirements.

5.1.1 Packing. Beads shall be furnished in quantities specified. The preservation, packing and marking shall be as specified below (see 6.2).

5.1.2 Marking. Each package shall contain the following information: Name and address of manufacturer, shipping point, trademark or name, the wording; "Glass Beads, Retro-reflective", the specification number, bead type, weight of the contents in kg and lb, the lot or batch number, information and warnings as may be required by federal and state laws, and the month and year of manufacture. Additional markings shall be as specified in the contract or order.

## 6. NOTES.

INFORMATION FOR GUIDANCE ONLY. (This section contains information of a general or explanatory nature that is helpful, but is not mandatory.)

### 6.1 Intended use.

Type I, Gradation A, coarse - low-index recycled glass beads for drop-on applications are intended for marking highways and all airfield markings.

Type I, Gradation B, fine - low-index glass beads for premixed paint are intended for marking highways, or for use in applying temporary airport or airfield markings.

Type III - high index glass beads for drop-on applications are intended for applications where increased retro-reflectivity is needed.

[NOTE: The increased retro-reflective values obtained from use of high index of refraction glass beads are only apparent to the observer in cases where the observer's line of sight is in close proximity to the path of the light source used to illuminate the markings. Studies by the USAF and the Federal Aviation Administration have shown that in cases where the light source is not in close proximity to the viewer's eye position, the added benefit from the use of the higher index of refraction beads is negligible.]

Type IV Gradation A – Large coarse, direct-melt, low-index glass beads for drop-on applications are intended for highways and all airfield markings.

Type IV Gradation B – Medium coarse, direct-melt, low-index glass beads for drop-on applications are intended for highways and all airfield markings.

See appropriate pavement marking guide for specific recommended uses and application rates.

6.2 Ordering Data. Purchasers should select the preferred options permitted herein and indicate the following information in procurement documents:

- a. Title, number, and date of this specification.
- b. Type and gradation required (see paragraphs 1.2.1 and 6.1).
- c. Size and type of container required (see 5.1).
- d. Palletization requirements.
- e. Special Marking requirements.
- f. Instructions and address for submission of MSDS (see 3.3).

6.3 Key Word Listing.

- a. Paint
- b. Reflective beads
- c. Traffic
- d. Airfield

MILITARY INTERESTS

Custodian  
Air Force -- 99  
Navy -- YD  
  
Reviewing Activity  
Air Force -- 50

CIVIL AGENCY  
COORDINATING ACTIVITIES:

FAA – AAS – 100

Preparing Activity  
Air Force-84

Agent activity  
Air Force-99

Project 8010-2007-009

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <http://assist.daps.dla.mil>.