

FACILITIES CRITERIA (FC)

AIR FORCE AIRCRAFT ARRESTING SYSTEMS (AAS) INSTALLATION, OPERATION, AND MAINTENANCE (IO&M)



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**AIR FORCE
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INSTALLATION, OPERATION, AND MAINTENANCE (IO&M)**

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AIR FORCE CIVIL ENGINEER CENTER (Preparing Activity)

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

Change No.	Date	Location

CANCELLED



FOREWORD

Facilities Criteria (FC) provide functional requirements (i.e., defined by users and operational needs of a particular facility type) for specific DoD Component(s), and are intended for use with unified technical requirements published in DoD Unified Facilities Criteria (UFC). FC are applicable only to the DoD Component(s) indicated in the title, and do not represent unified DoD requirements. Differences in functional requirements between DoD Components may exist due to differences in policies and operational needs.

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 FC), the SOFA, the HNFA, and the BIA, as applicable. Because FC are coordinated with unified DoD technical requirements, they form an element of the DoD UFC system applicable to specific facility types. The UFC system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applicable to the Military Departments, Defense Agencies, and the DoD Field Activities. The UFC System also includes technical requirements and functional requirements for specific facility types, both published as UFC documents and FC documents.

FC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQ USACE), Naval Facilities Engineering Command (NAVFAC), and the 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 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.

FC 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, *General Building Requirements*, for implementation of new issuances on projects.

AUTHORIZED BY:



RANDY E. BROWN, SES II, DAF

Director

Air Force Civil Engineer Center

**FACILITIES CRITERIA (FC)
NEW SUMMARY SHEET**

Document: FC 3-260-18F, *AIR FORCE AIRCRAFT ARRESTING SYSTEMS (AAS) INSTALLATION, OPERATION, AND MAINTENANCE (IO&M)*

Superseding: None

Description: Unless specified otherwise, requirements within this FC are mandatory and apply to all military, Department of Defense (DoD) or Department of Transportation (DoT) Federal Aviation Administration (FAA) civilians, or DoD contracted personnel who are tasked to install, operate, maintain, repair, or otherwise participate in or affect operation or use of an AAS owned or operated by the Air Force. This includes firefighters or other first-responder personnel and augmentees. Specifically, installation, maintenance and operation of all Air Force AAS must comply with the requirements provided in AFI 32-1043, *Managing, Operating, and Maintaining Aircraft Arresting Systems*, UFC 3-260-01, *Airfield and Heliport Planning and Design*, UFC 3-260-02, *Pavement Design for Airfields*, and UFC 3-535-01, *Design Standards for Visual Air Navigation Facilities*. Maintenance procedures, repair parts, and materials necessary to install, operate, and maintain each energy absorbing system, net engaging barrier, or hook cable support system, must comply with the requirements in this FC and in the appropriate and specific 35E8 Series Technical Order (T.O.) or approved Manufacturer's Manual.

Reasons for Document:

- Provide technical requirements for installation, operation, and maintenance of Aircraft Arresting Systems.
- Consolidate criteria located in multiple documents.
- Update information to reflect new and revised standards.

Impact: There are minor cost impacts associated with this FC. However, the following benefits should be realized

- Standardized guidance has been prepared to assist engineers in the development of the plans, specifications, calculations, and Design/Build Request for Proposals (RFPs).

Unification Issues

None

Note: *Use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this FC does not imply endorsement by the Air Force.*

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CHAPTER 1 OBTAINING AIRCRAFT ARRESTING SYSTEMS

1-1 NEW SYSTEMS

1-1.1 For new systems refer to AFI 32-1043, *Managing, Operating and Maintaining Aircraft Arresting Systems*.

1-2 TEMPORARY SYSTEMS (CONSTRUCTION PROJECTS, AIR SHOWS, EXERCISES)

Submit requests for temporary use of expeditionary Aircraft Arresting Systems (AAS) to HQ AFIMSC/IZB at least two months before the system must be in place and operational. (Air National Guard units request support through the Air National Guard Civil Engineer Technical Support Center [NGB/A7OC], Minot, ND).

1-2.3 Information Required

Give the following information in all requests:

- Number of systems needed.
- Reason the systems are needed, including the type of aircraft that will be using the systems.
- Geographic location of the requirement including the Stock Record Account Number (SRAN).
- Date the systems need to be operational.
- Date the systems can be removed.
- Points of contact and telephone numbers for the AAS Shop, Airfield Management, Safety, and Fire Department.

1-2.4 Operations and Maintenance Personnel

With the request for temporary AAS support for a mission, specify the intended source and the number of personnel who will operate and maintain the expeditionary system(s) at the site, including qualification levels.

1-2.5 Funding Source

The requesting activity must provide a fund citation to cover all costs associated with supporting the expeditionary installation. Including costs for:

- Shipment of the equipment.
- Transportation and per diem for temporary duty personnel.

- Expendable materials such as tapes, cables, and repair materials and parts including fuels, oils and lubricants.
- Repair or replacement of damaged items.
- Installation costs for equipment, materials, and other supplies.

1-2.6 Where to Send Requests

Send the information to the appropriate MAJCOM Civil Engineer at the appropriate address below (e-mail requests are encouraged):

AFIMSC Det 8 (ACC),

AFCENT/A7O,

NGB/A7OC,

AFIMSC Det 4 (USAFE),

AFIMSC Det 2 (PACAF)

1-2.7 Processing Time

The appropriate MAJCOM Civil Engineer evaluates each request on the basis of availability of personnel, equipment, and priority. It approves or disapproves requests within 10 working days.

CHAPTER 2 SITING SYSTEMS

2-1 INTRODUCTION

AAS and emergency overrun barriers are installed in several configurations. Typically, overrun barriers (nets such as MA-1A and BAK-15) and emergency arrestors such as E-5 chain gear (CHAG), Textile Brake, or soft ground arrestor systems (such as Engineered Material Arrestor Systems (EMAS) are installed as redundant systems for emergency recovery only. As such, they are installed in the overrun area of the runway. Operational arresting systems, such as BAK-12, are usually installed between the runway thresholds. This is necessary to allow pilots to touch down on the normal landing surface and stabilize the tail-hook before engagement. Fairlead beams or runway edge sheaves are used to direct the purchase tape path, and are installed on the runway shoulders to allow the energy absorber to be installed outside the mandatory zone of frangibility (at least 84 meters [275 feet] away from the runway centerline). Support ramps are constructed to lead up to exposed vertical surfaces of fairlead beams and tape tubes, allowing an aircraft to roll over them smoothly. Arresting gear that is installed on grade must have an "airfield friendly" structure built over it to protect the equipment from environmental degradation. The design should be in compliance with Typical Installation Drawings 67F2011A (on-grade with shelter) or 67F2012A (installed below grade within a vault), as applicable, this instruction, the applicable 35E8-series T.O., and the requirements detailed within UFC 3-260-01 (Chapter 3 and Appendix B13). Do not install any arresting system where the run-out will conflict with any other arresting system or any obstacle such as elevated airfield lights or signs. Although intervening taxiways may be within the run-out area, such cases should be avoided if possible to preclude blocking the intersection during an engagement, and increased wear to tapes caused by dragging them through the warped pavement interface between a centerline crowned taxiway and the runway. In cases where criteria cannot be met, a waiver must be established according to UFC 3-260-01 and/or the applicable 35E8-series T.O., as appropriate.

2-2 SITING OPERATIONAL SYSTEMS

The large rectangular pavement markings (fixed distance markings) located 300 meters (1000 feet) from the threshold represent the ideal aim point for pilots on approach to landing. Other visual landing aids, such as the visual glide slope indicator system, cue the pilot to touch down approximately 300 meters (1000 feet) from the threshold. This ensures a minimum threshold crossing height of at least 11 meters (35 feet). Since stabilizing the tail-hook after touchdown requires a distance of 150 to 240 meters (500 to 800 feet), the best location for an arresting system that accommodates approach end engagements is 450 to 540 meters (1500 to 1800 feet) from the threshold. Runways used extensively during instrument meteorological conditions may require that the system be sited as much as 670 meters (2200 feet) from the threshold; however, if aircraft that are not compatible with trampling the pendant must operate on the same runway, the installation commander may shift the installation site as close to the threshold as possible, but not closer than the distance that will allow an unobstructed runout with a standard BAK-12 system set-up (see paragraph 3.14 and T.O. 35E8-2-5-1, *Operation and Maintenance Instructions – Aircraft Arresting System Model BAK-12*). It

is critical that the runout area for an aircraft engaging the system from either direction not conflict with other AAS components (cables or cross runway troughs) or other equipment such as threshold or runway end light fixtures. Other operating scenarios, such as northern tier locations with heavy snow or ice accumulation, may dictate that you place an additional system at the midpoint of the runway. The installation commander must approve installation of a midfield AAS after coordinating the plan with the host MAJCOM/A3, SE, and MAJCOM Civil Engineer.

2-3 SITING EMERGENCY SYSTEMS

Locate unidirectional AAS and barriers (nets) in the overrun area of the runway. The energy-absorbing device dictates the distance from the threshold because of the need to maximize system run-out. Do not locate unidirectional systems or net barriers closer than 11 meters (35 feet) from the threshold of the runway. Note: Runway threshold markings begin 6 meters (20 feet) inboard of the full-strength pavement; therefore, do not install a unidirectional system within 17 meters (55 feet) of the beginning of the longitudinal threshold markings. Do not mark AAS warning markings on the pavement in overruns, or install arresting gear marker (AGM) lighted signs adjacent to AAS in the overrun to identify the locations of these systems. Installation of these markings and signs might cause a pilot to attempt an approach end engagement with the system.

CHAPTER 3 INSTALLATION REQUIREMENTS

3-1 MANDATORY REQUIREMENTS AND WAIVERS

Comply with the following standards when locating, configuring, installing, or repairing an AAS. BCEs must obtain the installation commander's approval and coordinate with MAJCOM/A3, SE, and MAJCOM Civil Engineer before deviating from these standards. A waiver to UFC 3-260-01 or the applicable 35E8-series T.O. will be required if these standards cannot be met. See paragraph 3-10 for information with regard to systems installed under previous standards.

3-2 LOCATING ARRESTING SYSTEMS

The BCE's designated representative determines the configuration and location of arresting systems in cooperation with representatives from A3 and SE. Design must conform to the configuration criteria of the appropriate 35E8-series T.O., the Typical Installation Drawings, the requirements in this FC, and UFC 3-260-01. In cases where criteria cannot be met, a waiver must first be established and approved according to UFC 3-260-01 and/or the applicable T.O., as appropriate.

3-3 PLACEMENT OF ENERGY ABSORBERS

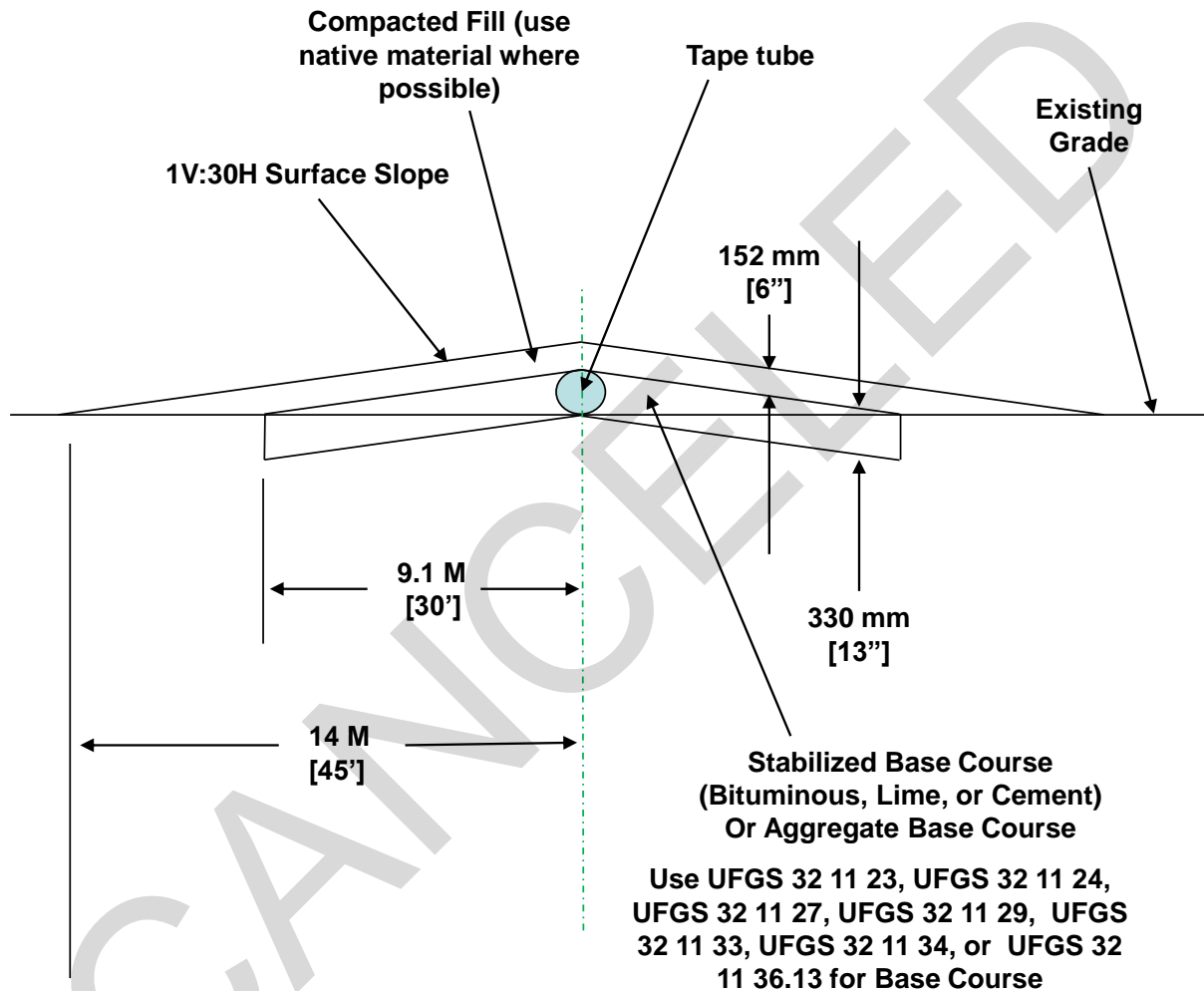
Locate all energy absorbers below grade or at least 84 meters (275 feet) from the runway centerline. (Exceptions: MA-1A and E-5 ship's anchor chains and textile brake modules may be located along the runway overrun shoulders. Bi-directional textile brake modules may be located either along the overrun or runway shoulders.) Provide paved transitions and buried crushed stone ramps around the arresting system components and a paved service road to the site from the runway, as well as a location other than the runway (beyond the controlled movement area or outside the Runway Safety Area (RSA) on civil airfields). Pit-type installations may be sited closer to the runway as long as they meet the minimum split-distance required (15.2 meters (50 feet) for BAK-12); however, all above-grade appurtenances must be frangible, the transition to the pit cover must meet runway shoulder grade allowances given in Chapter 3 of UFC 3-260-01, and the pit cover and door must be designed to support wheel loads in accordance with UFC 3-260-01, Chapter 3, "Shoulders" (paved or unpaved, as applicable).

3-4 SHOULDER REQUIREMENTS

Where fairlead beams, edge sheaves, and tape tubes project above the grade of the existing runway shoulders, provide suitable fill materials and compaction next to or over these components to a finished grade of 1V:30H or flatter. Tape tubes must be steel or ductile iron. Tape tubes of other materials must be programmed for replacement and inspected monthly for signs of damage or degradation. For new installations, select tape tubes that are capable of supporting wheel loads in accordance with UFC 3-260-01, Chapter 3, "Shoulders" (paved or unpaved, as applicable). See Figure 3-1 for construction details.

Figure 3-1 Unpaved Runway Shoulder Construction Details Adjacent to Tape Tubes

Tape Tube Ground Preparation on Unpaved Shoulder



3-5 OBSTRUCTION MARKING AND LIGHTING REQUIREMENTS

Provide obstruction marking and lighting and arresting system location marking and lighting according to the provisions of Air Force Instruction (AFI) 32-1042, *Standards for Marking Airfields* (future UFC 3-260-04, *Airfield and Roadway Marking*), and UFC 3-535-01, *Visual Air Navigation Systems*. This requirement also applies to temporary installations for construction or air shows unless waived within the temporary waiver by the Installation Commander or the designated authority. See UFC 3-260-01, Appendix B, Section 1. Do not mark AAS warning markings on the pavement in overruns, or install arresting gear marker (AGM) lighted signs adjacent to AAS in the

overrun to identify the locations of these systems. Installation of these markings and signs might cause a pilot to attempt an approach end engagement with the system.

3-6 ABOVE-GRADE SYSTEM SHELTERS

Provide protective shelters constructed for on-grade installations must be constructed from lightweight framing materials and sheathing using connections that will allow the structure to break away or collapse if struck by an aircraft wing. See UFC 3-260-01, Appendix B, Section 13. Provide shelters with a removable roof or end wall, or a door opening to facilitate major maintenance or replacement of the equipment. Also provide proper ventilation and windows that will allow the operator to view the runway and tape sweep areas in both directions. See Typical Installation Drawing 67F2011A, Sheet 2, Note 3.

3-7 PAVEMENT ADJACENT TO CABLES

3-7.1 The center 23 meters (75 feet) of pavement extending out for 60 meters (200 feet) on both the approach and departure sides of the arresting system pendant are critical areas. Exception: 46 meter (150-foot) -wide runways with BAK-14 systems, the critical area is limited to the off-center engagement capability for the BAK-14 system, which is the center 18 meters (60 feet) of runway pavement. For wider runways, the critical area is the center 23 meters (75 feet) of runway pavement for BAK-14 or any other model AAS, regardless of the stated off-center engagement capability.

3-7.2 Within these critical areas, protruding objects such as centerline lights or reflectors, excessive paint build-up, and undulating surfaces are detrimental to successful tail-hook engagements and are not allowable. The maximum permissible longitudinal surface deviation in this area is ± 3 millimeters (± 0.125 inch) in 4 meters (12 feet). This does not apply to the channels in grooved pavement surfaces.

3-7.3 The prohibition on changes in pavement type does not apply to arresting system cables located in overruns because overruns are constructed of asphaltic pavement, and the first 305 meters (1000 feet) of runways are constructed from Portland cement concrete (PCC).

3-7.4 Grooves to improve surface drainage and surface friction characteristics are not permitted within 3 meters (10 feet) of arresting system cables due to potential for increased surface wear due to cable slap during trampling.

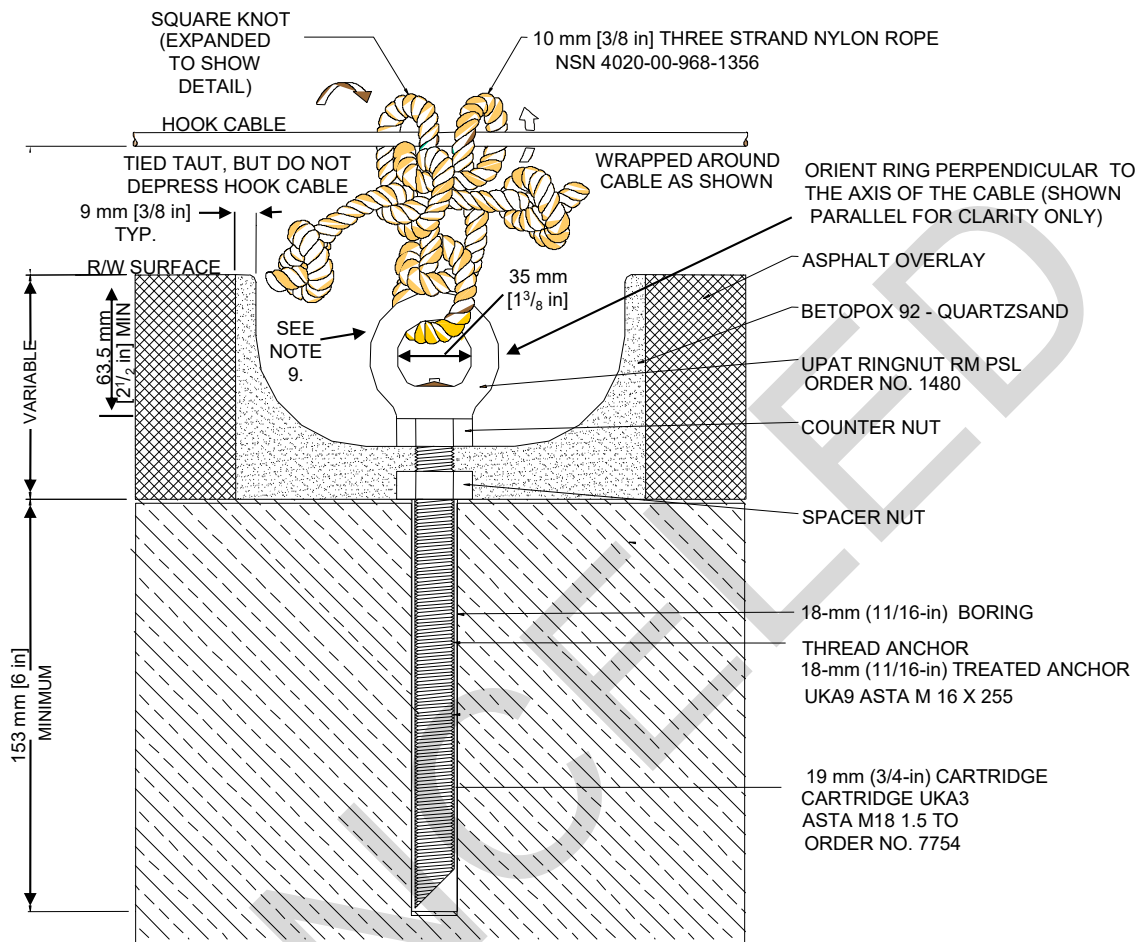
3-7.5 Changes in pavement type or an interface between rigid and flexible pavements are not permitted within 60 meters (200 feet) of arresting system cables in the center 23 meters (75 feet) of the runway. This does not apply to emergency systems located within overruns, sacrificial panels installed beneath cables, or to PCC anchor blocks installed for anchoring cable tiedowns in flexible pavement systems. These are not considered a change in pavement type because the individual foundations are not formed continuously from one tiedown to the next. This specifically prohibits rigid inlays from being used as a surface repair material beneath the cable in flexible runway pavement systems like hot mixed asphalt (HMA). This type repair causes high hook-

skip potential when the flexible pavement consolidates, exposing the leading edge of the rigid pavement. However, rigid pavement must be used as a foundation under sacrificial panels installed beneath AAS cables in both rigid and flexible pavement systems. In these cases, no part of the rigid foundation can be used as a top-wearing surface.

3-8 CABLE ANCHOR INSTALLATION REQUIREMENTS

Install cable tiedown anchors for operational systems (systems located between the runway thresholds) to limit cable bounce and potential aircraft damage during aircraft rollover. Install eight anchors for all operational systems regardless of primary aircraft supported on the airfield. Program systems with four anchor points to be upgraded to eight anchor points. When using the Mobile Aircraft Arresting System (MAAS) or other expeditionary cable systems for other than an air show or a short-term construction project, add cable tiedowns to the runway to prevent aircraft damage during aircraft roll-over and engagements. This also applies at forward operating locations, but may have to be postponed until time and materials are available to accomplish the work. Install anchors at 3-meter (10-foot) intervals centered on the runway width for eight-point tiedowns. For rigid pavements, it is desirable that all anchor locations be offset at least 609 millimeters (24 inches) from pavement joints. The minimum offset from pavement joints for anchor locations is 300 millimeters (12 inches). If sacrificial panels will be installed, see paragraph 3-14 for anchor spacing. See Figures 3-2 through 3-6 for various cable tiedown designs and installation details. Any of the three styles of anchors may be used for flexible or rigid runway pavements but the anchor block details shown in Figure 3-6 and the Typical Installation Drawings 67F2011A and 67F2012A are specifically designed for flexible pavement systems.

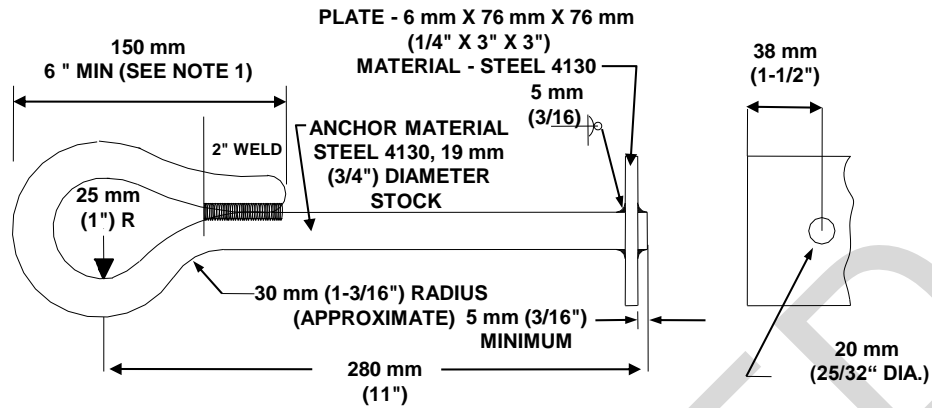
Figure 3-2 Designed Tiedown for Porous Friction Surfaces
(formerly “Alternate Cable Tiedown Anchor Installation”)



NOTES:

1. See paragraph 3-8 on cable tie-downs and locations for number and placement of tie-downs.
2. Tie-down ropes will be approximately 1,200 millimeters (48 inches) long.
3. Ring nut shall be perpendicular to pendant cable.
4. Minimum anchor insertion into Portland cement concrete shall be 153 millimeters (6 inches).
5. Tie-down anchor bowl shall not exceed 127 millimeters (5 inches) in diameter.
6. Ring nut shall be tightened to full thread depth and locked to the anchor with a thread locking compound.
7. Threaded anchors shall be set with an impact type drilling machine.
8. See paragraph 3-8 for placement of anchors within 609 millimeters (24 inches)
9. Top of ring nut shall be recessed approximately 12 millimeters (0.5 inch) below the runway surface.

Figure 3-3 4130 Grade Steel Cable Tiedown Anchor



NOTE:

This area must be cadmium plated and conform to spec QQ-P-416 Class 1, Type 1.

Figure 3-4 Installation of 4130 Grade Steel Cable Tiedown Anchor

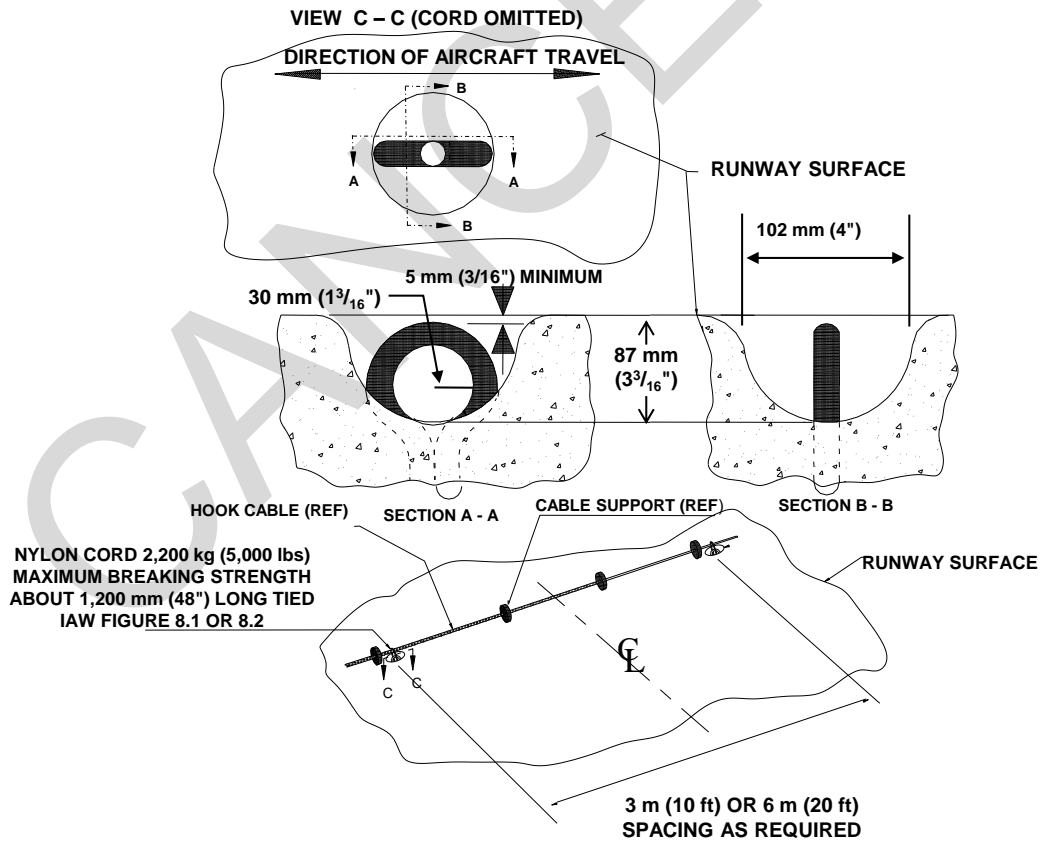
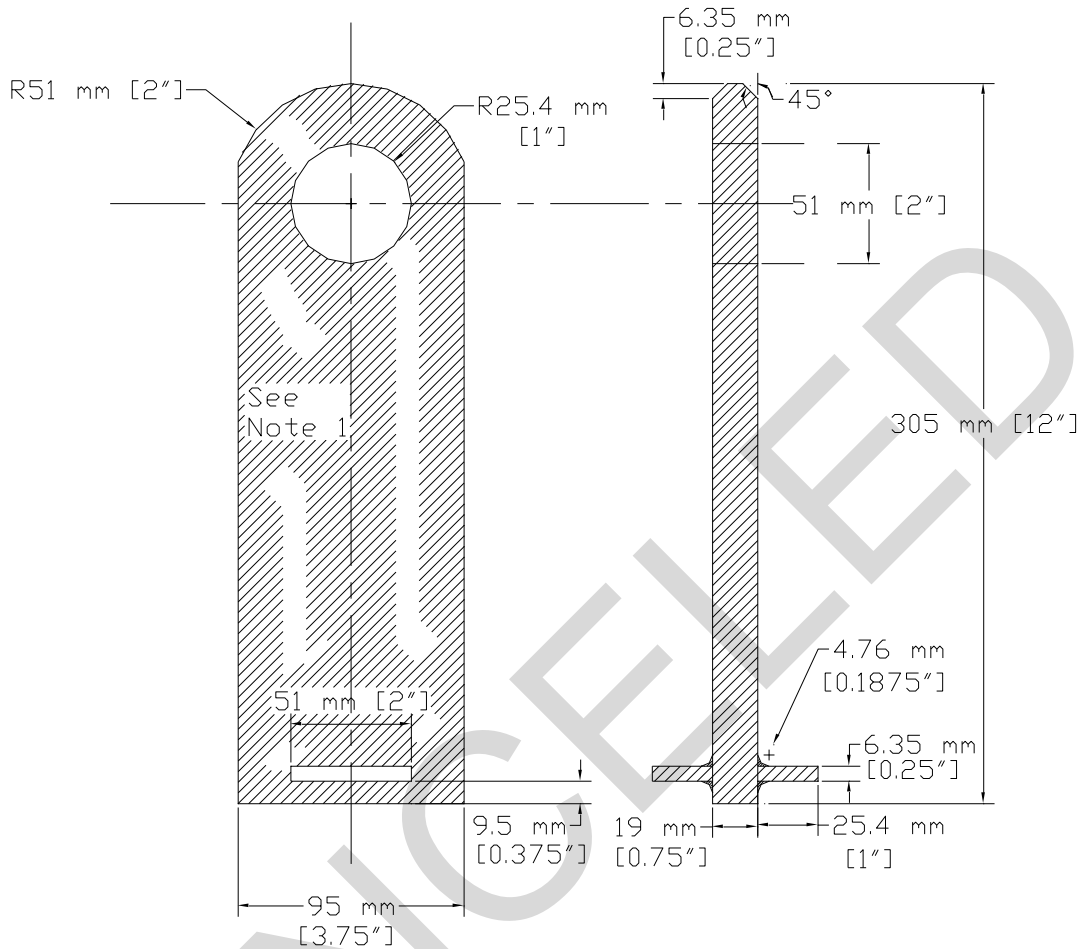


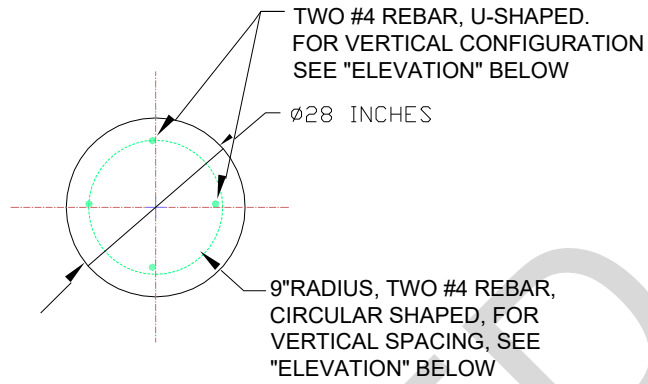
Figure 3-5 Locally Manufactured Cable Tiedown Anchor



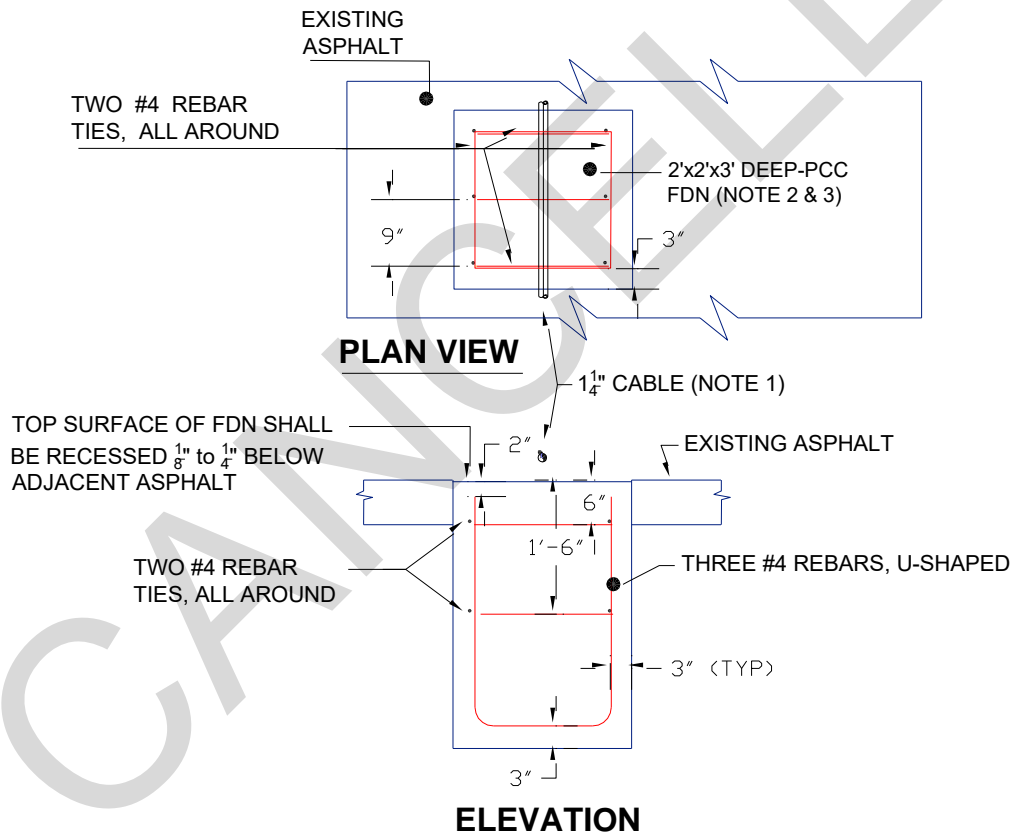
NOTES:

1. Anchor stock is ASTM A36 steel, 19 mm [$\frac{3}{4}$ "] by 95 mm [3.75"].
2. Anti-pull-out wings are 6.35 mm [$\frac{1}{4}$ "] by 51 mm [2"] by 25.4 mm [1"] ASTM 36 flat bar with 4.76 mm [$\frac{3}{16}$ "] fillet weld all around.
3. Chamfer top edges of anchor radius 6.35 mm [$\frac{1}{4}$ "] at 45°.
4. Remove sharp edges from 52 mm [2"] diameter through hole.
5. Coat with cold galvanized coating or two-part epoxy paint suitable for marine applications.
6. Orient anchor with the hole aligned parallel with the cable.

Figure 3-6 Tiedown Foundation Detail for Flexible Pavement Systems



REBAR PLACEMENT, ROUND FOUNDATION



NOTES:

1. CENTER FOUNDATION UNDER CABLE.
2. LOCATE ANCHOR IN CENTER OF FOUNDATION.
3. CUT ASPHALT AS REQUIRED TO EXCAVATE FOR, AND PLACE PORTLAND CEMENT CONCRETE FOUNDATION. FOUNDATION MAY BE ROUND (28" DIAMETER) TO ALLOW USE OF AUGER FOR EXCAVATION.

3-10 GRANDFATHERED SYSTEMS

On-grade BAK-12 systems installed before 1 July 1977 that are sited at least 76.2 meters (250 feet) from the runway centerline do not have to be relocated to meet the minimum setback requirement of 84 meters (275 feet) from the runway centerline. All systems equipped with 2-roller edge sheaves or 2-roller fairlead beams must be programmed for retrofit with 3-roller fairlead beams or edge sheaves to eliminate the longitudinal wheel abutment along the runway shoulder. Replacement foundations must be constructed as described in paragraphs 3.3, 3.4, and Typical Installation Drawings 67F2011A or 67F2012A to comply with the 1V:30H (3.3 percent) maximum slope requirement along the runway shoulder (see UFC 3-260-01, Table 3.2). The unpaved shoulder areas adjacent to the tape tubes must be constructed to comply with Figure 3-1.

3-11 INSTALLING SYSTEMS AT JOINTLY-USED AIRPORTS

3-11.1 The FAA acts for and on behalf of the DoD Service component in operating arresting systems installed at jointly used civil airports for the primary use of U.S. military aircraft.

3-11.2 Site arresting systems on civil airports jointly used by civil and military aircraft according to FAA Advisory Circular (AC) 150/5220-9, *Aircraft Arresting Systems*.

3-11.3 To install an arresting system at a jointly used civil airport, the installation commander must first notify the airport manager (or authority) of the need. If the airport manager agrees, the installation commander submits the plan with sketches or drawings to the Air Force liaison officer at the FAA regional office. Refer any disagreement between the responsible officials to the next higher level within the chain of command.

3-11.4 If construction involves a lease agreement that does not allow placing additional structures on the leased premises, contact the MAJCOM Civil Engineer.

3-11.5 Third-party claims presented for damage, injury, or death resulting from FAA operation of the system for military aircraft or from the Air Force or Air National Guard maintenance of the system may be the responsibility of the Air Force. Process such claims under the appropriate Air Force regulatory guidance (AFI 51-502, *Personnel and Government Recovery Claims*).

3-11.6 The FAA is responsible for claims presented for damage resulting from FAA operation of the system for civil aircraft; therefore, separate agreements between DoD and FAA concerning liability for such damage are not necessary.

3-11.7 The MAJCOM negotiates the operational agreement with FAA for a jointly used civil airport. The MAJCOM may delegate this authority to the installation commander. The agreement describes FAA functions and responsibilities concerning the remote-control operation of arresting systems by FAA air traffic controllers. See Appendix C for a sample letter of agreement.

3-12 MILITARY RIGHTS AGREEMENTS FOR FOREIGN LOCATIONS AND USE BY NON-U.S. GOVERNMENT AIRCRAFT

3-12.1 Install these systems under the military rights agreement with the host government. The installation commander coordinates any separate agreements required with the local U.S. diplomatic representative and negotiates the agreement with the host nation. If the parties are unable to agree, refer the issue to the MAJCOM.

3-12.2 In an emergency, the pilot of a non-U.S. Government aircraft may request and use arresting systems at Air Force bases and jointly used airports within the CONUS and overseas.

3-13 STANDARD BAK-12 SYSTEM SETUP

3-13.1 For any of the three installation methods described within T.O. 35E8-2-5-1, site selection should be made to accommodate a standard system configuration for the allowable runout area.

3-13.2 For a 1200-foot (366-meter) runout, a standard system configuration for maximum BAK-12 runout includes a 1260-foot (384-meter) paved runout area (maximum runout plus aircraft length). Establish synchronization pressure, cam advancement, relief valve setting, tape stack height and cam gearbox drive sprocket size according to T.O. 35E8-2-5-1 Chapter 5. The system must also be equipped with a 1.25-inch (32-millimeter) -diameter pendant, supported by 6-inch (152-millimeter) - diameter support disks (donuts) or a BAK-14 or Type-H Hook cable support system.

3-13.3 For a 950-foot (290-meter) runout, a standard system configuration for a standard BAK-12 overrun runout includes a 1010-foot (308-meter) paved runout area (standard runout plus aircraft length).. Establish synchronization pressure, cam advancement, relief valve setting, tape stack height and cam gearbox drive sprocket size according to T.O. 35E8-2-5-1 Chapter 5. The system must also be equipped with a 1.25-inch (32-millimeter) -diameter pendant, supported by 6-inch (152-millimeter) - diameter support disks (donuts) or a BAK-14 or Type-H hook cable support system.

3-13.4 For a 900-foot (274-meter) runout, a standard system configuration for a 900-foot (274-meter) BAK-12 overrun runout includes a 960-feet (293-meter) runout area (standard runout plus aircraft length). Establish synchronization pressure, cam advancement, relief valve setting, tape stack height and cam gearbox drive sprocket size according to T.O. 35E8-2-5-1 Chapter 5 The system must also be equipped with a 1.25-inch (32-millimeter) -diameter pendant, supported by 6-inch (152-millimeter) - diameter support disks (donuts) or a BAK-14 or Type-H Hook cable support system.

3-13.5 For runway widths greater than 200 feet (61 meters), the control cam must be changed. Refer to T.O. 35E8-2-5-1 Table 5-5.

3-13.6 Once the site has been selected and the system installed, the Aircraft Arresting Systems Report (RCS: HAF-ILE [AR] 7150) must be submitted in accordance with paragraph 7, and a copy provided to the airfield manager. Information pertaining to

location (with respect to runway thresholds) and runout must be published within the DoD Flight Information Program (FLIP). Once this has been reported and published, any change to the standard configuration (system runout, pendant cable diameter, or donut size) must not be made without an approved waiver from the Air Force Life Cycle Management Center (AFLCMC) and concurrence from the installation commander, and the MAJCOM Civil Engineer.

3-14 INSTALLATION OF ULTRA-HIGH MOLECULAR WEIGHT (UHMW) POLYETHYLENE PANELS BENEATH CABLES FOR HEAVILY TRAFFICKED PAVEMENTS

3-14.1 In cases where aircraft repeatedly trample donut-supported AAS cables, the pavement directly beneath the cable will erode to form a transverse groove in the pavement across the runway. This section provides procedures, material requirements, and other pertinent information for installation of UHMW polyethylene panels under AAS cables to prevent this damage. It also includes panel specifications and installation. Inspection guidelines are listed in Chapter 4.







3-14.2 Requirements of this FC are mandatory where UHMW panel installations are necessary. Designers should also consider a thickened slab under UHMW panels for new construction to ensure adequate runway pavement strength and sufficient anchoring depth is provided for panel studs and cable tiedown anchors. Installation of UHMW panels is also the preferred method of repair for existing pavements that are distressed from cable trampling. Other repair options such as installation of a hook cable support system (like BAK-14 or Type H) may be justified based on economy or mission.

3-14.3 AAS cables impact underlying pavement by eroding a groove in the pavement directly beneath the cable. The pendant support disks (donuts) must rest in the groove when the cable is in a pre-tensioned state, lowering the effective pendant height (EPH), and reducing the potential for a successful engagement. When the EPH is below 38 millimeters (1.5 inches) there is even higher potential the aircraft hook may not engage the cable, as well as a requirement to publicize the reduced engagement potential to aviators (see paragraph 4-5.2). These areas must be repaired to maintain a uniform pavement surface and the proper EPH to ensure reliability of the arresting system.

3-14.4 Materials must be easily installed and must be minimally susceptible to warping or rapid wear. They must also be cost effective. The Air Force has used numerous pavement repair materials under arresting system cables with varying performance, from satisfactory to very poor. Most of these repairs have been costly and/or eroded quickly. Therefore, the pavements subject matter experts have established that in cases where preformed panels are the best repair option, UHMW panels should be specified. Further, it is absolutely critical to keep panels flush with, or, preferably, slightly recessed 1.6 to 3.2 millimeters (0.0625 to 0.125 inches) below the adjacent pavement surface. Thermal compatibility of the panel material and pavement, security of the anchoring system, and elevation and smoothness of the adjacent pavement and joint seals are extremely important. If possible, plan to install the panels

and sealant during average annual temperatures to allow for optimum sealant placement. If the panels are placed in cold weather the joints will tend to close completely in hot weather. If placed in hot weather the joints will tend to be too wide during cold weather. For this reason, it is desirable to use light-gray colored panels to help minimize thermal expansion and contraction (see some recommended panel colors in Figure 3-7).

Figure 3-7 Preferred Panel Colors from FED STD 595, *Colors Used in Government Procurement*

36173		Low solar absorbent gray #17
36231		Gray #23 (36231 replacement of MIL-MIL-DTL-700, Formula 20L)
36270		Low solar absorbent gray #27 (also with anti-stain properties)
36307		Gray #30 (Bulkhead gray)
36373		Low solar absorbent gray #37 (Light gray, color#26373)
36492		Gray #49 (Gull or pearl gray)

3-14.5 Generally, uncut panel stock is 1220 millimeters (48 inches) wide by 3048 millimeters (10 feet) long by 38 millimeters (1.5 inches) thick (panel stock must not be less than 36.5 millimeters (1.4375 inches) nor more than 38.1 millimeters (1.5 inches)). This allows five 1220 millimeter (48 inch) –long panels to be cut from the 3048-millimeter (10-foot) -long stock with minimal waste. To reduce panel warping and damage to joints from cable impact, panels should nominally be 610 millimeters (24 inches) wide for all installations. Cut panels in lengths so panel joints line up with runway pavement joints. Do not allow panels to overlap pavement joints. This prevents pavement, anchor, or panel failure due to thermal expansion or contraction. For runways with slabs sized in 1524-millimeter (5-foot) increments, such as those having 6-meter (20-foot) longitudinal paving lane joint spacing, panels should be 1207 millimeters (47.5 inches) long. Panels may be shorter but must never exceed 1219 millimeters (4 feet). Order prefinished panels in lengths to suit slab width(s) located

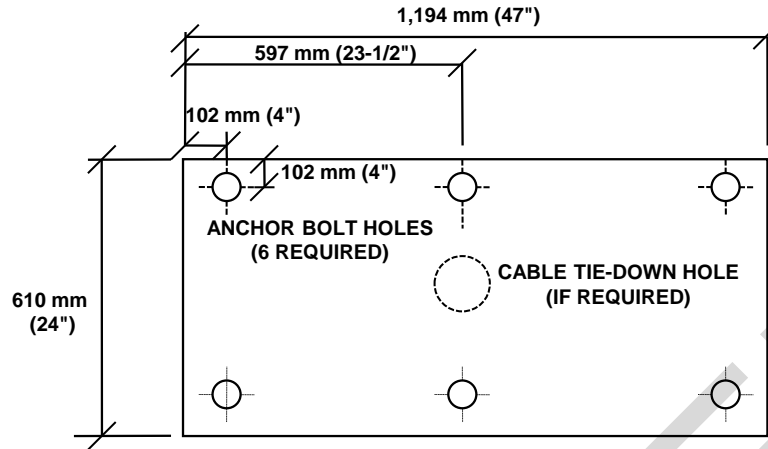
beneath the AAS cable on the runway. Take care to ensure there will be no overlap of panels and pavement joints, and no panel anchors will be set closer than 4 inches from any joint. Overlap of joints will cause premature failure. Panels should be drilled and counter-bored for hold-down anchors, and a 4-inch hole cut in the center of panels for those that must accommodate a cable tiedown anchor.

3-14.5.1 Panel Dimensions. Order panels cut to 24 inches wide by 48 inches long or less. Tolerance on panel length and width will be ± 3.2 millimeters (± 0.125 inch). Panel thickness will be no greater than 38.1 millimeters (1.5 inches) or less than 36.5 millimeters (1.4375 inches).

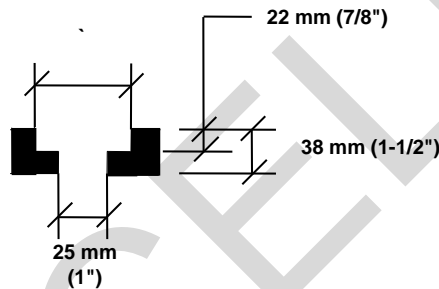
3-14.5.2 Anchor Stud Hole Locations and Dimensions. Each full-sized panel will have six anchor stud holes centered 102 millimeters (4 inches) from the edges of the panel corners and at mid-length. Each partial-sized panel will have four anchor stud holes centered 102 millimeters (4 inches) from the edges of the panel at each corner. The anchor stud hole will be 25.4 millimeters (1 inch) for the through hole and 51 millimeters (2 inches) for the countersink hole. The countersink hole will be 22 millimeters (0.875 inch) deep with square shoulders for a flat washer to lie against. Figure 3-9 shows dimensions and drilling details. Tolerances on dimensions for locations and diameters of anchor holes will be ± 1.6 millimeters (± 0.0625 inch).

3-14.5.3 Locating Cable Tiedown Anchor Holes. The agency ordering panels must specify the total number of panels required to be drilled to accommodate cable tiedown anchors (four or eight per inlay). The cable tiedown anchor hole must be 102 millimeters (4 inches) in diameter and drilled completely through the panel. Cable tiedown anchor holes will be located in the center of the panel. The location of the cable tiedown anchor hole is shown in Figure 3-8. Cable tiedowns must not be located closer than 305 millimeters (12 inches) from existing pavement joints. Install cable tiedown anchors for operational systems (systems located between the runway thresholds) to limit cable bounce and potential aircraft damage during aircraft rollover. Install eight anchors for all operational systems regardless of primary aircraft supported on the airfield. Program systems with four anchor points to be upgraded to eight anchor points (ref: paragraph 3-8).

Figure 3-8 Panel Dimensions and Anchor and Tiedown Locations



PANEL DIMENSIONS AND ANCHOR HOLE LOCATIONS



Detail of Anchor Hole

3-14.5.4 As indicated above, panel lengths must be sized to ensure panel joints do not overlap longitudinal pavement joints, or joints in the panel foundations. Lengths selected must also accommodate cable tiedown anchor spacing and minimize warping. To accomplish these goals, some slabs will require longer panels, mixed with some partial-length panels. These should be patterned to minimize the number of lengths needed, and spread uniformly across the runway width. Partial panels should never be used to accommodate a cable tiedown anchor. They should only be drilled at each corner. Tiedown anchors should only be placed in full length panels with six anchors. Figures 3-9 through 3-13 shows exact panel, and partial panel lengths, as well as appropriately adjusted spacing for cable tiedown anchors for various slab widths. The dimensions shown allow for 13-millimeter (0.5-inch) -wide joints between panels and pavement edges.

Figure 3-9 Cable Tiedowns for Panels Placed on 3.8-Meter (12.5-Foot) Slabs

- FULL PANEL, @ 1,076 mm (42.375")* LONG, 6 ANCHORS EACH
 - PARTIAL PANEL, @ 530 mm (20.875")* LONG, 4 ANCHORS EACH
 - FULL PANEL WITH TIE-DOWN
- *(LENGTH ADJUSTED FOR JOINTS)

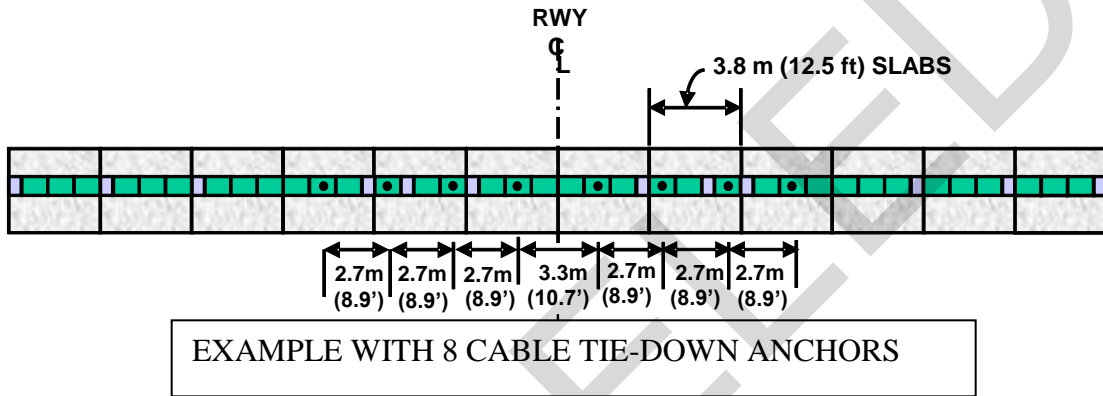


Figure 3-10 Cable Tiedowns for Panels Placed on 4.6-Meter (15-Foot) Slabs

- FULL PANEL, 1,130 mm (44.5 inches)* LONG, 6 ANCHORS EACH
 - PARTIAL PANEL, 559 mm (22 inches)* LONG, 4 ANCHORS EACH
 - FULL PANEL WITH TIE-DOWN
- *(LENGTH ADJUSTED FOR JOINTS)

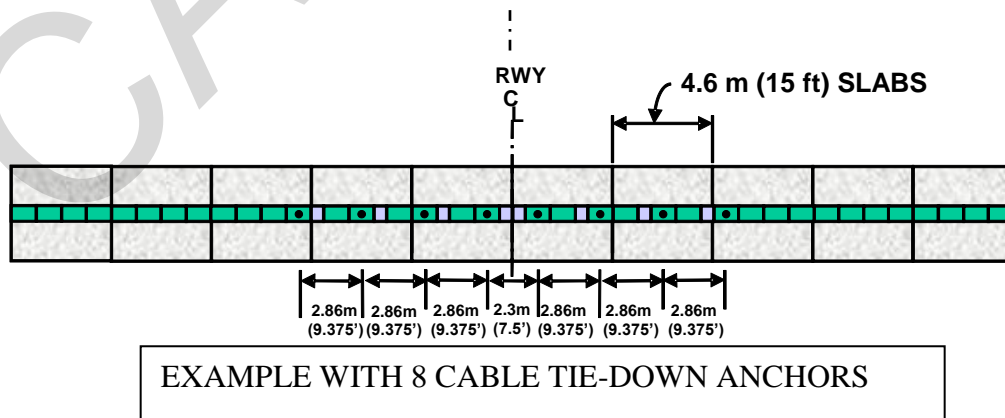


Figure 3-11 Cable Tiedowns for Panels Placed on 5.7-Meter (18.75-Foot) Slabs

- FULL PANEL, 1,130 mm (44.5 inches)* LONG, 6 ANCHORS EACH
 - HALF PANEL, 559 mm (22 inches)* LONG, 4 ANCHORS EACH
 - FULL PANEL WITH TIE-DOWN
- *(LENGTH ADJUSTED FOR JOINTS)

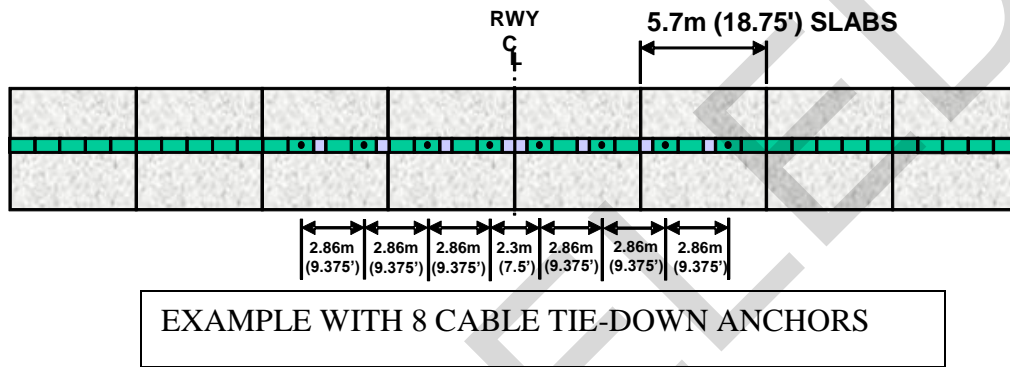


Figure 3-12 Cable Tiedowns for Panels Placed on 6-Meter (20-Foot) Slabs

- FULL PANEL, 1,207 mm (47.5 inches)* LONG, 6 ANCHORS EACH
 - EIGHT PARTIAL PANELS 597 mm (23.5 inches)* LONG, 4 ANCHORS EACH AND TWO 902 mm (35.5 inches)* LONG, 4 ANCHORS EACH
 - FULL PANEL WITH TIE-DOWN
- *(LENGTH ADJUSTED FOR JOINTS)

4.6 m (15 ft) SLABS AT BOTH ENDS
(THREE FULL PANELS AND ONE
902 mm (35.5") PARTIAL PANEL) EACH

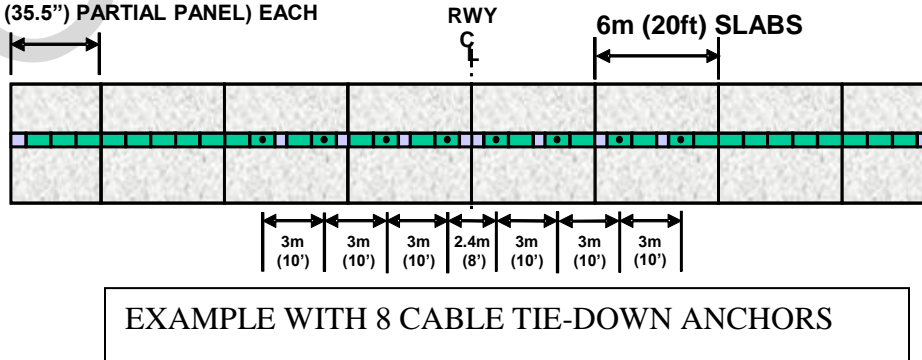



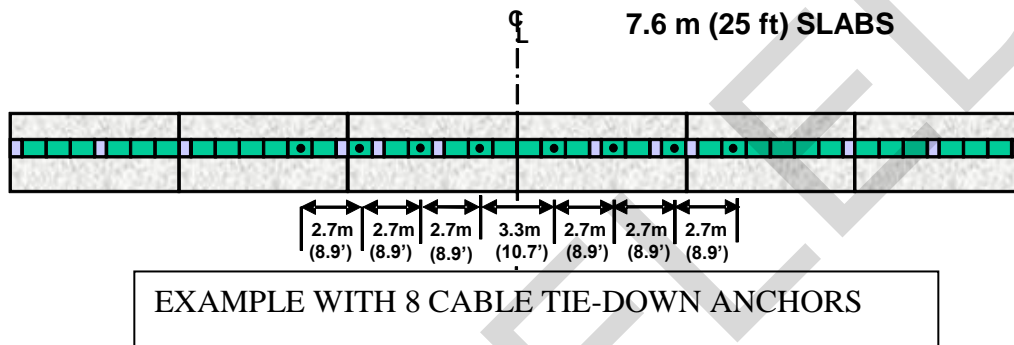


Figure 3-13 Cable Tiedowns for Panels Placed on 7.6-Meter (25-Foot) Slabs

-  FULL PANEL, 1,076 mm (42.375 inches)* LONG, 6 ANCHORS EACH
 -  PARTIAL PANEL, 530 mm (20.875 inches)* LONG, 4 ANCHORS EACH
 -  FULL PANEL WITH TIEDOWN
- *(LENGTH ADJUSTED FOR JOINTS)



3-14.6 The panels must be fabricated from virgin and/or recycled UHMW polyethylene and will be a variable shade of gray in color, and UV-stabilized. An antistatic additive must be added to the UHMW polyethylene and it must meet the physical requirements of Table 3-1.

Table 3-1 Physical Requirements for UHMW Polyethylene

Property	Test Method	Requirement
Density	ASTM D1505	0.92–0.94 g/cm
Tensile elongation at break	ASTM D638	300–400 percent
Tensile yield strength	ASTM D638	2800–4000 psi
Shore hardness "D"	ASTM C886	60–70
Coefficient of friction	ASTM D3028	0.2
Izod impact strength	ASTM D256, Method A (see Note)	>20 ft-lb/inch

Note: The test specimens must have two opposing 15-degree notches.

3-14.7 When considering the installation of UHMW panels it is important to verify thickness of the existing pavement. The panels must be anchored in a sound concrete foundation. A typical anchor stud is 245 millimeters (9.625 inches) long and the foundation is drilled slightly deeper to ensure the anchor does not protrude above the panel when installation is completed. For this reason, a minimum slab thickness of 280

millimeters (11 inches) is needed to properly anchor the panels. If the existing concrete is not thick enough, you must remove and replace it with adequate thickness concrete prior to UHMW panel installation, or select alternative repair methods.

3-14.7.1 Flexible Pavement Systems

3-14.7.1.1 For installation in asphalt pavement:

- Saw-cut and remove a minimum 635-millimeter (25-inch) –wide transverse section of the asphalt and underlying materials to a depth of 915 millimeters (3 feet).
- Backfill the bottom of the trench with a well-graded crushed stone material and compact to a 305-millimeter (12-inch) thickness in 150-millimeter (6-inch) lifts.
- Place the 570 millimeters (22.5 inches) -thick concrete foundation for panel installation.
- Ensure the concrete foundation is finished on the same plane as the runway surface (matches transverse runway slope), and at the proper depth for the panel surface to be slightly below the adjacent pavement.
- Once the concrete is cured, proceed with installing and anchoring the panels as outlined in this section.

These instructions describe an installation procedure for an existing asphalt pavement. However, if installing UHMW panels in conjunction with construction of new flexible pavement (or reconstruction of an existing pavement), the above procedure is still recommended to allow uniform longitudinal compaction.

3-14.7.1.2 Installation in a Rigid Pavement System

For installation in Portland cement concrete (PCC) pavement:

- Prepare the receiving slot.
- Place a cementitious setting bed.
- Install the UHMW panels.
- Install panel anchor studs.
- Install new cable tiedown anchors.
- Seal the joints.

3-15 Step-by-Step Procedures for Preparing Installation of UHMW Panels

3-15.1 Prepare Receiving Slot

Prepare the receiving slot by first removing the concrete. The dimensions of the area of concrete removed depend upon the number of panels installed. For example, for a runway with 3.8-meter (12.5-foot) slabs, each full panel is 1076 millimeters (42.375 inches) long by 610 millimeters (24 inches) wide, and partial panels are 530 millimeters (20.875 inches) long and 610 millimeters (24 inches) wide, with 13-millimeter (0.5-inch) gaps between panels. Therefore, for a 22.86-meter (75-foot) -long inlay of 18 full panels and six partial panels across the runway (11.4 meters [37.5 feet]) on each side of the runway centerline, the saw cut area must be:

- 22.87 meters (75 feet, 0.5 inch) long
- 635 millimeters (25 inches) wide
- At least 64 millimeters (2.5 inches) deep

3-15.2 Saw Cut Perimeter of Inlay

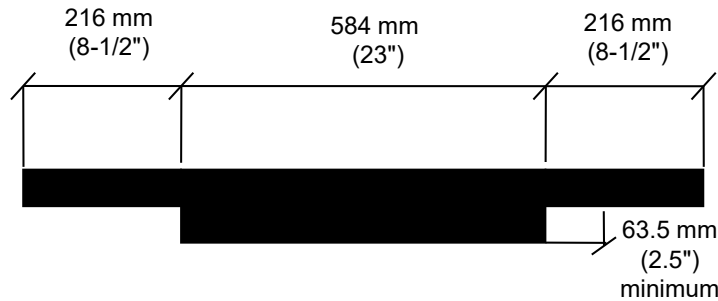
Perimeter saw cuts must be 76 millimeters (3 inches) deep and overlap at least 76 millimeters (3 inches) to ensure that corners are perfectly square when pavement is removed. Remove all loose, unsound concrete within the area. Additional saw cuts inside the perimeter will make removing the concrete easier (using chipping hammers) and result in a more uniform concrete profile

NOTE: For partial-runway-width installations, provide a means of drainage for the receiving slot to prevent damage from trapped water or dirt that may enter at leaks in the joint seals. Several saw cuts made to run from the ends of the inlay to the shoulders and cut at the same depth as the receiving slot will typically suffice.

3-15.3 Inspect Receiving Slot Following Concrete Removal

With a notched board (Figure 3-14), check the depth of the concrete within the recessed setting bed. Use a chipping hammer to remove any portions less than 64 millimeters (2.5 inches) from the surface of the adjacent pavement then visually check the concrete, sound it with a steel rod to identify any unsound portions, and remove all unsound concrete. Cut existing AAS cable tiedown anchors flush with the bottom of the concrete substrate before placing the setting bed.

Figure 3-14 Notched Board Used to Check the Receiving Slot



3-15.4 Remove Existing Tiedown Anchors

Cut existing AAS cable tiedown anchors flush with the bottom of the concrete substrate before placing the setting bed.

3-15.5 Clean Concrete Substrate

Upon removal of concrete from the slot, it is important to adequately clean the slot to ensure the new setting bed material will adhere to the substrate. Particular care should be taken to remove the laitance from the smooth faces of the saw cut walls; sandblast or use wire brushes, followed by compressed air.

3-15.6 Place a Setting Bed

Place a cementitious setting bed under the panels and allow the bed to cure before drilling and anchoring the panel anchor studs. Use ordinary PCC at airfield strength (34,474 kPa [5000 psi] compression/4482 kPa [650 psi] flexural strength in 28 days) when several hours' cure time is available. As a suggested mix, use:

- A lean seven-bag mix with 10-millimeter (0.375-inch) maximum size aggregate.
- Water-to-cement ratio not to exceed 0.3:1.
- Plasticizer admixture.
- Substitute fly ash for -50 sieve size sand as required.

This mixture will allow drilling within 18 to 24 hours. For short-cure-time applications, a prepackaged material such as Rapid Set® Concrete Mix is satisfactory. Rapid Set® Concrete Mix is packaged in 27-kilogram (60-pound) bags that yield approximately 0.014 cubic meters (0.5 cubic foot) of concrete when mixed with water (refer to Table 3-3 for ordering information). Placing a small test sample in a disposable pail the same depth as the setting bed may also serve as a helpful tool in determining adequate cure time for drilling operations.

3-15.7 Positioning Mixing Equipment

Position two mechanical mortar or concrete mixers approximately 6 meters (20 feet) from the prepared inlay near the center of the runway. Transport mixed mortar in a wheelbarrow. Mortar mixers are preferred. Depending upon the type of material used, drum mixers may not agitate the material enough to produce the desired workability when the recommended amount of water is used.

3-15.8 Mixing and Placing Rapid Set® Concrete Mix

- Place 2.8 to 3.8 liters (3 to 4 quarts) of water in the mixer. In hot climates, using cold water can extend the setting time of the mix. In cold climates, using hot water and heating the substrate may shorten the setting time.
- Add one bag of Rapid Set® Concrete Mix and mix for two to three minutes. Note that this mix "wets" slowly. Do not add more water until the full mixing time has elapsed. Over-wetting will weaken the final mix. Place the material within 10 minutes after mixing. If temperature is above freezing, wet the substrate first. If below freezing, do not wet the substrate.

3-15.9 Finishing

Finish the material from the center of the bed to the edges to achieve proper bonding along the side walls of the excavation.

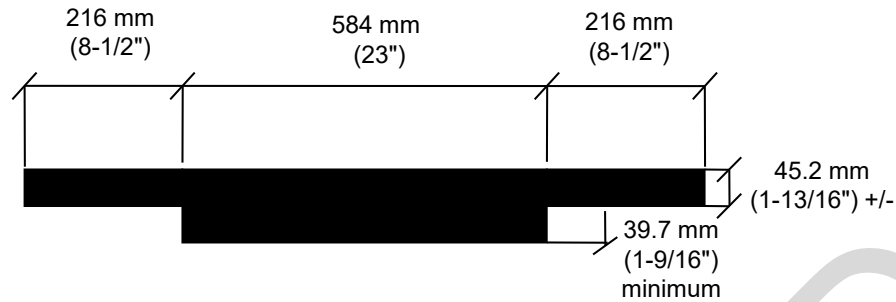
3-15.10 Curing

After initial set, when the surface becomes hard to the touch, fog- or spray-mist-cure with water for one hour. Do not add an excessive amount of water. Over-wetting will weaken the setting bed.

3-15.11 Leveling the Setting Bed

Mechanically vibrate the concrete before you screed to consolidate the mass. Even simple hand-tamping with a garden rake greatly reduces the percent of voids in the mix. Level the concrete to the proper depth in the setting bed using a notched screed board (Figure 3-15). Strike the screed periodically to ensure proper depth and uniform surface. The 39.7-millimeter (1.5625-inch) depth of the screed board is based upon a panel thickness of 38 millimeters (1.5 inches). Measure the actual thickness of each panel upon delivery to ensure they are all the same thickness and to establish the required screed dimensions. The setting bed must be level and of the proper depth to correctly support the panels. A properly-placed setting bed will help avoid a lot of aggravating manual labor. A setting bed that is not level or is placed at an improper depth requires excessive grinding of the pavement and/or shims, or may require grinding of the adjacent pavement surfaces. Shims should be used only as a last resort, not planned into the job. When required, the shim stock should be a nonferrous metal and should be sized to provide full surface support for the panel, not just point support at the anchor locations.

Figure 3-15 Notched Screed



3-15.12 Joints

Extend existing pavement joints through the setting bed by saw-cutting or using an expansion board. The saw cut should be a single blade-width and extend completely through the setting bed. Expansion boards must be set the full depth of the setting bed.

3-16 INSTALLATION OF UHMW PANELS

3-16.1 Allow the setting bed to harden (approximately 4 hours, depending on the type bed used) to the minimum strength that allows drilling without damage to the concrete.

3-16.2 Lay the panels in place and inspect to ensure that the top surface of the panel is at least 1.6 millimeters (0.0625 inch) lower than the adjacent pavement surface. Grind the bedding material or panel edges as necessary so that the panel surface is slightly recessed (1.6 to 3.2 millimeters [0.0625 to 0.125-inch]) below the adjacent pavement surface. Panel height is especially critical in the center half of the runway.

3-16.3 Set spacing between panels using 13-millimeter (0.5-inch) -thick shims and secure all panels in place with wood wedges (minimum four sets per panel) to prevent panels shifting during drilling of anchor stud holes. UHMW panels expand and contract greatly with temperature changes. The panels should be placed and anchored at the median annual temperature for the given location to allow for movement either way with temperature changes.

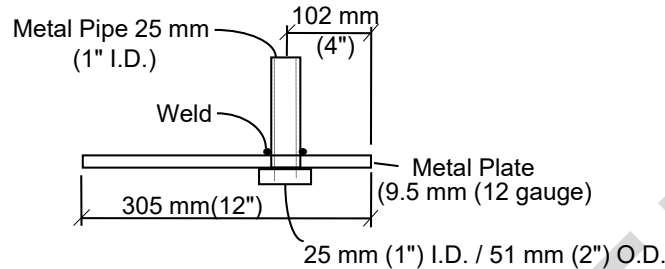
3-17 INSTALL PANEL ANCHOR STUDS

For a list of required tools and equipment, see Table 3-2.

3-17.1 Position the locally fabricated alignment tool (Figure 3-16) over each predrilled hole in the panel and drill 22-millimeter (0.875-inch) -diameter holes in the setting bed. Not all anchor studs are consistent in length as ordered, so check actual anchor stud lengths and drill to accommodate the longest stud. The depth of the hole is critical — if it is not deep enough, the stud will protrude above the panel surface and require excessive grinding; if it is too deep, the adhesive capsule will be positioned below the stud and not provide adequate coverage. Use a drill-mounted depth gage rod

or mark a position on the drill bit shaft the length of the stud plus the depth of the alignment tool to ensure proper hole depth when drilling.

Figure 3-16 Drill Guide (Anchor Boring Alignment Tool)



3-17.2 Thoroughly clean debris from the drilled hole with a round wire brush and compressed air. A 9- to 13-millimeter (0.375- to 0.5-inch) -diameter tube attached to the compressed air line is necessary to remove all fines from the holes. Insert tubing to the bottom of the hole before purging to ensure all particles are removed. **CAUTION: Wear eye protection.**

3-17.3 Install each anchor stud as described below. To avoid work stoppage while the adhesive cures, plan to have at least 12 cap nuts available for setting anchors.

3-17.3.1 Insert an adhesive capsule into each hole with the rounded end facing the bottom of the hole. Screw a cap nut (or other manufacturer-provided adapter) onto the end of the anchor bolt and attach the unit to a heavy-duty drill (or rotary impact hammer). Insert a flat washer onto the threaded stud just below the adapter, or position the washer over the panel hole inside the counter-bore. Drive the anchor stud to the bottom of the hole to break the capsule(s) and mix the adhesive (in accordance with the manufacturer's instructions for drill speed and mixing time). Once the anchor stud is in position, do not disturb it until the adhesive has gelled. Allow the adhesive to cure as recommended by the manufacturer before the cap nut can be removed without disturbing the stud position.

3-17.3.2 Remove cap nut and flat washer; seal around stud with silicone sealant; reinsert flat washer and a thread-locking compound, then install a nut to the top of the anchor stud.

- Allow adhesive to fully cure according to the manufacturer's instructions and then torque the nuts to 81 newton meters (N•m) (60 pound feet [lb ft]).
- Grind off any portion of a stud that protrudes above the panel surface.

CAUTION—Take care to set anchors at the proper depth to avoid the need to grind the anchor rods. Excessive grinding will cause rapid build-up in the temperature of the anchor. Some epoxy manufacturers indicate heating the epoxy to 250° F or greater will degrade or destroy the strength of the epoxy bond.

3-18 INSTALL NEW CABLE TIEDOWN ANCHORS

Install cable tiedown anchors for operational systems (systems located between the runway thresholds) to limit cable bounce and potential aircraft damage during aircraft rollover. Install eight anchors for all operational systems regardless of primary aircraft supported on the airfield. Program systems with four anchor points to be upgraded to eight anchor points (ref: paragraph 3-8).

3-18.1 Each cable tiedown anchor hole will be located in the center of the appropriate panel. Refer to Figures 3-9 to 3-13 for location and spacing.

3-18.2 When installing cable tiedowns, ensure the top of the tiedown is at least 5 millimeters (0.1875 inch) to 13 millimeters [0.5 inch]) below the final panel surface height.

3-18.3 Depending on the location of existing runway pavement joints in relation to the runway centerline and the longitudinal joint spacing, UHMW panels may be installed with a panel joint or panel center falling on the runway centerline.

3-18.4 Figures 3-9 through 3-13 depict recommended cable anchor tiedown locations when installing standard full-sized and partial panels in various slab sizes. The partial panels are required to permit acceptable tiedown spacing and to avoid overlapping joints in the existing slabs. For installation in slabs sized other than those shown, consult the AAS engineer.

3-19 SEAL THE JOINTS

Use silicone sealant and apply joint seals in spacing between panels, around anchors and tiedowns, and between panels and pavement edges.

3-19.1 The joint surface must be recessed at least 6.35 millimeters (0.25 inch) below the panel top surface. Silicone sealants should be used in lieu of hot-pour asphalt or tar sealants.

3-19.2 The size of the backer rod must be carefully selected due to the expansion properties of the panels. The spaces between panels should be noted when the panels are in their contracted state to ensure an undersized backer rod is not used. Undersized backer rod may allow sealants to leak.

3-19.3 A non-shrinkable, non-absorbent, highly compressible foam backer rod should be used, sized to span the maximum expected gap but placed at the medium temperature and set at a depth to ensure a proper shape factor is created for the sealant reservoir.

3-20 INSTALLATION TOOLS, EQUIPMENT, AND MATERIALS

Table 3-2 provides a list of tools and equipment, with recommended quantities, needed to install a typical UHMW panel inlay for the full width of a 46-meter (150-foot) wide runway.

Table 3-2 Typical Tools and Equipment for Installation

Quantity	Unit	Description
1	each	Concrete saw, self-propelled
1	each	Hand-held portable saw
2	each	Saw blades
1	each	Water distributor
50	LF	Expansion board, asphalt impregnated, 102 mm x 13 mm (4 in x 0.5 in)
3	each	Mortar mixer, 4 cubic feet (two for use, one spare)
1	each	Sandblast unit for air compressor
3	each	Jackhammer, 40 kg (90 lb), with chisel and spade bits
1	each	Heavy-duty disc-type electric grinder
2	each	5 L (1.25 gal) containers for mixing water
3	each	Electric generators (1 per drill)
3	tons	Pea gravel (clean, washed gravel, 9 mm [0.375 in])
150	bags	Rapid Set® Concrete Mix repair material
4	buckets	5 gal size, for measuring aggregate
1	board	Notched screed, 51 mm x 102 mm x 1 m (2 in x 4 in x 40 in)
1	board	Notched depth gauge, 51 mm x 102 mm x 1 m (2 in x 4 in x 40 in)
As required (30 in this case)	panels	UHMW polyethylene, 610 mm (24 in) wide, sized, drilled and counter-bored.
As required (192 in this case)	each	Anchor studs, 19-mm (0.75-in) diameter, 245 mm (9.65 in) long, fully-threaded, with nuts, flat washers and vinyl ester resin vials (six per panel plus spares)
12 (min)	each	Cap nuts, 19-mm (0.75-in), 10 UNC
2	each	Magnesium floats
1	pair	Vice grips for cap nut removal
1	each	Screwdriver to help with cap nut removal
1	each	Concrete vibrator, small size

Table 3-2 Typical Tools and Equipment for Installation

Quantity	Unit	Description
2	each	Steel trowels
4	each	Shovels, square point
1	each	Electric drill, 13-mm (0.5-in) drive
1	each	Torque wrench to apply 81 N•m (60 lb ft) torque
1	each	TYMCO® airfield sweeper
1	each	Air compressor
1	each	Front end loader
2	each	Dump trucks
2	each	Wheelbarrow, 4 cu ft
2	each	Knives
1	each	Pickup truck
2	each	Hammer
2	each	Steel chisel, hand-held
1	each	Joint seal kettle with SS-S-1401 joint seal. Note: Silicone joint seal is also recommended and preferred. A recommended silicone joint seal is Dow Corning® 890-SL in 0.8-L (29-oz) tubes (96 tubes required) and a caulking gun for 0.8-IL (29-oz) caulk tubes.
3	each	Electric impact drill (Hilti HE72 or equivalent) with 22-mm (0.875-in) -diameter by 530-mm (21-in) -long masonry bits.
1	each	Gooseneck wrecking bar, 1220 mm (4 ft) long, minimum
1	each	Pick for debris breakout and removal
2	each	Wire brushes for slot cleaning
1	each	Roll of heavy cloth or plastic tape for marking drill bits for drilling depth
2	each	Alignment tools for drilling holes vertically
As req'd		Wood wedges to secure panels in position, minimum eight tapered wood wedges per panel
As req'd		Safety equipment including, but not limited to, dust masks, goggles, ear protectors, work gloves, and safety shoes *Ensure an eye wash is available.
As req'd		Wood spacers, approximately 13 mm (0.5 in) thick by 102 mm (4 in) by 76 mm (3 in), used to maintain spacing between panels during panel installation
As req'd		String line, spray paint, straightedge board, and a 30-m (100-ft) tape to measure and mark for saw cuts

3-21 MATERIALS AND SUPPLIES

Table 3-3 provides a list of materials, supplies and the recommended quantities needed to install a typical UHMW panel inlay for the full width of a 46-meter (150-foot) wide runway.

**Table 3-3 Estimated Material Cost and Suggested Sources of Supply
(150-Foot Wide Runway)**

Quantity	Item	Suggested Source	Cost
30 each	UHMW polyethylene panels, predrilled with six counter-sunk anchor holes	Röchling Engineered Plastics http://www.roechling-plastics.us/ or Ultra Poly http://www.ultrapoly.com/	\$16,900
192 each	Anchor studs, 19 mm (0.75 in) diameter, 245 mm (9.65 in) long, full-threaded (Hilti PN 068660) with vinyl ester bonding vials (Hilti PN 256702), nuts, and flat washers (Hilti HVA Adhesive Anchor System with HEA 19-mm [0.75-in] capsule and HAS 19-mm [0.75-in] rod)	Hilti Fastening Systems http://www.us.hilti.com/ or Williams Form Engineering Corporation http://www.williamsform.com/	\$2,662
4 each	Drive sockets (PN 65279)	Hilti Fastening Systems	\$74
4 each	Drive socket shafts (setting tool, square drive): SDS Max Connector, P/N 32221, <u>or</u> SDS Top Connector, P/N 332169		\$484 \$299
4 each	Masonry drill bits, 22 mm (0.875 in) diameter, 530 mm (21 in) long	Hilti Fastening Systems	\$650
25 each	Cap nuts, 19 mm (0.75 in) diameter, 10 UNC (P/N 91855A036)	McMaster-Carr http://www.mcmaster.com/	\$163

**Table 3-3 Estimated Material Cost and Suggested Sources of Supply
(150-Foot Wide Runway)**

Quantity	Item	Suggested Source	Cost
150 bags	Rapid Set Concrete Mix	CTS Products www.ctscement.com or www.rapidset.com/rs Midwestern Regional Office 1211 South 6th Street St. Charles, IL 60174 Phone: (312) 773-4949 1-800-929-3030	\$4,550
96 tubes	Silicone joint seal (Dow Corning 890-SL)	The Fred R. Hiller Company http://www.fredhiller.com/	\$3,250
<p>Note: Costs do not include shipping. Suggested vendors are provided to assist in locating sources. The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this FC does not imply endorsement by the Air Force.</p>			

3-22 TYPICAL SCHEDULE OF EVENTS

Table 3-4 provides an example schedule of events for installing eight panels (partial width installation).

Table 3-4 Installation Schedule for Eight Panels

Day	Times	Event Description
1	1800–2200	Perimeter saw cutting, Runway 33. Crew size: 2 men. Saw cuts 76 mm (3 in) deep.
2	1500–1745	Excavation starts on Runway 33 inlay. Crew size: 9 men. Concrete removed using three 40-kg (90-lb) jackhammers and one cold milling cutter drum on a Bobcat 843 skid-steer loader. Debris loaded into dump truck using front-end loader. Large rubble removed by hand and shovel; small debris removed using the suction wand of the airfield sweeper.
2	1745–1915	Excavation complete. Slot cleaned with high-pressure air. Substrate sounded and delaminated (unsound, hollow) material removed. Approximate final slot size: 30 m (100 ft) long by 635 mm (25 in) wide by 76 mm (3 in) deep. Notched depth gauge board used to check depth in the center 12.2 m (40 ft) area where panels will be installed.
2	1915–2000	Final slot inspection. Loose hollow-sounding areas removed with jackhammer and pick. (Hand-held hammer and steel chisel may also be used.) Slot side walls cleaned with wire brushes. Slot cleaned and dried with high-pressure air.

Table 3-4 Installation Schedule for Eight Panels

Day	Times	Event Description
2	2000–2230	Mixing and placing of setting bed begins. Both concrete mixers used. Ten-person crew used. No bonding agent used or needed. Notched board used to keep setting bed at the correct level below the surrounding pavement surface.
2	2030–2242	Curing compound applied periodically as the setting bed is placed.
2	2242–2300	Cleanup accomplished and runway cleared. Approximately 90 bags of mortar placed.
3	0855–1030	Joints and cracks saw-cut through the mortar patches, both flush and recessed patch areas. Hand-held portable saw used for recessed setting bed cracks/joints and self-propelled pavement saw used for flush patches.
3	1015–1045	Panel placement begins. Panels positioned and tightly wedged into place using wood spacers and wood shims (wedges). (Panels as ordered for the job have predrilled anchor bolt holes.)
3	1050–1130	Drilling bolt holes begins. Three heavy-duty electric impact drills (two Hilti HE72, one Milwaukee) used and work well. Three minutes drilling time per hole required. Portable drill alignment tool used to keep drill bit positioned vertically to start hole. Drill bits marked with tape to control hole depth. Long slender tube inserted completely to bottom of bolt holes delivers compressed air to thoroughly clean holes. Recommended wire brushing of holes is not accomplished.
3	1130–1345	Panel anchor studs set in position using electric drill with adapter attachment. Anchor studs anchored into pavement with adhesive capsule inserted before inserting anchor stud in hole. Installation of anchors is delayed during first hour while new adapter is fabricated locally for anchor installation. After first adapter is tried and proven, two more adapters are fabricated. Anchor stud installation then progresses rapidly with most anchor studs installed in last hour. Applying oil on ends of studs aids adapter removal after stud installation.
3	1340–1400	Shims removed. Site cleaned with compressed air to remove all particles before sealing around panels with joint sealant.
3	1710–1730	Studs torqued to 81 N•m (60 lb ft) with torque wrenches. All studs torqued adequately but several stud ends protrude above panel surface.

Table 3-4 Installation Schedule for Eight Panels

Day	Times	Event Description
3	1810–1820	High studs ground down flush with surface using a heavy-duty disc-type electric grinder. CAUTION—Excessive grinding will cause rapid build-up in the temperature of the anchor rod. Some epoxy manufacturers indicate heating the epoxy to 250° F or greater will degrade or destroy the strength of the epoxy bond. Take care to set anchors at the proper depth to avoid anchor failure.
3	1720–1820	Sealant applied to joints around panels using kettle with hot-applied, single-component, non-jet-fuel-resistant sealant (SS-S-1401). Job complete.
3	1820–1830	Final inspection and job site cleanup completed.

CANCELLED

CHAPTER 4 OPERATION, MAINTENANCE, CERTIFICATION, AND INSPECTION

4-1 INTRODUCTION

4-1.1 This chapter provides basic information on inspection, maintenance, certification, operation, maintenance records, and deficiency reporting for AAS. Information contained in this chapter is intended to be general in nature. Specific technical information may be found in the applicable 35E8-series T.O.s.

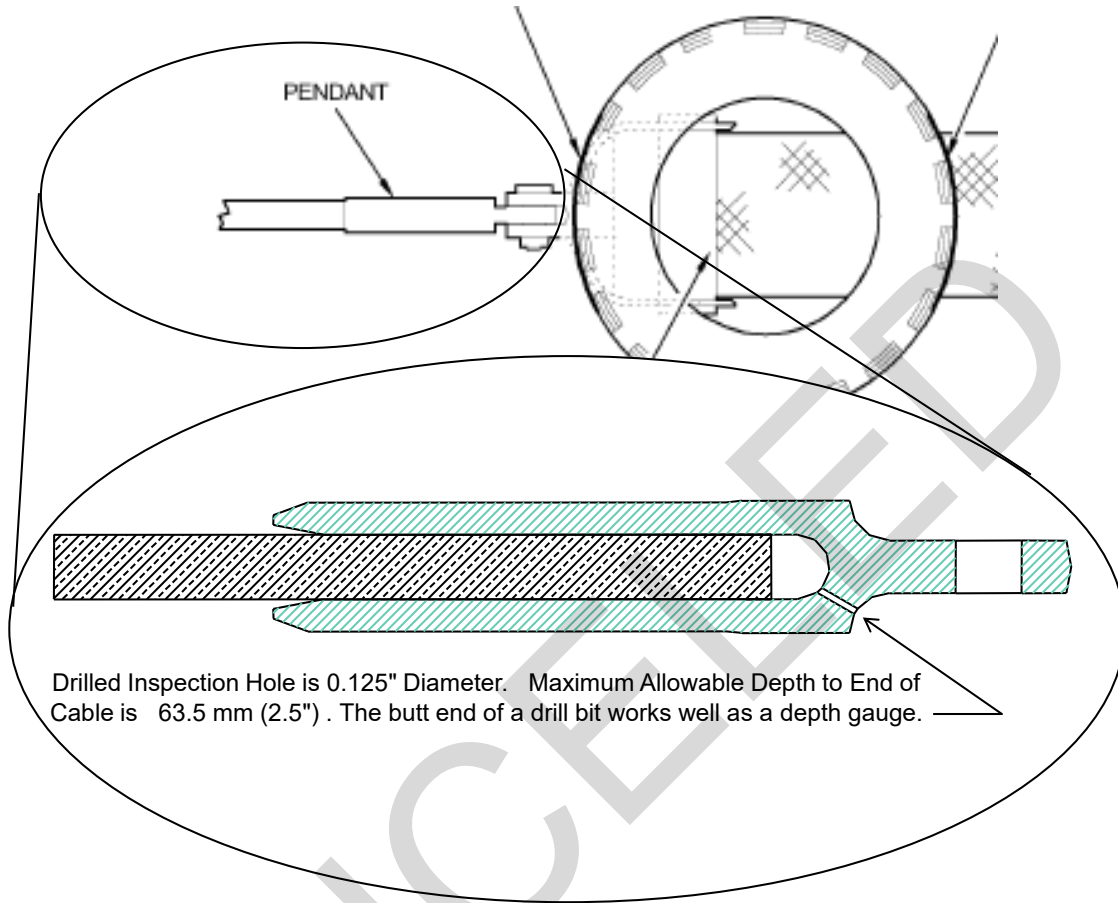
4-1.2 The BAK-12 T.O. provides alternate procedures for removing an aircraft from the cable after engagement. These alternate procedures are commonly referred to as a "slingshot" removal of the aircraft. Potential for aircraft damage is high when using these methods; therefore, use these procedures only during contingencies or in-flight emergencies that require rapid removal of an aircraft from a cable. The procedure must be approved by the installation commander before being used for routine disengagement of aircraft during local exercises or scheduled testing of the arresting system (e.g., certification).

4-2 CABLE (PENDANT) INSPECTIONS

4-2.1 Inspections must be performed in accordance with the applicable T.O., information contained within this instruction, and the 35E8-series work cards.

4-2.2 In-service pendant cables must be inspected daily and after each engagement. Use cable inspection criteria from BAK-12 or BAK-13 T.O.s for textile brake AAS. For all AAS cables (pendants), measure and record the swaged end cable insertion depth measurement in the maintenance records before placing any arresting system cross-runway pendant in service (see Figure 4-1). Do not install cables with swaged end depth measurement greater than 63 millimeters (2.5 inches). The previous requirements to mark the cable with paint or some other means of permanent marking and to perform post-arrestment measurements have been made optional at the discretion of the AAS shop supervisor. Spare pendants should be stored indoors or on their original shipping container.

Figure 4-1 Swaged End Measurement for Cable to Terminal End Fitting



4-3 EXPEDIENT TRIM PAD ANCHORING SYSTEM CABLE INSPECTIONS

4-3.1 Expedient trim pad anchoring systems can be installed using K-M anchoring components from the MAAS. Use ETL 06-4, *Expedient Trim Pad Anchoring Systems*, to install and inspect expedient trim anchors. Use the following guidance for cable inspection and disposition if AAS pendants are used to restrain the aircraft during trim operations.

4-3.2 Cables used with the expedient trim pad setup shall be kept separate from cables used for aircraft engagements, and shall only be used for trim operations (e.g., cables used for trim operations shall not be used for aircraft engagements, and cables that have been used for engagements shall not be used for trim operations).

4-3.3 Develop a use and inspection log for each new cable and record the date and pertinent details of each trim operation in the log. Maintain the log for the life of the cable. There is no limit to the number of trim operations that can be performed with a single cable within a 36-month period; however, all cables will be removed from service 36 months after their initial installation date unless they fail to meet the requirements stated below.

4-3.2.1 Before installing any cable, measure and record the swaged end cable insertion depth as prescribed above in paragraph 4-2.2. Also, inspect the cable in accordance with instructions in T.O. 35E8-2-5-1. Do not install cables with defects identified in the T.O. or if the insertion depth measurement exceeds 63 millimeters (2.5 inches).

4-3.2.2 After each trim pad operation, inspect the cable in accordance with instructions in T.O. 35E8-2-5-1. Also, measure and record the swaged end cable insertion depth for each end, or inspect for swaged end movement if the swaged end position has been marked as described in paragraph 4-2.2 above. Remove the cable from service if it fails to meet the inspection requirements of T.O. 35E8-2-5-1 or shows any change in the swaged end position on the cable.

4-4 TAPES, NETS, SUSPENSION STRAPS, AND BARRIER WEBBINGS

4-4.1 Crop exposed tape between the runway edge sheave (fairlead beam) and the tape connector on the BAK-12 according to the appropriate 35E8-series T.O. Crop the tape between the absorber base and the tape connector according to the appropriate 35E8-series T.O. on expeditionary systems if a tape tube is not used. Perform (end-for-end) on the tapes on all systems according to the appropriate 35E8-series T.O. No nylon tapes should be retained in service longer than T.O. requirements or if usage exceeds the maximum allowable for engagements, pull-outs or tape stack height in the applicable 35E8-series T.O. Due to the negative effects of UV light on nylon, every effort must be made to protect tapes from direct sunlight. For this reason, all spare nylon tapes must be stored indoors with the original protective seal in place.

4-4.2 For MA-1A and BAK-15, a new webbing assembly and suspension straps must be installed after each engagement according to the appropriate 35E8-series T.O. Inspect pendant cables and replace if required.

4-5 PAVEMENTS ADJACENT TO AND BENEATH AAS CABLES

4-5.1 Critical Pavements

The center 23 meters (75 feet) of pavement extending out for 60 meters (200 feet) on both the approach and departure sides of the arresting system pendant are critical areas. Protruding objects, excessive paint build-up, excessive joint sealant material, warped sacrificial panels, and undulating surfaces are detrimental to successful tail-hook engagements and are not allowed. This area of the runway must be visually inspected at least monthly for indications of the above noted conditions. Suspect areas, such as pavement cracks and joints, pavement, and panels beneath the cable must be inspected more closely, and when warranted, checked to ensure the effective pendant height is adequate for successful engagements. Increased attention will be necessary after each freeze-thaw cycle.

4-5.1.1 Problem areas must be immediately identified to the installation pavements engineer for a more thorough inspection and corrective action. The airfield manager must also be notified so that Notice(s) to Airmen (NOTAMs), local NOTAMs,

and aircrew briefings can be issued to highlight the potential problem pending corrective action.

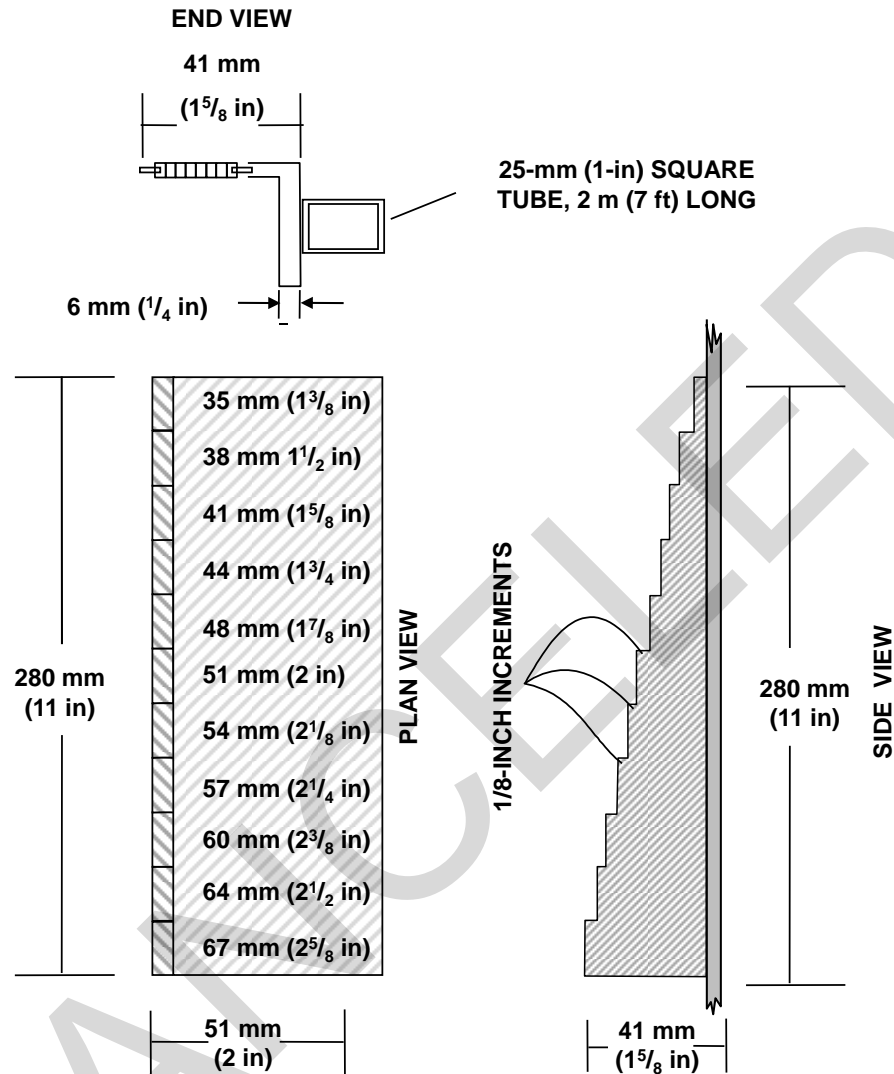
4-5.1.2 Perform more detailed inspections of suspect areas with a 4-meter (12-foot) straightedge. Begin on the runway centerline and check the pavement in the immediate area of the cable for high spots, depressions, or other undulations. Perform the inspection out to a point beyond the first transverse pavement joint on rigid pavements or for approximately 3 meters (10 feet) past the suspect area, or for a minimum longitudinal distance of 6 meters (20 feet), whichever is greater. Repeat this procedure within 1 meter (3 feet) on both sides of the runway centerline, and then at not more than 2-meter (6-foot) intervals across the runway, for a total distance of 11.5 meters (37.5 feet) on either side of the runway centerline. Grind flush any high spots exceeding 3 millimeters (0.125 inch). Report depressions exceeding 3 millimeters (0.125 inch) in depth to the installation pavements engineer for corrective action.

4-5.2 Effective Pendant Height (EPH)

The EPH is the vertical distance (in millimeters or inches) from the underside of the pendant to the pavement surface, or if worn, a projected surface representing the original plane of the runway surface beneath the cable. The EPH for an undamaged or non-grooved runway surface is approximately 60 millimeters (2.38 inches) for a 32-millimeter (1.25-inch) pendant cable. Maintaining this cable height as near to maximum as possible greatly increases the probability the aircraft tail-hook will successfully engage with the arresting system pendant cable. However, as the cable is trampled by aircraft, the rotational oscillations induced by roll-over cause the pavement to wear.

4-5.2.1 Measure the EPH along the center third of the runway width at 3-meter (10-foot) intervals or less using an EPH-measuring tool (see Figure 4-2). Manufacture the tool locally for use by the AAS shop. Perform measurements with AAS cable under tension. Ensure cable tiedowns are not pulling the cable towards the runway surface. Preferably perform measurements in the area between cable support disc.

Figure 4-2 EPH Stepped Feeler Gauge



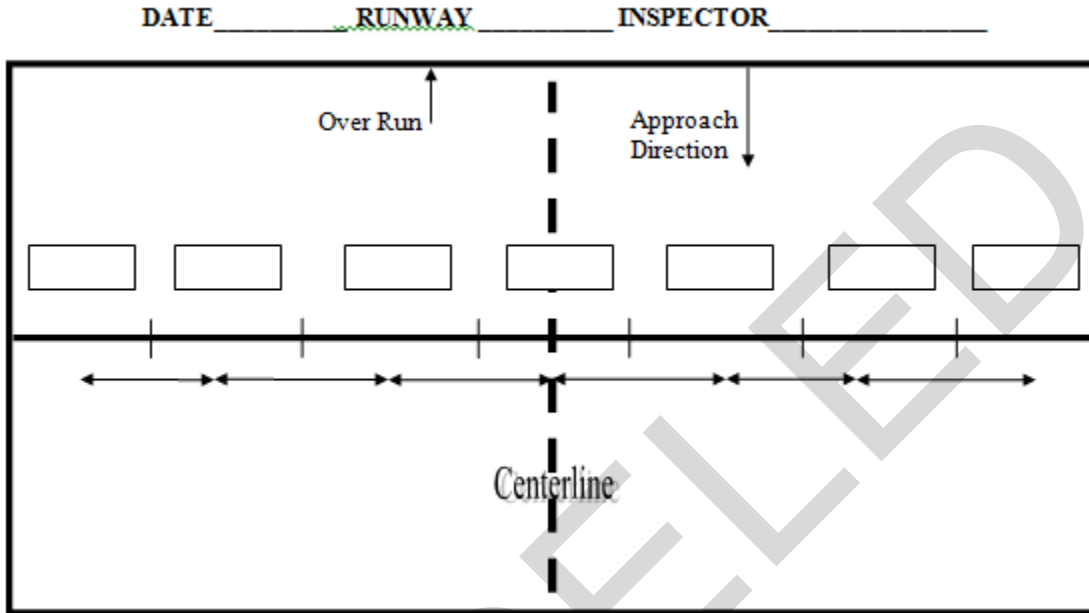
EPH MEASURING TOOL CONSTRUCTED FROM 51-mm (2-in) ANGLE STOCK
(NOT TO SCALE)

4-5.2.2 Start measuring when pavement erosion or grooving is noticed and repeat measurements at least monthly until repaired. As the EPH approaches 38 millimeters (1.5 inches), take and record measurements daily until repaired.

4-5.2.3 Record EPH measurements in the arresting system maintenance log, using a sketch to demonstrate the EPH values and the distance to the location where the measurement was taken (see Figure 4-3). Distance between measurements should not exceed 10 feet. Measurements should be taken in the center most point between cable support disk. Indicate the distance between measurements left and right of the

runway centerline. Perform and record measurements while facing the runway approach for documentation consistency.

Figure 4-3 EPH Measurement Log Sample



4-5.2.4 AAS maintenance personnel must notify the local Pavements Engineer, MAJCOM representative and local Airfield Manager when EPH measurements become necessary. Provide status reports of changes to the EPH as they occur. Problem areas must be immediately identified to the installation pavements engineer for a more thorough inspection and corrective action. The Airfield Manager must also be notified so that Notice(s) to Airmen (NOTAMs), local NOTAMs, and aircrew briefings can be issued to highlight the potential problem pending corrective action.

4-5.2.5 Arrange for pavement repairs when any EPH measurement drops to 44 millimeters (1.75 inches) or less. Make the repair before the lowest EPH drops below 38 millimeters (1.5 inches). Perform emergency repairs (permanent or temporary) when any EPH measurement is less than 38 millimeters (1.5 inches).

4-6 ULTRA HIGH MOLECULAR WEIGHT (UHMW) POLYETHYLENE PANEL INSPECTION AND MAINTENANCE

Installations should establish formal procedures to ensure satisfactory performance of UHMW panels. UHMW panels should be inspected daily and monthly for effects of aircraft traffic and thermal movement (expansion/contraction/warping) in accordance with the following.

4-6.1 Daily Inspection. Panel inspection should be added to the daily arresting system inspection checklist for power production personnel. Visually check for panel

buckling, warping, and surface variations. If disparity is found, initiate corrective measures.

4-6.2 Weekly Inspection. Check for panel buckling, warping, and surface variations by placing a steel straightedge on top of each panel parallel with the runway centerline at:

- Each joint between panels.
- At least two locations within each panel.
- Any other location that appears raised or irregular.

The straight edge must be long enough to overlap the pavement on each side of the panel by a minimum of 305 millimeters (12 inches). Immediately report raised edges or high spots exceeding 3.2 millimeters (0.125 inch) above the plane of the adjacent runway to the installation Pavements Engineer, local Airfield Manager and to the MAJCOM AAS engineer for further evaluation. Take color photographs to document findings.

4-6.3 Monthly Inspection. The installation pavements engineer should participate once each month in the daily inspections with the AAS personnel. Record all panel conditions, including (but not limited to):

- Erosion affecting a reduction in EPH.
- Distresses in the pavement or panels.
- Warping or edge curling.
- Soundness.
- Delamination.
- Anchor nuts and studs. (Note that anchor stud-nuts may be over-torqued if tightened repeatedly. If any are found loose, use a thread-locking compound such as Loctite® on the threads before tightening, then reseal.)
- Joint Seals.
- Spalling.

Report any deterioration or other problems to the appropriate AFIMSC Detachment for further evaluation.

4-6.4 Joint Maintenance. Joints should be resealed as needed, and just prior to onset of cold weather to prevent moisture accumulation and freezing below the panels. Ice formation beneath panels may cause panel failure, anchor failure, or excessive panel warping.

4-7 CERTIFICATION

4-7.1 All Air Force arresting gear (excluding MA-1A, E-5, BAK-15, textile brake, and soft ground arrestor systems) that have not been engaged at a speed sufficient to exercise the hydraulic system within the past 12 months must be certified by an aircraft engagement. Refer to AFI 32-1043, *Managing, Operating and Maintaining Aircraft Arresting Systems*. Report all engagements or missed engagements per AFI 32-1043.

4-7.2 Maintenance and recovery crews will also be evaluated during certification engagements. The following factors will be considered:

- Evaluate crew proficiency in disconnecting the aircraft and returning the AAS to service.
- Evaluate adequacy of maintenance, training records, established Special Levels of replacement parts and supplies, and engagement data.
- Evaluate availability of necessary tools, bench stock, and special equipment.

4-7.3 Responsibility for assuring that certification is accomplished according to this instruction, appropriate 35E8-series T.O. and AFI 32-1043, *Managing, Operating and Maintaining Aircraft Arresting Systems* rests with the host command. AAS personnel must provide an information copy of each record of certification engagement or certification inspection report to airfield management for their file. Records of certifications will also be maintained in accordance with requirements for Maintenance Records in this FC.

4-8 OPERATION

4-8.1 Refer to AFI 32-1043, *Managing, Operating and Maintaining Aircraft Arresting Systems*, for unidirectional barrier net and pendant cables located in the overruns of the approach end of the runway.

4-8.2 Maintain operational arresting systems like BAK-12 and MAAS in the ready position on the approach and departure ends of the runway and in overruns (but not underruns) unless the installation commander directs otherwise.

4-8.3 AAS, Barriers and interconnected hook cables may be removed from the overrun and runway during snow and ice removal operations. However, coordinate removal with airfield management, then return the AAS, Barriers and interconnected hook cables to operational status as soon as possible.

4-8.4 Hook cable support and retraction systems are not designed to operate in the up position with repeated aircraft rollovers. Repeated high-speed rollovers will damage the system components, reduce system reliability, increase the chance of a missed engagement, and increase maintenance costs.

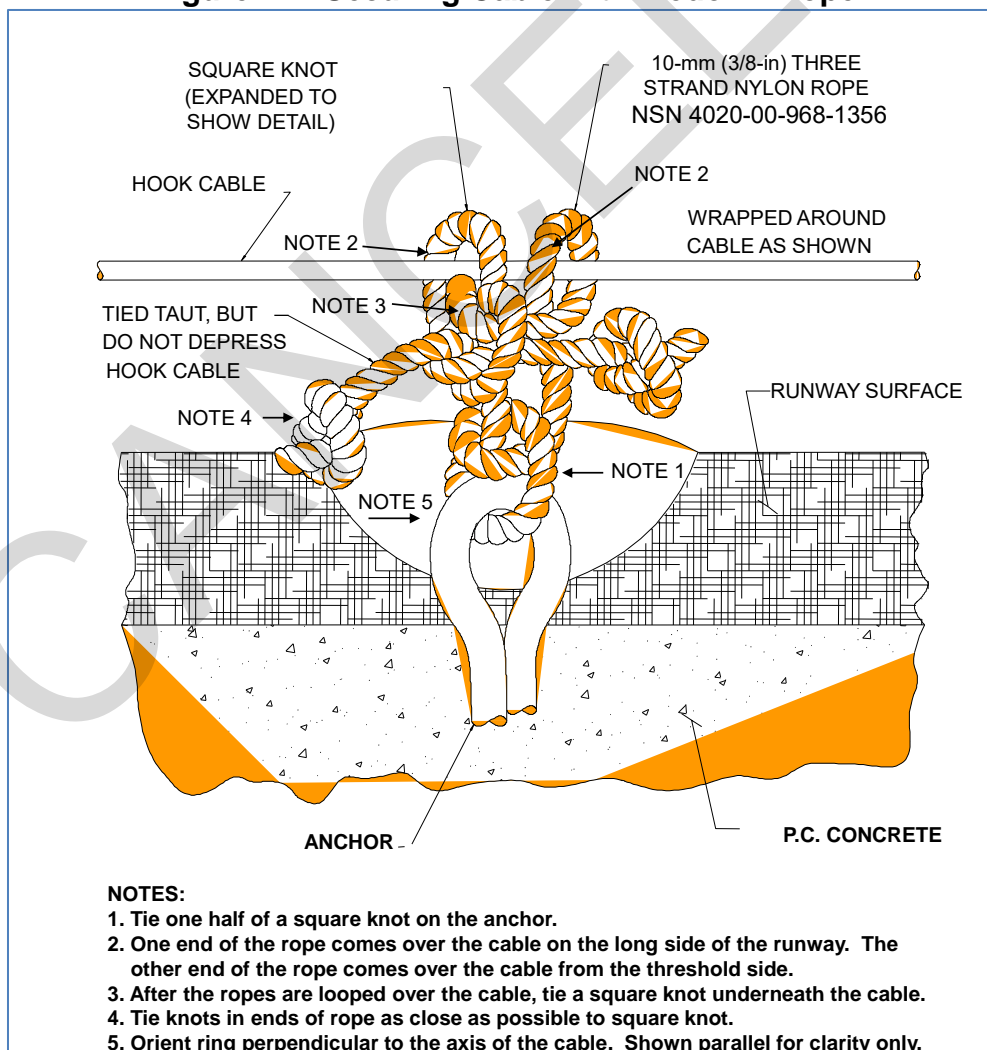
4-8.4.1 Low-speed taxi rollovers must also be kept to a minimum to prevent degradation of system performance.

4-8.4.2 If the AAS is not required to stop the aircraft, air traffic control (ATC) should lower the BAK-14 or Type H cable support system prior to aircraft rollover.

4-8.4.3 Local airfield operating instructions should include provisions for ensuring the BAK-14 or Type-H cable support system is lower prior to the arrival or departure of non-hook equipped or arrestment-capable aircraft

4-8.5 Secure the cable to the cable tiedown anchors with a length of 10-millimeter (0.375-inch) -diameter, three-strand nylon rope (nsn 4020-00-968-1356) approximately 1200 millimeters (48 inches) long (2200 kilograms [5000 pounds] maximum breaking strength). The rope must be fastened to the anchor with a simple overhand knot then tied to the cable with a square knot that is finished on the underside of the cable. Tie a simple overhand knot as close to the square knot as possible with the remaining rope. This will prevent the square knot from becoming loose. See Figure 4-4.

Figure 4-4. Securing Cable with Tiedown Rope



4-9 RADIO PROCEDURES AND STANDARD PHRASEOLOGY

When performing duties associated with AAS and barriers in the airfield environment, it will be necessary to communicate with ATC, ground control, fire emergency services, and airfield management by two-way radio. Follow local procedures established within the airfield operating instruction (AOI) and the base airfield driving regulations and program. General terms to be used for radio communication are provided in AFI 13-204, Volume 3, *Airfield Operations Procedures and Programs*, AFI 13-213, *Airfield Driving*, and Federal Aviation Administration (FAA) Order JO 7110.65T, *Air Traffic Control*, "Pilot/Controller Glossary." The most common terms for use and their definitions are provided below. Appendix B-2 also provides definitions for the various terms that relate specifically to the airfield and airfield operational areas, including the method used to designate the in-use runway. The phrase "clear" must not be used when communicating with tower personnel.

- "Acknowledge" — Request that you have received and understand the message.
- "Affirmative" — Yes.
- "Negative" — No.
- "Say Again" — Request to repeat the message.
- "Roger" — I have received and understand the last transmission.
- "Hold Short" — Do not proceed per the tower's instructions.
- "Wilco" — I have received and will comply with your message.

4-10 Reporting System Status

Report the status of an AAS or Barrier to the ATC using the terms "operational," "not operational," "in-service," "out of service" or "pendant cable disconnected and off the runway" consistently when reporting status to the airfield authority. These terms are easy-to-understand descriptions of AAS or Barrier status. The specific terms selected for each installation should be specified within the local AOI.

4-11 Reporting System Location

When communicating the location of an AAS on the active runway, use the active runway designation and refer to the system in question by approach, midfield, or departure end AAS, or approach or departure end barrier. In this case, it is important to differentiate between AAS and barriers. BAK-12 and BAK-14 systems are AAS systems, not barriers. Net systems such as MA-1A and BAK-15 systems are barriers. See the definition of terms in Appendix B-2 of this FC. The active runway (the runway in use) is identified by the numeric designation of the approach end of the runway. For example, for Runway 12/30, the active runway would be "Runway 12" when aircraft are taking off from or landing toward the end of Runway 12, or are on a 120-degree compass heading.

4-12 Hand Signals

Standard hand signals for use between AAS crewmembers and aircrew members are provided in AFI 11-218, *Aircraft Operations and Movement on the Ground*. Standard hand signals for use between AAS crewmembers are shown in Figures 4-5 and 4-6. During night operations or restricted visibility, the ground crew will use a pair of same color light wands and done a Type III reflective vest.

Figure 4-5 Hand Signals for Rewind, Point Man to Pilot

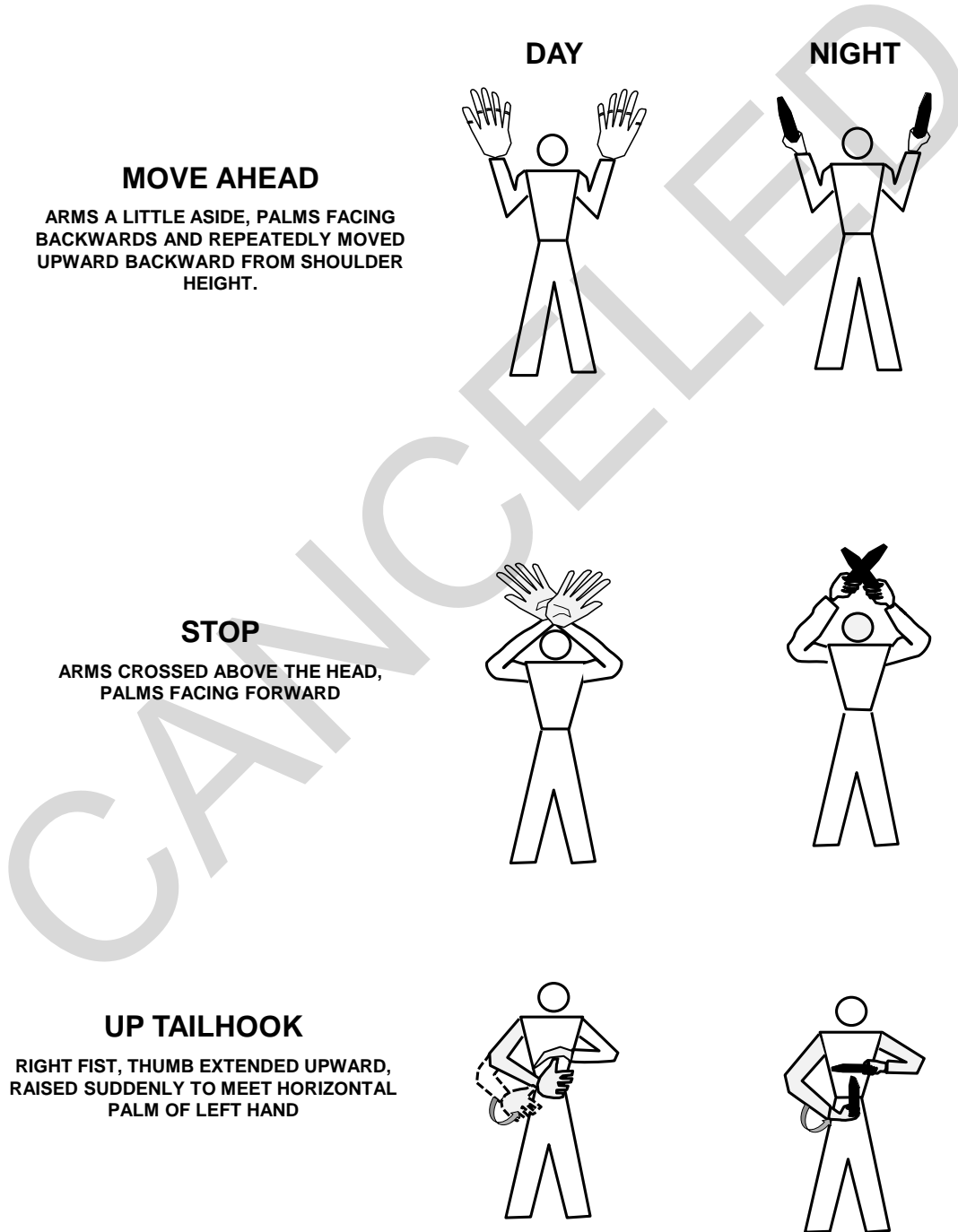
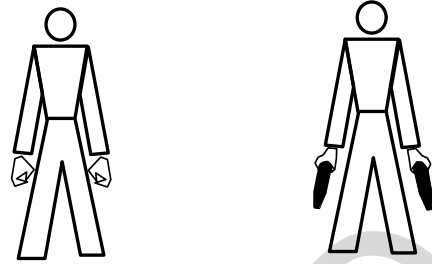
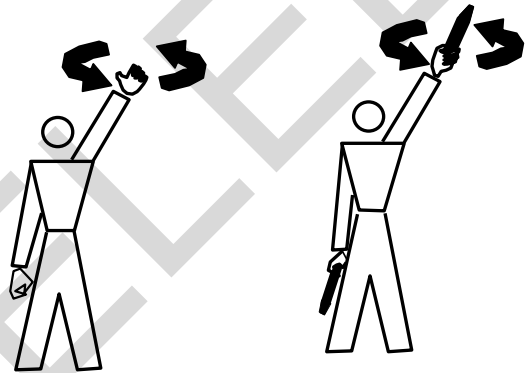


Figure 4-6 Hand Signals for Rewind, Point Man to Rewind Operator, Sheet 1

STOP (Both Units As Shown)
NIGHT - LIGHT WANDS TO SIDES, LIGHTS OFF
DAY - HANDS TO SIDES, FISTS CLENCHED



**REWIND OR PRETENSION
ONE UNIT**
AS INDICATED BY HAND USED TO
SIGNAL



REWIND BOTH UNITS

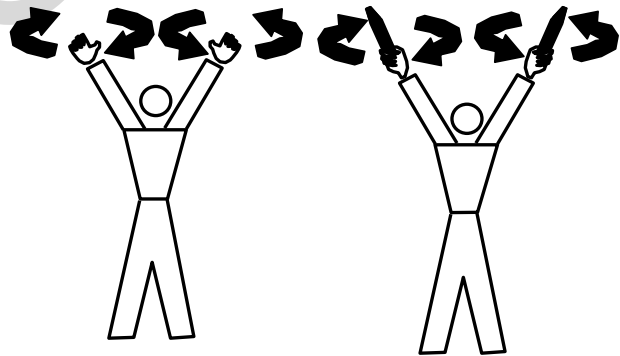


Figure 4-6 Hand Signals for Rewind, Point Man to Rewind Operator, Sheet 2

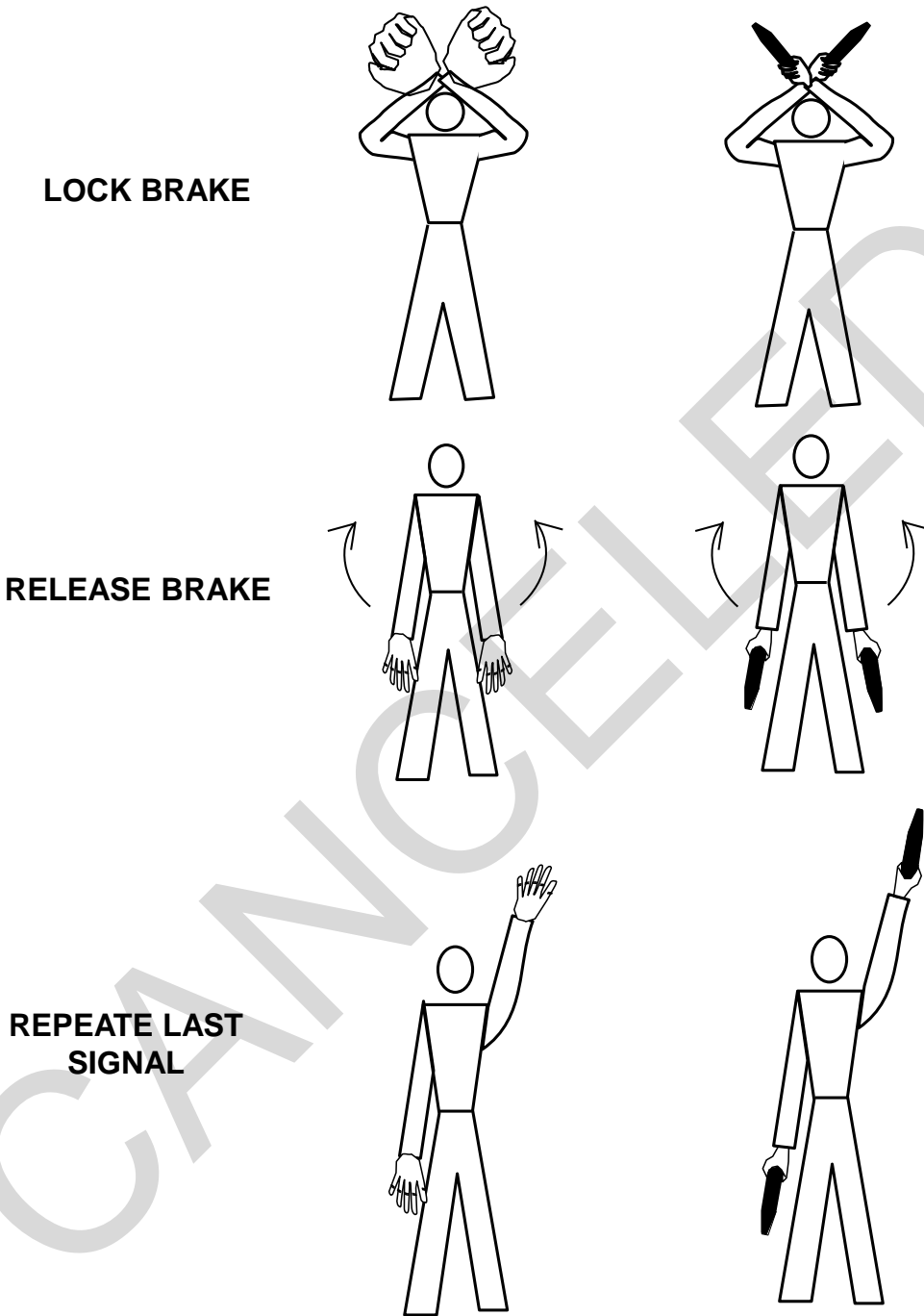
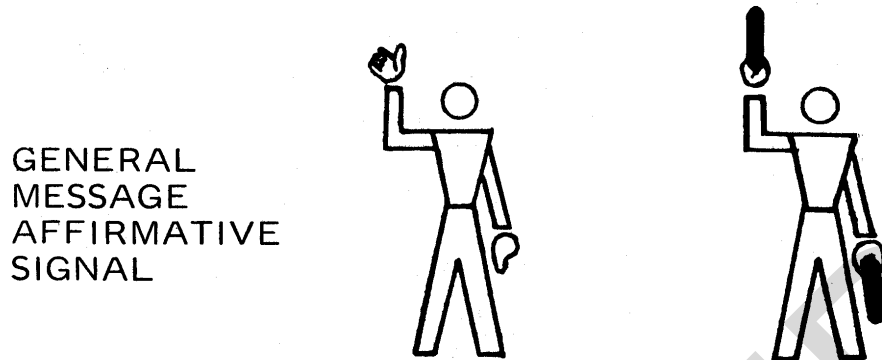


Figure 4-6 Hand Signals for Rewind, Point Man to Rewind Operator, Sheet 3



4-13 MAINTENANCE DOCUMENTATION AND RECORDS

4-13.1 Document all activities (maintenance and inspections, etc) in a log book as soon as the task has been accomplished. Identify the time and date of the activity, location of the activity, all personnel performing the work and on the work site, as much information as is available for parts and materials used (including part number, manufacturer's name and CAGE Code, serial number (if any), contract number, batch, and date of manufacture) and status of the AAS or barrier.

4-13.1.1 Maintain the log book until all systems referenced are removed or replaced.

4-13.1.2 The AAS supervisor will ensure a record of inspections, repairs, and authorized modifications are kept in a log and that arresting system historical records are maintained in the AAS work center.

4-13.1.3 The AAS supervisor will review and sign the log daily except weekends or holidays. Work accomplished on weekends and holidays will be reviewed and signed off the next duty day

4-13.1.4 The AAS supervisor will perform quality assurance inspections on the installation and maintenance of AAS, historical records and the vehicles and tools used to perform AAS activities. Quality assurance inspections will be documented in the AAS log book.

4-13.1.4 Log books shall be retained and stored for 5 years from the date of the last entry.

4-13.2 Establish a historical maintenance record for each system for the overhaul service life of the system, and document, at a minimum, the following information in the record:

- AAS or Barrier type, date installed, location on airfield, and serial numbers (number of system engagements on BAK-12, and MAAS).

- Last overhaul date (including fairlead beams or edge sheaves).
- Last non-destructive inspection (NDI) date with results.
- Daily inspections.
- Weekly inspections.
- Monthly inspections.
- Quarterly inspections
- Semi-annual inspections
- Annual inspections
- Multi-year inspections
- Purchase Tape data (date installed, contract number, manufacturer, usage data for each tape and serial number of the AAS the purchase tape installed).
- Cable replacement data (date installed, manufacturers' identification code, serial number, and contract number).
- System certification and certification inspection records/reports. (Submit all engagement reports per AFI 32-1043, *Managing, Operating, And Maintaining Aircraft Arresting Systems*)
- Aircraft engagement reports.
- Replacement parts and/or materials (including part number, manufacturer's name and CAGE Code, serial number (if any), contract number, batch, and date of manufacture)

4-13.3 Historical records must be kept with the system for the life of the equipment to ensure they are returned to the overhaul facility when the system is changed out. This includes War Reserve Materiel (WRM) systems in storage, as well as systems designated for training use only, as applicable. Provide a copy of maintenance records to the overhaul facility or WRM location when the system removed.

The AAS supervisor will review and sign each historical record entry to verify accuracy of the entry. Work accomplished on weekends and holidays will be reviewed and signed off the next duty day

4-13.4 The AAS supervisor shall establish and maintain an AAS status board in the AAS work center that indicates at a minimum for all installed and stored AAS and/or barriers:

- Current status each AAS and/or barrier
- Current pendant or net system configuration
- Due dates for maintenance activities
- Current tape count, pendant count, and system count
- Date of installation for tapes, pendants and textile systems and nets
- Last engagement date

4-14 DEFICIENCY REPORTING

Report all deficiencies discovered with AAS and components to base supply according to T.O. 00-35D-54, USAF Material Deficiency Reporting, Investigation, and Resolution.

CANCELLED

CHAPTER 5 SYSTEMS USED ON USAF INSTALLATIONS

5-1 DESCRIPTION

Aircraft arresting systems consist of engaging devices and energy absorbers. Engaging devices are net barriers such as MA-1A and BAK-15, disc-supported pendants (hook cables), and cable support systems such as BAK-14 and the Type H that raise the pendant to the battery position or retract it below the runway surface. Energy-absorbing devices are ships' anchor chains, rotary friction brakes (such as the BAK-12), tearing strap modules such as textile brake systems, and soft ground systems such as the Engineered Material Arresting System (EMAS). Tables 5-1 and 5-2 below show the leading particulars for Air Force energy-absorbing systems.

Table 5-1 USAF Aircraft Arresting System Energy Absorber Leading Particulars (Except Textile Brake)*				
System Type	BAK-12 66-Inch Reel	Dual BAK-12 66-Inch Reel	MAAS 990-Foot Runout	MAAS 1200-Foot Runout***
Nominal Aircraft Weight (lb)	50,000	100,000	40,000	68,400
Energy Capacity (ft-lb)	85 x 10 ⁶	170 x 10 ⁶	40 x 10 ⁶	98 x 10 ⁶
Nominal Runout (ft)	1,200	1,200	990	1200
Tape Strength (lb)	105,000	105,000	105,000	105,000
Cable Strength (lb)	130,000	130,000	130,000	130,000
Maximum Speed (kn)**	180	180	150	180
<p>* The operating characteristics given in this table are described in inch-pound units as reported by the original equipment manufacturers.</p> <p>** 190 knots is the dynamic limit for steel cables used in AAS. Random failures will occur at 190 knots and above; therefore, 180 knots is established as the working limit for cable-engagement systems.</p> <p>*** MAAS configured for 1200-foot runout in the 31-stake, PCC, or set-back anchoring schemes having the same technical characteristics as a 66-inch BAK-12.</p>				

Table 5-2 USAF Textile Brake Aircraft Arresting System Leading Particulars*		
System Type	MB 60.9.9.C	MB 100.10C
Cable diameter/strength	1.25 inches/130,000 lb	1.25 inches/130,000 lb
Stage 1 runout (length of available braking force)	551 feet	N/A
Energy capacity stage 1 (ft-lb)	26 x 10 ⁶	N/A
Total system energy capacity (ft-lb)	52 x 10 ⁶	44 x 10 ⁶
System runout (total length of available braking force)	1000 feet	889 feet
Energy capacity calculated at 160 knots. Note: Twelve percent increase in energy capacity when using a net. * The operating characteristics given in this table are described in inch-pound units as reported by the original equipment manufacturers.		

5-2 CHAIN ABSORBER ARRESTING GEAR (CHAG) SYSTEMS

5-2.1 MA-1A

The MA-1A emergency arresting system consists of a net barrier and cable system designed to engage the main landing gear of an aircraft (Figure 5-1). Because it is a unidirectional system, it must always be installed in the overrun area. Aircraft engaging this system above the speed and weight limits provided in Figure 5-3 (or Chart 1-1 of T.O. 35E8-2-2-1) will result in a runout greater than 305 meters (1000 feet) or cable failure. Most MA-1A systems employ ships' anchor chains as the energy absorber. These systems require a runout area of at least 259 meters (850 feet) plus the length of the aircraft. The chains lie on either side of the runway overrun, beginning at the barrier location and running in the direction of aircraft travel; however, some MA-1A systems use a BAK-9 instead of a ship's anchor chain as the energy absorber. These systems require a runout area of at least 290 meters (950 feet) plus the length of the aircraft. This configuration is an MA-1A/BAK-9.

5-2.2 MA-1A Modified

The MA-1A may also be complemented with a hook-cable interconnect to accommodate hook engagement. This arrangement is shown in Figure 5-2. The MA-1A is not currently in production as a system. Do not consider it for new installations unless you can salvage the necessary equipment from another facility. Obtain further technical information on this system from T.O. 35E8-2-2-1.

Figure 5-1 MA-1A Barrier

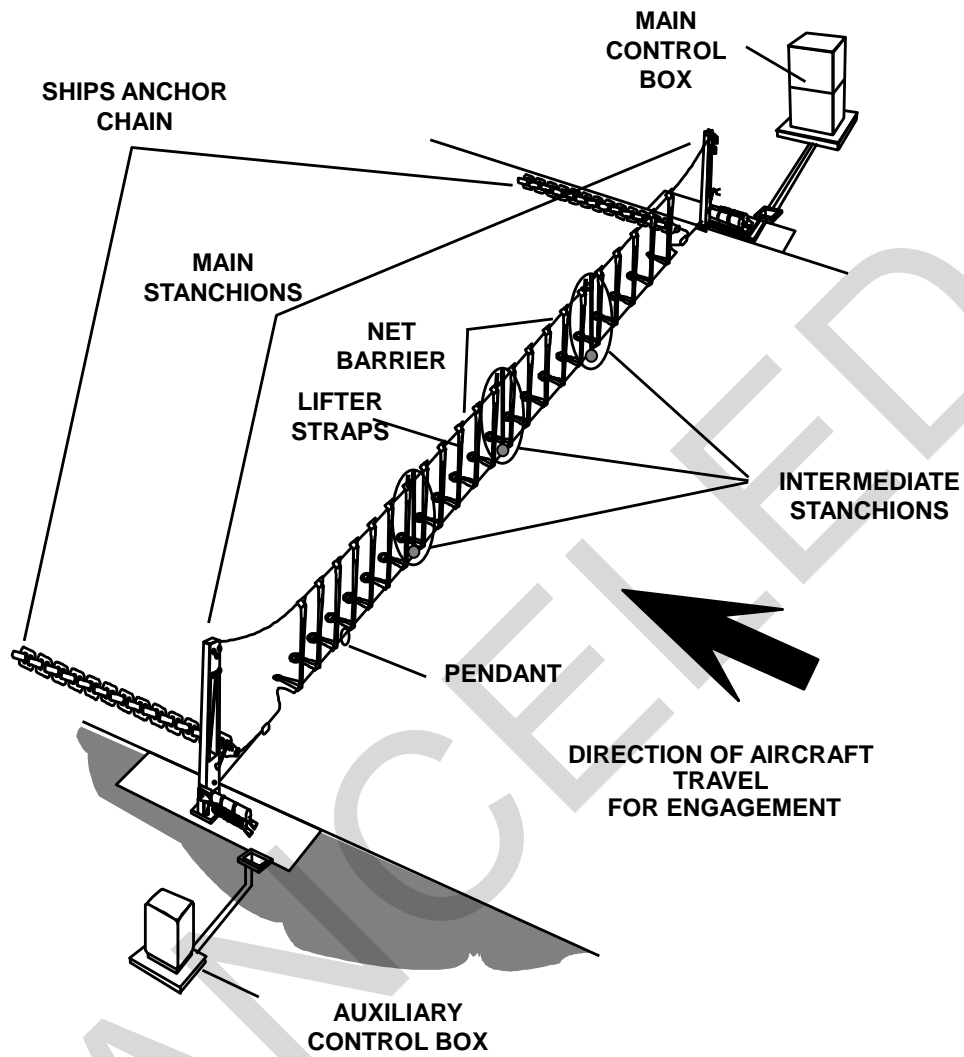


Figure 5-2 MA-1A Modified Barrier With Hook Cable Interconnect

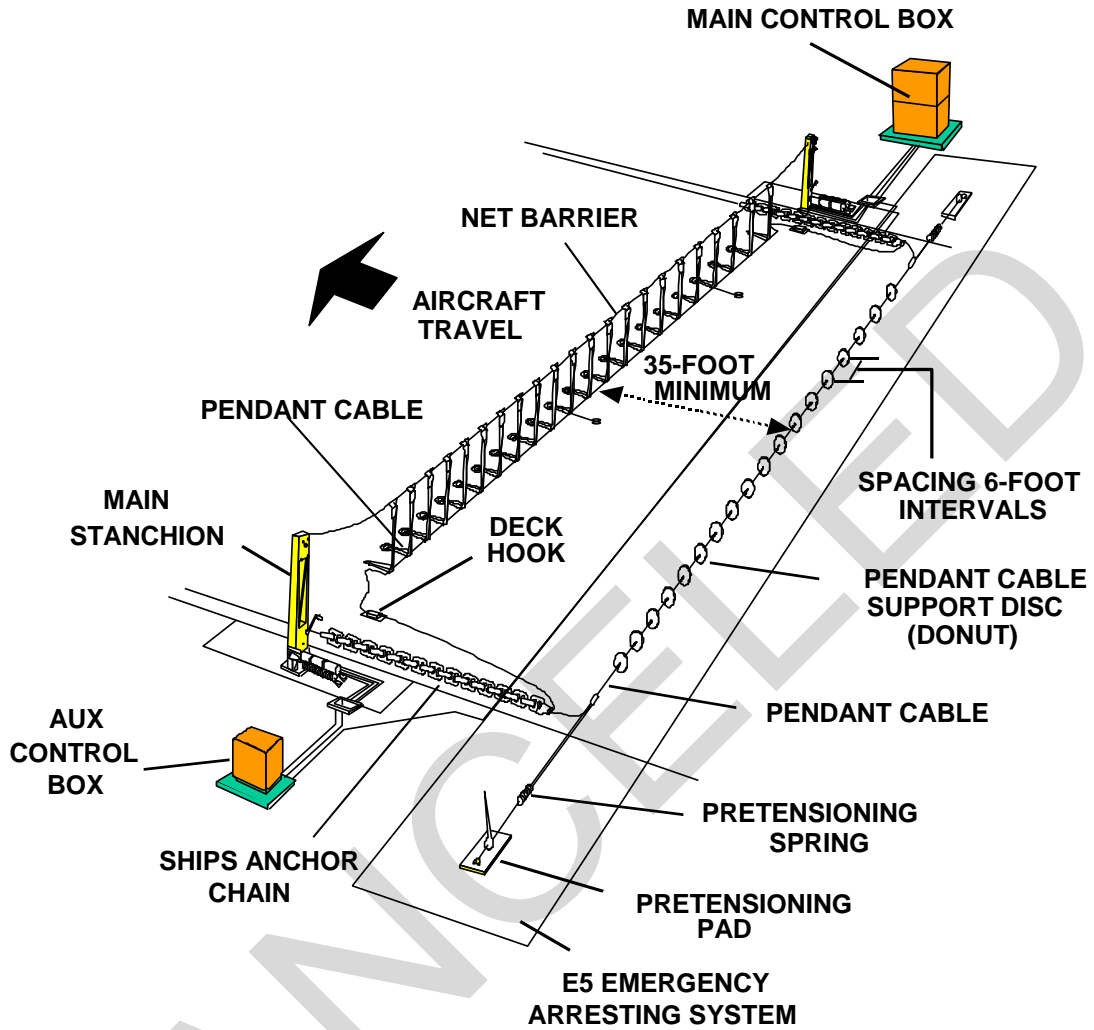
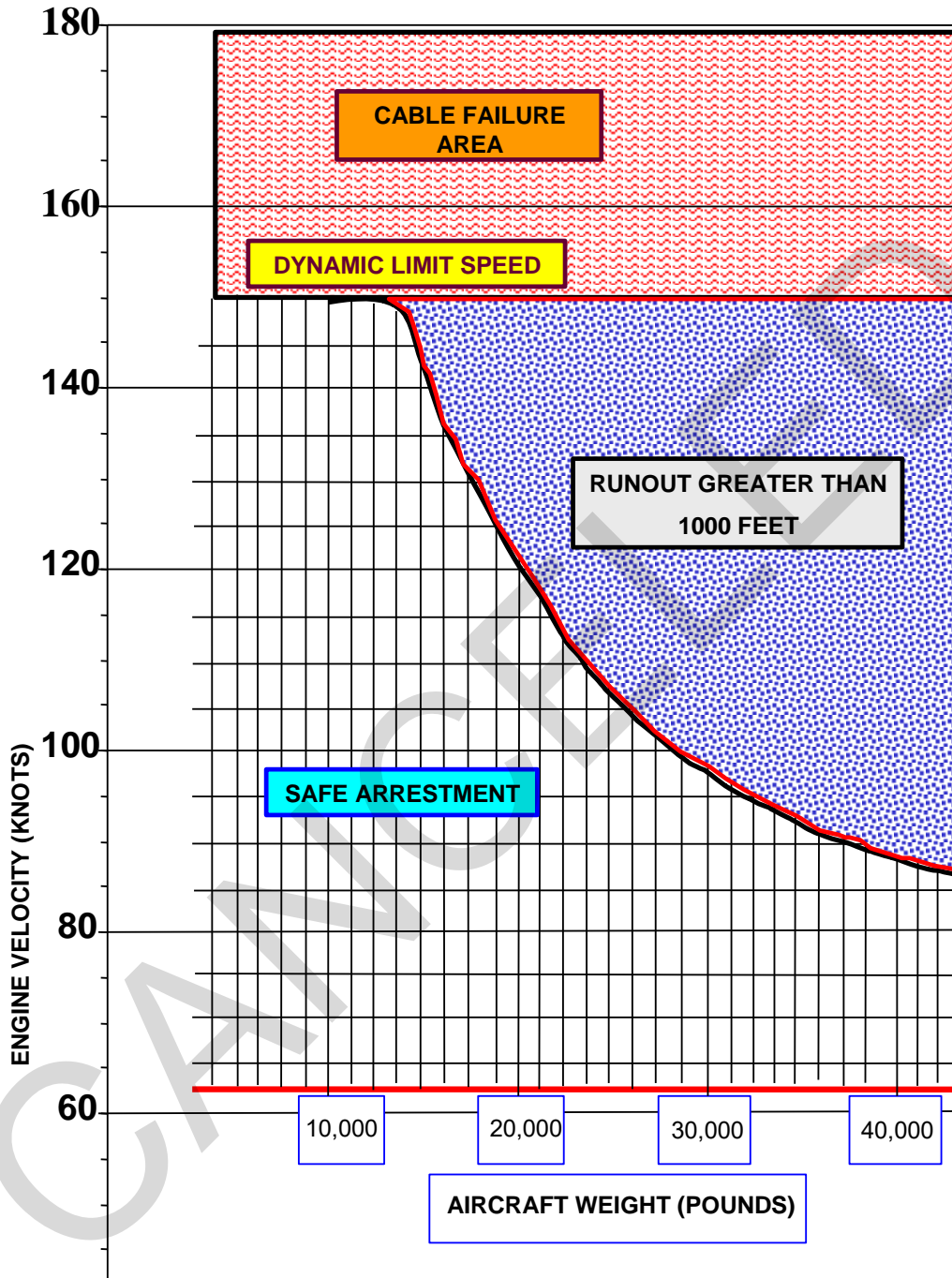


Figure 5-3 Speed and Weight Chart for Chain Gear

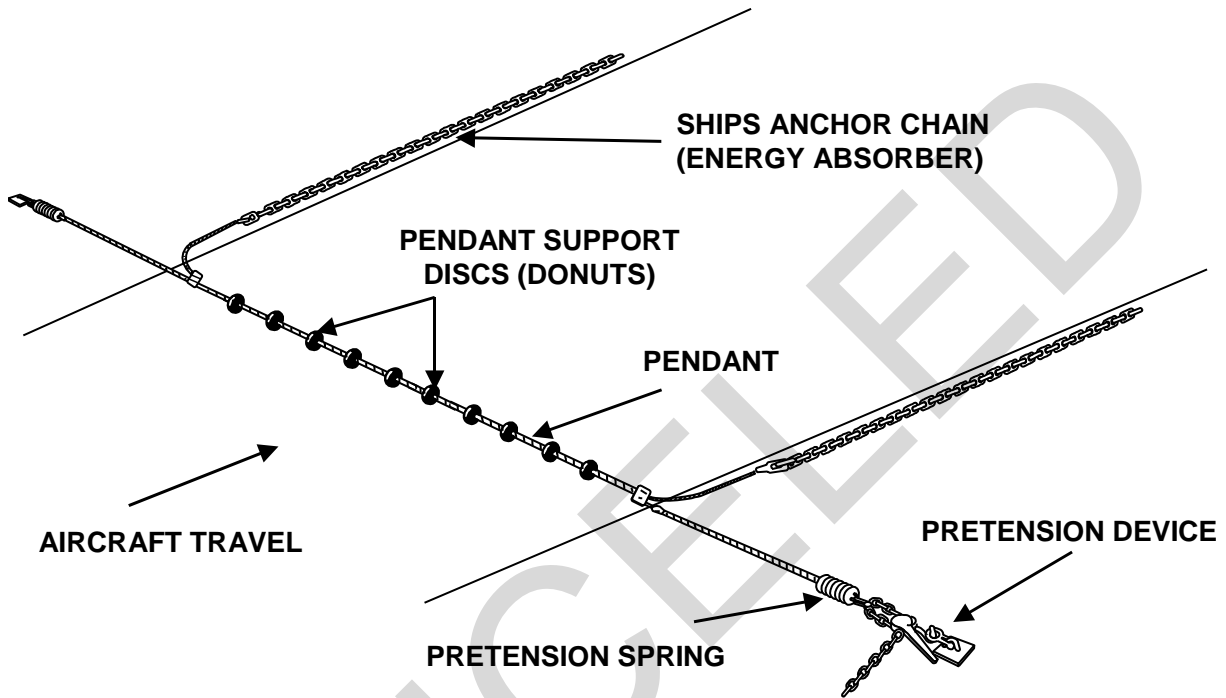


5-3 E-5

This unidirectional emergency arresting system is a U.S. Navy design and designation. Much like the MA-1A, this system uses several shots of ship's anchor chain as the energy absorber but these systems are never connected with a barrier (net). For the Navy or Marine Corps, these systems can have from one to four disc-supported hook cables, with designations of E-5 and E-5 Mod 1 through E-5 Mod 3. Obtain further

technical information on the Navy configuration of this system from the Naval Air Warfare Center, Lakehurst, New Jersey. For the Air Force, these systems use only one pendant and are sited and maintained as described in the MA-1A T.O. (TO 35E8-2-2-1). They are designated as an E-5 (Figure 5-4).

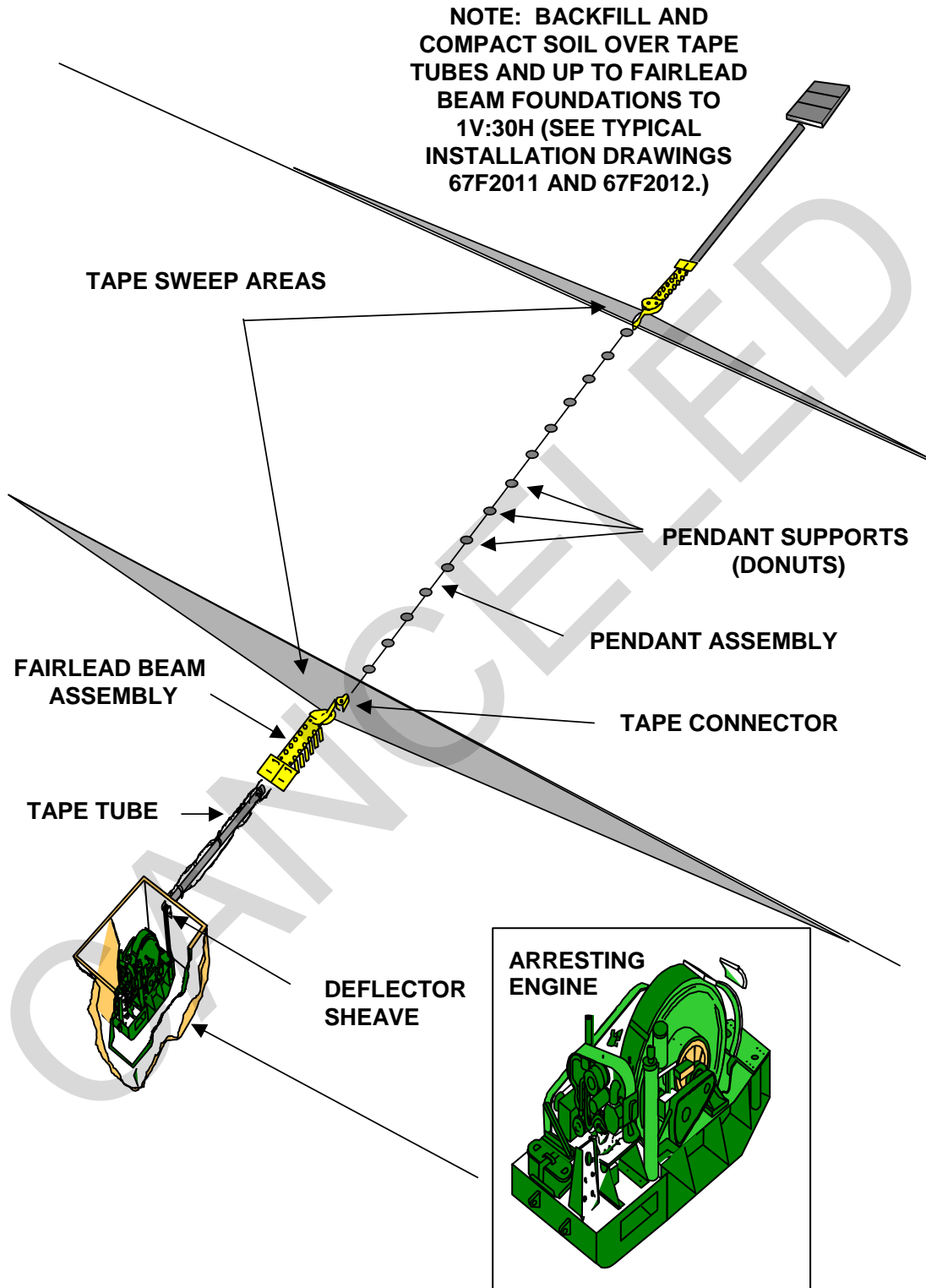
Figure 5-4 E-5 Hook Cable CHAG



5-5 BAK-12 Rotary Friction Brake Absorber

5-5.1 The BAK-12 (Figure 5-5) is the standard Air Force operational AAS. This bi-directional system employs two energy absorbers. Each absorber consists of two multi-disc rotary friction brakes mounted on either side of the purchase-tape reel on a common shaft. The energy absorbers are located on opposite sides of the runway or overrun, connected to a 32-millimeter (1.25-inch) disc-supported pendant by the purchase tapes. Ideally, the energy absorbers should be in a below-grade pit with a minimum split distance of 15.24 meters (50 feet). (Split distance is a measurement taken between the lead-on sheave of the fairlead beam or edge sheave, and the energy absorber.) Split distances of up to 91 meters (300 feet) are acceptable for all BAK-12 installations. You may also install BAK-12 systems above grade in one of two configurations, the selection depending upon site conditions and operational requirements. These are the expeditionary installation for periods of up to one year, and the semi-permanent installation, well-suited for long-term use and typically selected when site conditions will not allow a pit-type installation. Siting and grading requirements are in Section 3 of T.O. 35E8-2-5-1. *Typical Installation Drawings for pit-type installations (drawing number 67F2012A) and permanent surface type installations (drawing number 67F2011A) are available from AFCEC/COS and the AFLCMC.*

Figure 5-5 BAK-12 Aircraft Arresting System



5-5.2 Originally, BAK-12 energy absorbers were fitted with a 60-inch purchase-tape storage reel. This design allowed the maximum energy expected to be imparted during an aircraft engagement to dissipate within a runout of 290 meters (950 feet) plus the length of the aircraft. Designers have since improved the BAK-12 to meet increased demands of heavier and faster aircraft. The energy absorbers have been retrofitted with larger 66-inch or 72-inch tape storage reels to accommodate increased runout, thus increasing the total energy capacity of the system. These systems require 366 meters (1200 feet) plus the length of the aircraft for maximum runout. The 72-inch reel systems are special-purpose systems configured for 610 meters (2000 feet) of runout.

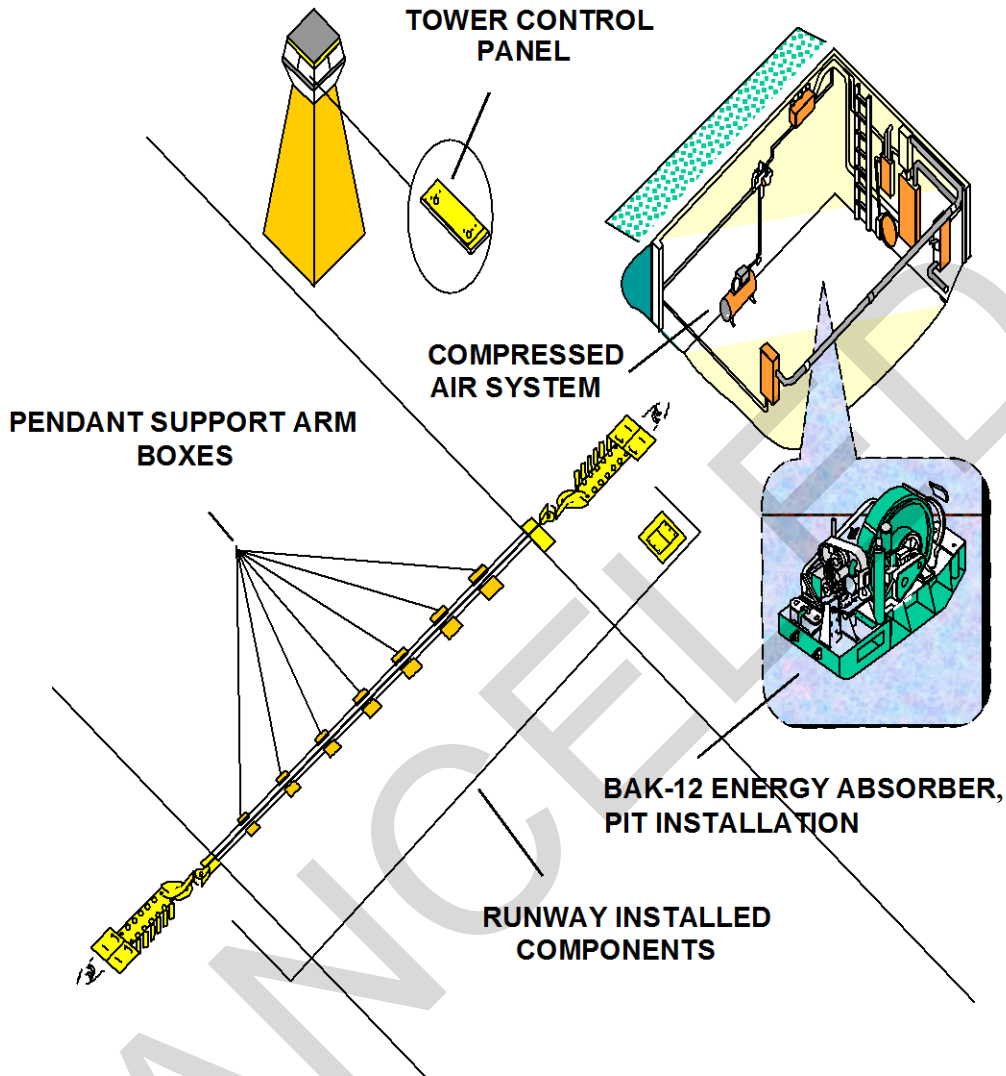
5-5.3 The standard BAK-12 is configured for cross-runway separations of up to 61 meters (200 feet) (distance between fairlead beams or edge sheaves). For installations with cross-runway spans exceeding 61 meters (200 feet), replace the BAK-12 control valve cam to accommodate full runout of the system. Refer to T.O. 35E8-2-5-1 to identify the part number for the correct replacement cam and installation procedures. Also select a pendant length of at least 80 percent of the distance between the fairlead beams to avoid adverse cable dynamics. Selected cable length should be at least 2 meters (6 feet) less than the total span between runway edge sheaves. This will allow sufficient exposed tape on each side of the runway (at least 0.6 meter [2 feet]), as well as an offset between the runway centerline and the center point of the cable, to further reduce cable dynamics by disrupting parity in the kink wave caused by the engagement.

5-5.4 Dual BAK-12 systems are special-purpose installations configured to accommodate high-energy engagements of aircraft ranging from 27,200 to 63,500 kilograms (60,000 to 140,000 pounds). These configurations consist of four BAK-12 energy absorbers arranged in pairs on either side of the runway. The energy absorbers may be standard BAK-12s, or be equipped with 72-inch-diameter tape storage reels to accommodate 610 meters (2000 feet) of runout. Special tape connectors and edge sheaves are needed for these installations. For details of these components and other special considerations, see Section VIII of T.O. 35E8-2-5-1.

5-6 BAK-14 AND TYPE H HOOK CABLE SUPPORT SYSTEMS

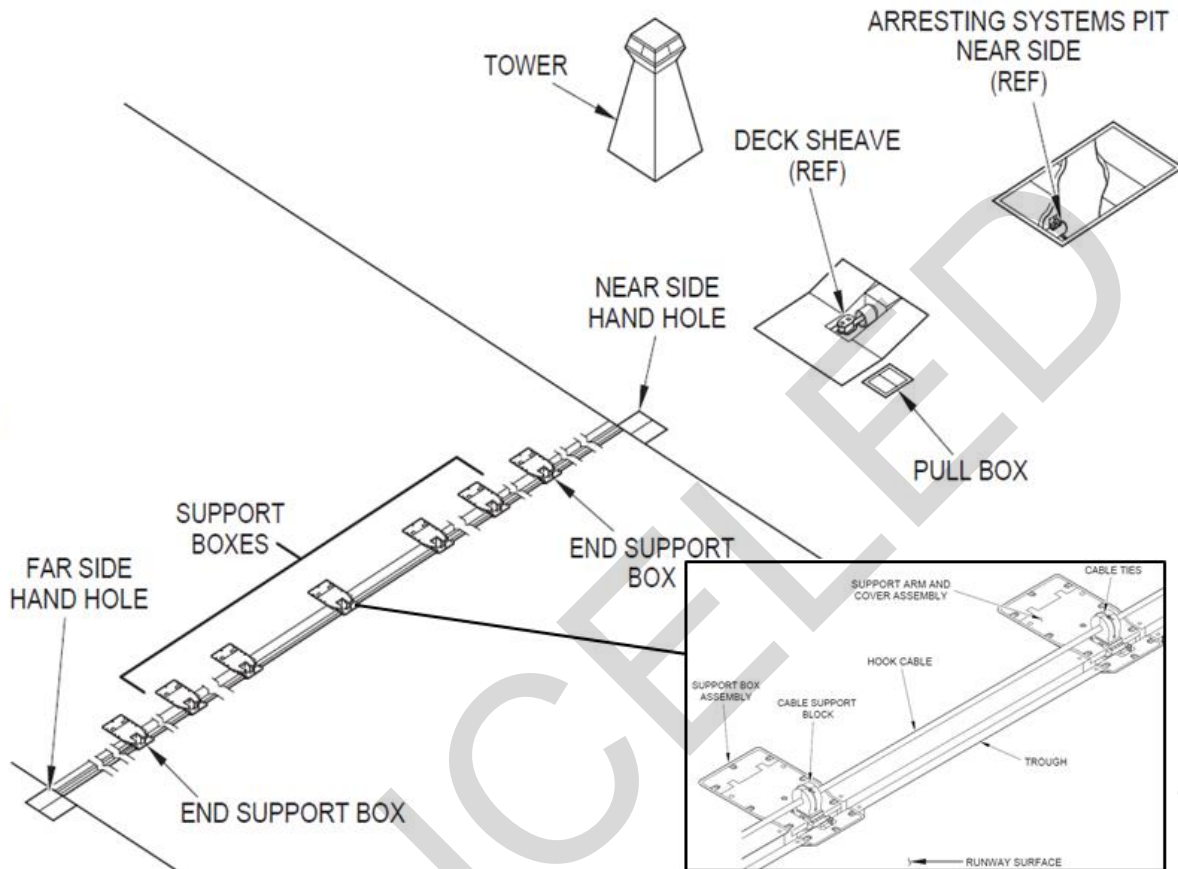
5-6.1 The BAK-14 hook cable support system (Figure 5-6) is a bidirectional hook cable (pendant) support system used in conjunction with the BAK-12, or a comparable pair of arresting system absorbers to engage and safely stop a hook-equipped aircraft. It provides the means to support the pendant at least 51 millimeters (2 inches) above the runway surface while giving Air Traffic Control the means to lower the pendant below the surface of the runway to prevent damage to low-undercarriage aircraft, the pendant, and the pavement below the pendant during trampling. These systems can accommodate 45-, 60-, and 90-meter (150-, 200-, and 300-foot) -wide runways, and can be ordered to suit the specific application. The control side BAK-12 pit or protective shelter and foundation must be enlarged to house the compressed air and control systems needed to operate these supplemental systems. The site and utility considerations for installation are in T.O. 35E8-2-8-1, *Operation, Maintenance, and Installation Instructions with Illustrated Parts Breakdown, Hook Cable Support System, Model BAK-14*.

Figure 5-6. BAK-14 Cable Support and Retraction System



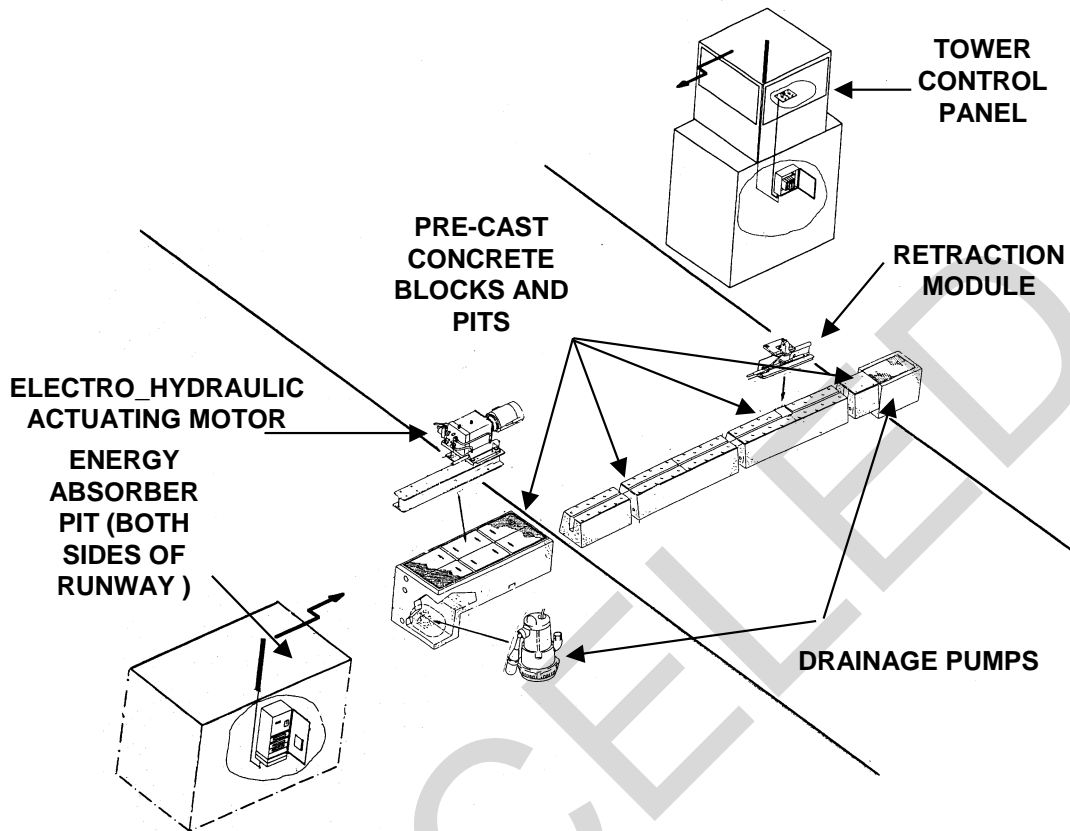
5-6.2 The BAK-14 Modified or BAK-14M (Figure 5-7) is a bidirectional hook cable (pendant) support system used in conjunction with the BAK-12, or a comparable pair of arresting system absorbers to engage and safely stop a hook-equipped aircraft. The system consists of either 14 or 20 support blocks which support the hook cable 3 inches (nominal) (two inches minimum) above the surface of the runway while giving Air Traffic Control the means to lower the pendant below the surface of the runway to prevent damage to low-undercarriage aircraft, the pendant, and the pavement below the pendant during trampling. The system can accommodate 45-, 60-, and 90-meter (150-, 200-, and 300-foot) -wide runways. The BAK-14M contains modified support box covers that provide easier maintenance access and rapid support box replacement. The site and utility considerations for installation are in T.O. 35E8-2-8-1-11, *Operations Manual for the BAK-14 Hook Cable Support Systems (Pit Mounted with Heaters) 14 and 20 Box Systems*.

Figure 5-7. BAK-14M Cable Support and Retraction System



5-6.3 The Type H hook cable support system (Figure 5-8) is a bi-directional hook cable support system that can be used in conjunction with any type of energy-absorbing device. It provides a means to raise a cable at least 51 millimeters (2 inches) above a runway surface or lower it below the runway surface in less than 1.5 seconds. It can be supplied to accommodate runway widths of 46, 60, and 90 meters (150, 200, and 300 feet). A radio remote-control system provides Air Traffic Control the means to operate the system and to monitor its operational status. It typically consists of 14 to 18 (depending on runway width) retraction modules installed into pre-cast concrete blocks across the runway and connected together by metallic rods to form a rigid loop. This loop is actuated by an electro-hydraulic motor located in a concrete pit on one side of the runway. Detailed information (i.e., description, operation, maintenance, illustrated parts list), are provided in T.O. 35E8-2-8-12, *Type H45-200 Aircraft Arresting Cable Retraction System Abbreviated Component Maintenance Manual With Illustrated Parts List* and Aerazur Technical Manual 256-722, *Type H45-200 Component Maintenance Manual With Illustrated Parts List*. Installation drawings are available from the manufacturer. It should be noted, three-phase power is needed at the Type H installation site to power the hydraulic pump actuator.

Figure 5-8. Type H Hook Cable Support System



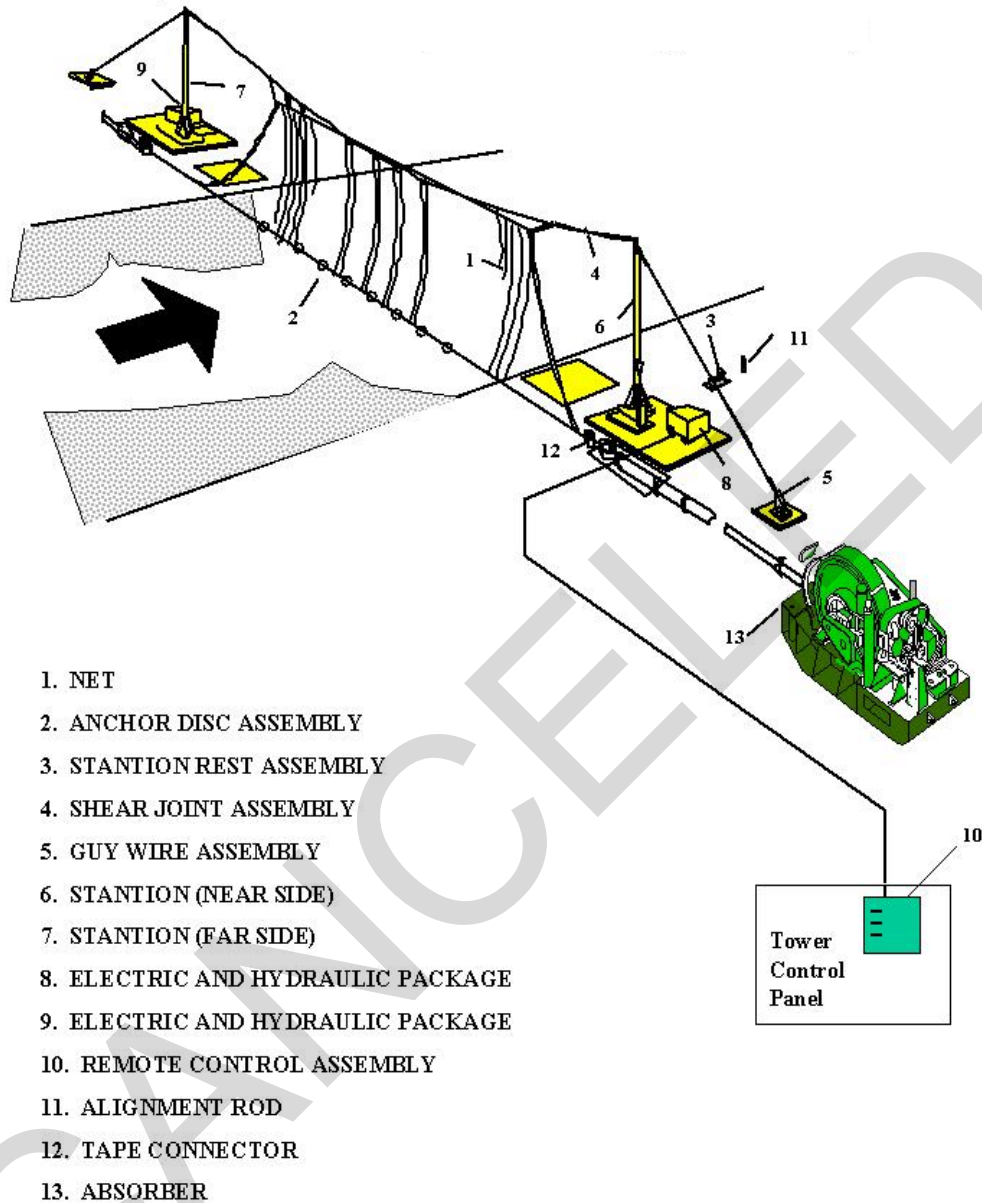
5-7 BAK-15 (61QSII)

5-7.1 The BAK-15 aircraft arresting barrier consists of a pair of electro-hydraulically powered steel masts that provide support and remote-controlled movement for a unidirectional nylon net barrier (Figure 5-9). The masts are installed on opposite sides of the runway overrun on concrete foundations. The ATC tower contains a remote-control panel which can be hard-wired, but most commonly is radio-controlled.

5-7.2 The barrier must be augmented with an energy-absorbing device such as a ship's anchor chain, BAK-12, or textile brake. During an aircraft engagement, shear links in the net suspension straps separate by the force of the aircraft engaging the net. The net then envelops the aircraft and seats on the leading edge of the wings, transferring the forward momentum of the aircraft to the energy-absorbing device.

5-7.3 The system can be complemented with a standard disc-supported pendant to accommodate tail-hook engagements through interconnect configuration hardware similar to that used for the MA-1A Modified. The hook cable interconnect kit is designated as the 62 NI (net interconnect). System operation and maintenance instructions are in T.O. 35E8-2-12-1, *Operation And Maintenance Instructions BAK-15 Aircraft Arresting Systems*. Obtain installation drawings from the manufacturer through the procuring activity at the time of procurement.

Figure 5-9. BAK-15 Net Barrier (Pictured with BAK-12 Absorbers, BAK-15/12)



5-8 MOBILE AIRCRAFT ARRESTING SYSTEM (MAAS) CONFIGURATION

5.8.1 The MAAS (Figure 5-10) is essentially a BAK-12 AAS mobilized through installation on a specially developed trailer. It is configured for a maximum aircraft runout of 302 meters (990 feet). This system was initially developed and tested to accommodate recovery of fighter aircraft returning to a battle-damaged airfield. Such cases require rapid deployment and installation and may require that only the minimum essential anchoring hardware be installed to accommodate this scenario. When installed for this purpose, the MAAS is installed along the shoulder of the runway this configuration can be either unidirectional or bi-directional (upgrade kit required) engagement capability with a maximum aircraft weight and speed of 18,144 kilograms (40,000 pounds) at 150 knots

(Table 1-1). Installing the MAAS without a set-back configuration limits the system weight capabilities and the type of aircraft capable of operating on the airfield. For detailed instructions on this system, refer to T.O. 35E8-2-10-1, *Operation and Maintenance Instructions, Arresting Systems, Aircraft, Mobile*.

5.8.2 When the MAAS is installed in the set-back configuration it presents a significantly reduced profile on the runway edge allowing the airfield to accommodate wide body aircraft. The MAAS set-back configuration is accomplished with Mobile Runway Edge Sheave (MRES) (Figure 5-11) or Lightweight Fairlead Beam (LWFB) (Figure 5-12) and postures the MAAS in a bi-directional engagement capability for a maximum aircraft runout of 366 meters (1200 feet). The engagement capability in the set-back configuration is a maximum aircraft weight and speed of 31026 kilograms (68,400 pounds) at 180 knots. For detailed instructions on this system, refer to T.O. 35E8-2-10-1, *Operation and Maintenance Instructions, Arresting Systems, Aircraft, Mobile*.

5.8.3 The MAAS can be installed over soil, concrete, asphalt, and asphalt over soil or concrete. The MRES and LWFB can only be installed over soil and concrete. Careful planning should take place to fully understand the obstacles of the proposed installation site. The California Bearing Ratio (CBR) will be a determining factor when a MAAS is planned to be installed over soil. Expeditionary soil installation should not be used if the anticipated period of service is longer than one year. Waivers to extend use longer than one year are processed through AFLCMC. The preferred method of installation for an anticipated period extending beyond one year is concrete pads for the MAAS and MRES or LWFB. Contact AFCEC/COS for drawings.

Figure 5-10 Mobile Aircraft Arresting System (MAAS)

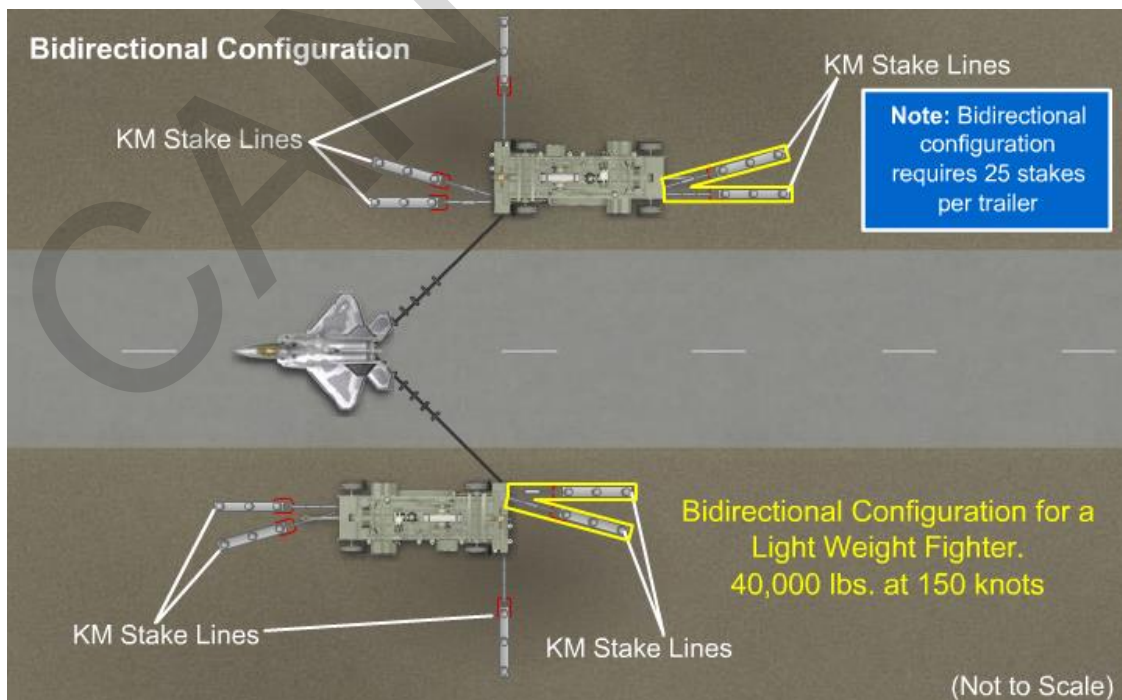


Figure 5-11 Mobile Aircraft Arresting System (MAAS) in Set-Back Configuration with Mobile Runway Edge Sheave (MRES)

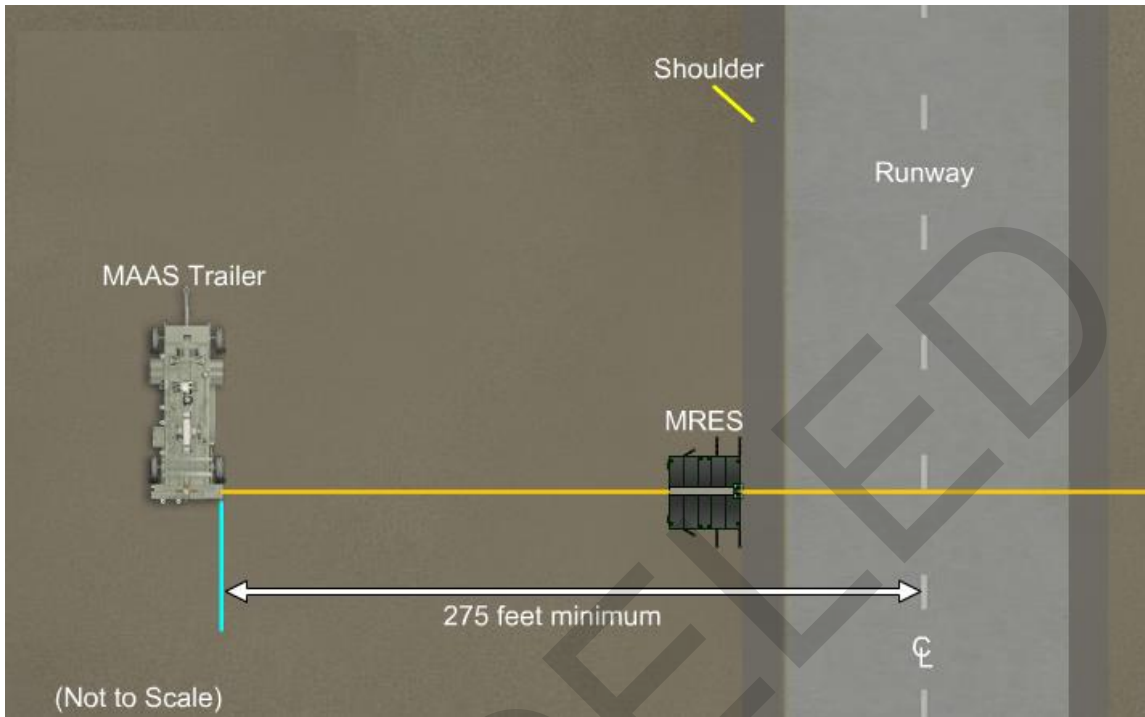


Figure 5-12 Mobile Aircraft Arresting System (MAAS) in Set-Back Configuration with Lightweight Fairlead Beam (LWFB)



5-9 TEXTILE BRAKE

5-9.1 This modular arresting system is primarily intended as an emergency back-up system for standard operational systems. It is composed of multiple modules arranged in equal numbers on both sides of the overrun (or runway if a bidirectional model) that contain specially woven textile tearing straps to absorb the kinetic energy generated during an engagement. One end of each module is anchored to the ground, and the other end is connected to a tensioned cable or barrier positioned across the runway to engage an aircraft. The system is available in a two-stage unidirectional configuration (Figure 5-13) see Table 5-2 and T.O. 35E8-2-13-1, *Operation, Service, Overhaul with Illustrated Parts Breakdown Textile Brake and Hook Cable Aircraft Arresting System, Type MB 60.9.9.C*, . For information on the single-stage bi-directional system (Figure 5-14) MB 100.10.C, see Table 5-2 and T.O. 35E8-2-14-1, *Operation and Service, Overhaul Instructions, Illustrated Parts Breakdown for Textile Brake and Hook Cable Aircraft Arresting System, Type MB 100.10.C*.

5-9.2 The advantages of the two-stage system (MB 60.9.9.C) over the MB 100.10.C bi-directional system are higher system capacity and lower costs for reconfiguration after low-energy engagements. The modules in a stage (breaking line) are expended upon aircraft engagement and must be replaced; however, a life cycle analysis indicates system costs are approximately 50 percent of the life cycle cost for a BAK-12 installed in the overrun area of a runway due to the low number of engagements that occur there. These systems are designed for tail-hook-equipped fighter aircraft but can also be complemented with a net barrier such as the BAK-15 or a net and cable interconnect system. They may also be configured for expeditionary or temporary installations.

5-9.3 If the bi-directional version of the textile brake arresting system is installed on the operational runway surface due to a non-standard length overrun, the arresting gear marker (AGM) signs should be blanked when viewed from the approach. This is because the system is a low-energy-capacity system (compared with BAK-12) and is not intended for approach end engagements.

Figure 5-13 Textile Brake, Model MB.60.9.9.C

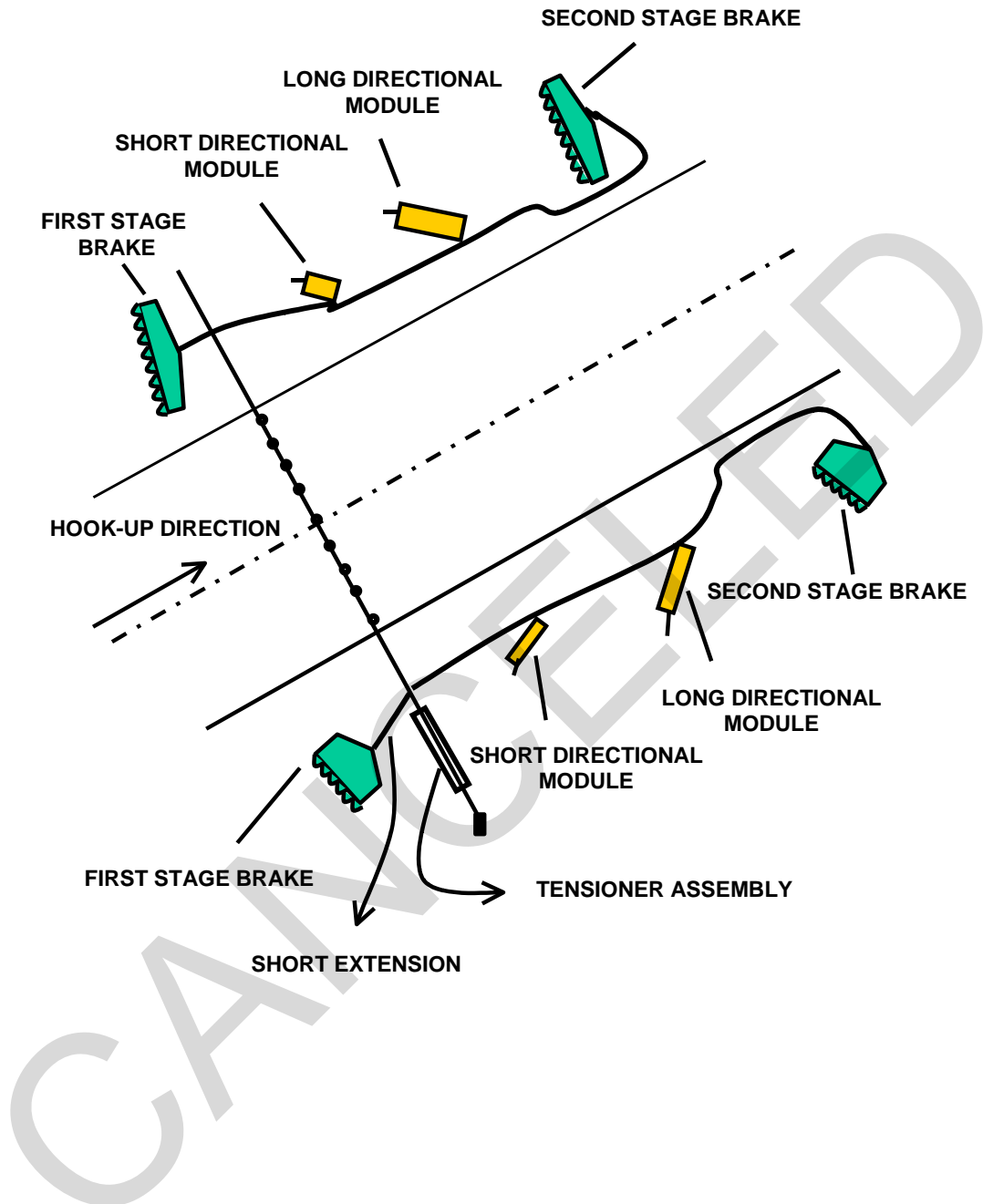
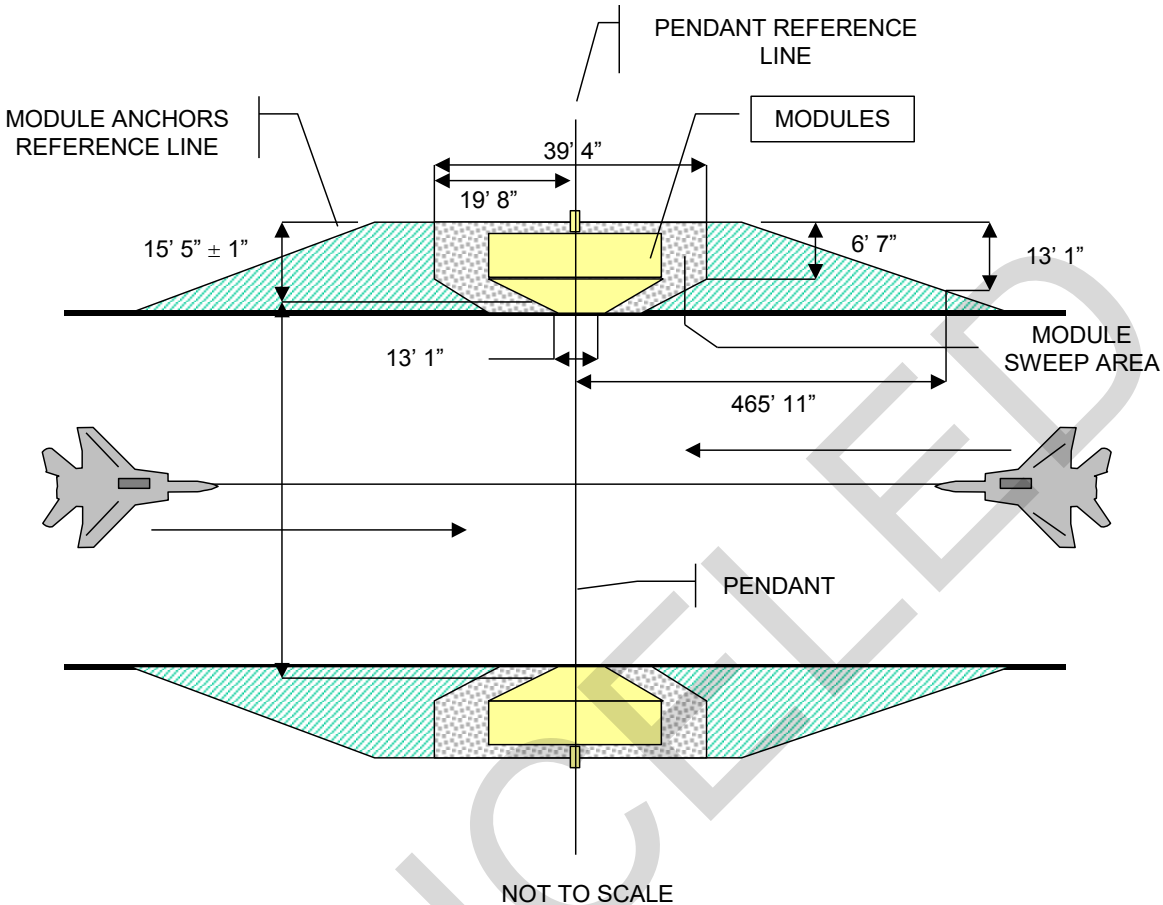


Figure 5-14 Textile Brake, Model MB.100.10.C

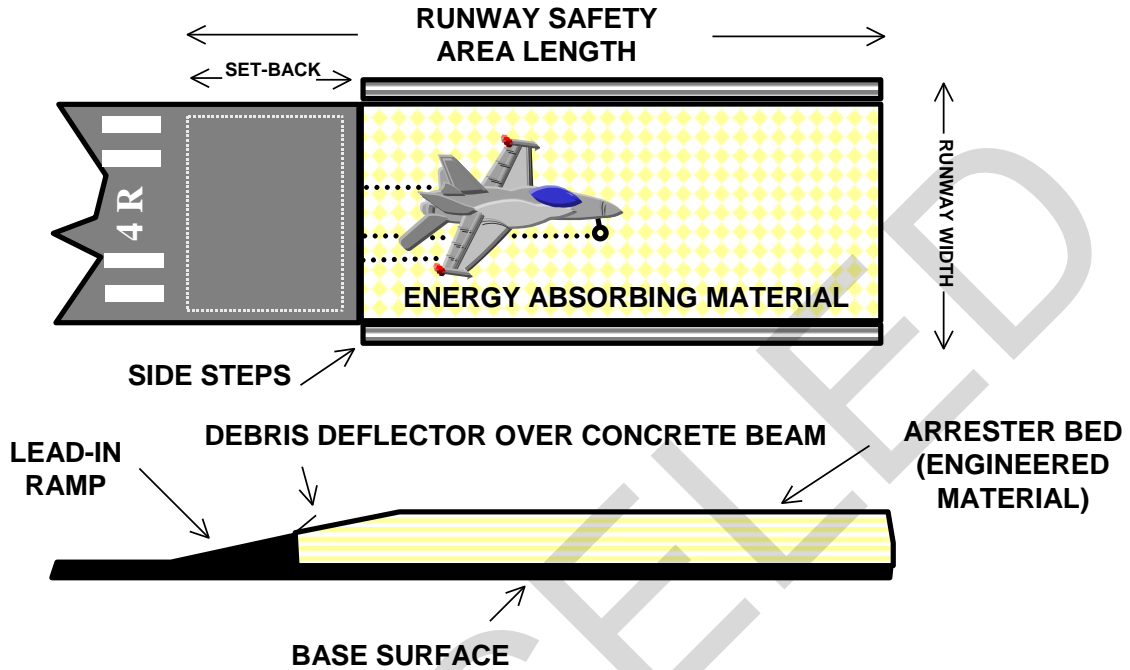


5-10 SOFT GROUND TYPE AAS

The Engineered Material Arresting System (EMAS) is an FAA-approved soft ground system normally used for civil airports to mitigate short safety areas (less than 305 meters [1,000 feet] long) at runway ends. The system is constructed of cellular foam concrete of specific strength and thickness to decelerate an aircraft that overruns the runway through rolling resistance. The design for each system is aircraft-specific, based upon the type of aircraft that will use the runway. FAA AC 150/5220-22, *Engineered Materials Arresting Systems (EMAS) for Aircraft Overruns*, provides the design basis. It is intended for use where it is impractical to obtain the standard 305-meter (1000-foot) overrun (FAA term Runway Safety Area (RSA)) and other alternatives are not feasible. See Figure 5-15 for layout of a typical soft ground type system. For purposes of design, the soft ground arrestor system can be considered fixed by function and frangible since it is designed to fail at a specific impact load; therefore, a soft ground system is not considered an obstruction under Federal Aviation Regulation (FAR) 14 Code of Federal Regulation (CFR) Part 77, Subpart C--*Standards for Determining Obstructions to Air Navigation or Navigational Aids of Facilities*. Soft ground systems are located beyond the end of the runway, centered on the extended runway centerline. They will usually begin at some distance from the end of the runway to avoid damage to the system due

to jet blast or short landings. This distance will vary depending on the area available and the specific system design.

Figure 5-15 Typical Soft Ground Aircraft Arrestor System



CHAPTER 6 NUMBER AND TYPES OF SYSTEMS AUTHORIZED

6-1 Use the following examples for guidance, keeping in mind the primary mission aircraft, climatic region, and other operational factors dictate the total number, type, and location of AAS required on runways. The MAJCOM operating the tail-hook-equipped aircraft, or other aircraft compatible with net barrier or soft ground systems requiring support makes this determination through operational risk management (ORM), considering runway length and configuration, and proximity to other airfields and other factors.

6-2 The typical configurations described in paragraphs 6-2.1 through 6-2.3 for both runways and overrun systems may not necessarily be required in all cases.

6-2.1 A runway intended primarily for operating tactical or training tail-hook-equipped aircraft should typically have an emergency system in each overrun and an operational system at each end of the runway to provide a safety factor for possible missed engagements. However, some locations at forward operating bases or where snow and ice accumulation warrants, two operational systems may be necessary for each runway end, and a midfield installation may be needed as well.

6-2.2 Runways that are primary divert facilities for bases operating tactical or training tail-hook-equipped aircraft should typically have an emergency system in each overrun, and an operational system on each end of the primary runway.

6-2.3 Bases that are occasional hosts to arrestment-capable transient aircraft should have an emergency system installed in each overrun of the primary runway, or an operational system on each end of the primary runway.

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CHAPTER 7 AIRCRAFT ARRESTING SYSTEM LOCATION REPORT [REPORT CONTROL SYMBOL (RCS): HAF-ILE (AR) 7150]

7-1 DoD needs an accurate accounting of all AAS to determine worldwide operational capabilities. BCE representatives are responsible to ensure that the status and locations of their arresting systems are correct in the DoD FLIP. Report changes in the arresting system array promptly so that other agencies can validate and publish the addition or correction. Report all information in inch-pound units.

7-2 Submit arresting system location report information to the local installation airfield manager for inclusion in the DoD FLIP. Provide a courtesy copy to AFCEC/COS at the following address:

AFCEC/COS
Attn: Aircraft Arresting System SME
139 Barnes Drive, Suite 1
Tyndall AFB FL 32403-5319
afcec.co@us.af.mil (e-mail submissions are encouraged)

7-3 Submit the following information, along with a diagram similar to the diagram in Figure 7-1:

- Base name
- MAJCOM or sponsor
- Runway designations
- System type
- Length of runway to the nearest 100 feet (threshold to threshold)
- Width of runway, in feet
- Length of overrun, in feet (threshold to end of overrun)
- Longitudinal location of the arresting system with respect to the threshold, in feet (for example, "plus (+) 950" indicates that the system is 950 feet from the threshold on the runway; "minus (-) 35" indicates that the system is 35 feet from the threshold into the overrun)

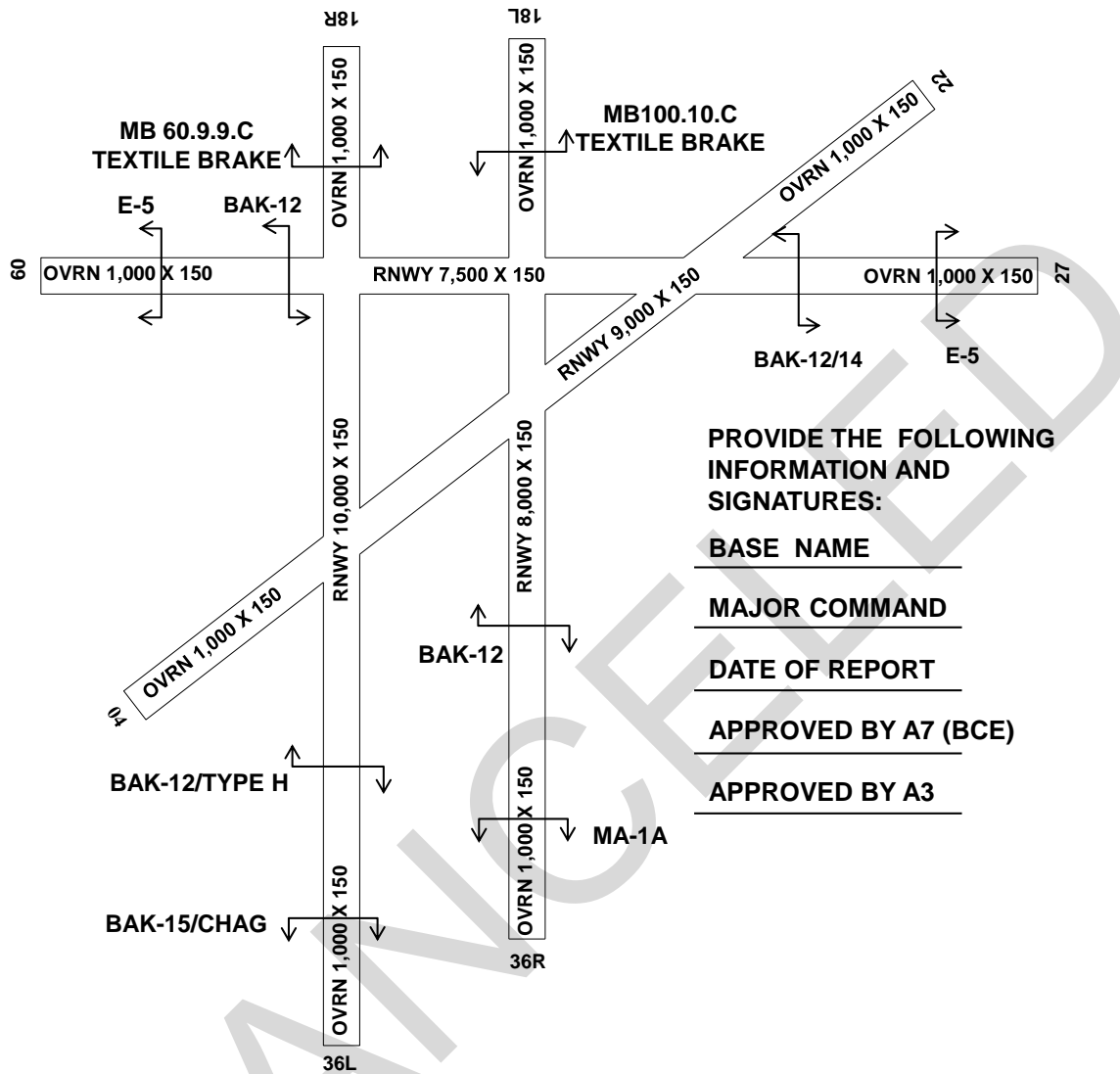
7-4 Describe the arresting system installation characteristics for each system indicated on the airfield scheme using the following notations:

- AG — above ground
- BG — below ground
- EX1 — expeditionary system (BAK-12)

- EX2 — expeditionary system (MAAS)
- IC — barrier interconnected with a hook cable
- RR — remote radio control
- RH — remote hard-wired control
- MO — manually operated barrier net (raised and lowered)
- Z — owned by another service, country, or agency
- O — out of service, inoperative
- SR — 950-foot runout
- ER — 1200-foot runout
- NSR — nonstandard runout (indicate runout in feet following code entry)

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Figure 7-1 Sample Airfield Diagram for Aircraft Arresting Systems Report



NOTES:

1. Indicate runway and overrun lengths and widths for all runways as shown above.
2. Indicate runway designations as shown above.
3. Indicate arresting system locations as shown above.
4. Include remarks describing any non-standard configurations or conditions (attach additional sheets as necessary).

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APPENDIX A REFERENCES

UNIFIED FACILITIES CRITERIA

http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4

UFC 1-200-01, *General Building Requirements*

UFC 3-260-01, *Airfield and Heliport Planning and Design*

UFC 3-260-02, *Pavement Design for Airfields*

UFC 3-535-01, *Visual Air Navigation Facilities*

AIR FORCE

<http://www.e-publishing.af.mil/>

AFI 11-218, *Aircraft Operations and Movement on the Ground*

AFI 13-204V3, *Airfield Operations Procedures and Programs*

AFI 13-213, *Airfield Driving*

AFI 32-1043, *Managing, Operating, and Maintaining Aircraft Arresting Systems*

AFI 51-502, *Personnel and Government Recovery Claims*

Electronic Technical Information Management System (ETIMS)

<https://www.my.af.mil/etims/ETIMS/index.jsp>

T.O. 00-35D-54, *USAF Deficiency Reporting and Investigating System*

T.O. 35E8-2-2-1, *Operation and Service Instructions - Runway Overrun Barrier, Types MA-1 and MA-1A*

T.O. 35E8-2-2-3, *Overhaul Instructions - Runway Overrun Barrier, Types MA-1 and MA-1A*

T.O. 35E8-2-2-4, *Illustrated Parts Breakdown – Aircraft Arresting System Model MA-1 and MA-1A*

T.O. 35E8-2-5-1, *Operation and Maintenance Instructions – Aircraft Arresting System Model BAK-12*

T.O. 35E8-2-5-3, *Overhaul Maintenance with Illustrated Parts Breakdown - Aircraft Arresting System Model BAK-12*

T.O. 35E8-2-5-4, *Illustrated Parts Breakdown – Aircraft Arresting System Model BAK-12*

- T.O. 38G1-113-3, *Diesel Engines Overhaul Instructions with Illustrated Parts Breakdown*
- T.O. 35E8-2-8-1, *Operation, Maintenance, and Installation Instructions with Illustrated Parts Breakdown, Hook Cable Support System, Model BAK-14*
- T.O. 35E8-2-8-1-11, *Operations Manual for the BAK-14 Hook Cable Support Systems (Pit Mounted with Heaters) 14 and 20 Box Systems*
- T.O. 35E8-2-8-12, *Type H45-200 Aircraft Arresting Cable Retraction System Abbreviated Component Maintenance Manual With Illustrated Parts List*
- T.O. 35E8-2-12-11, *Operation and Maintenance Instructions BAK-15 Aircraft Arresting Systems.*
- T.O. 35E8-2-10-1, *Operation and Maintenance Instructions, Arresting Systems, Aircraft, Mobile*
- T.O. 35E8-2-10-3, *Overhaul Instructions, Arresting Systems, Aircraft, Mobile*
- T.O. 35E8-2-10-4, *Illustrated Parts Breakdown, Arresting Systems, Aircraft, Mobile*
- T.O. 35E8-2-13-1, *Operation, Service, Overhaul with Illustrated Parts Breakdown Textile Brake and Hook Cable Aircraft Arresting System, Type MB60.9.9.C*
- T.O. 35E8-2-14-1, *Operation and Service, Overhaul Instructions, Illustrated Parts Breakdown for Textile Brake and Hook Cable Aircraft Arresting System, Type MB100.10.C*

Air Force Civil Engineer Center (AFCEC)

Typical Installation Drawing 67F2011A

Typical Installation Drawing 67F2012A

FEDERAL

Code of Federal Regulation (CFR) Part 77: Subpart C--*Standards for Determining Obstructions to Air Navigation or Navigational Aids of Facilities*

Federal Standard 595, *Colors Used in Government Procurement*,
<http://www.gsa.gov/portal/content/142623>

FAA

FAA AC 150/5220-22, *Engineered Materials Arresting Systems (EMAS) for Aircraft OVERRUNS*

FAA AC 150/5220-9, *Aircraft Arresting Systems*

FAA Order JO 7110.65, *Air Traffic Control*, "Pilot/Controller Glossary"

AMERICAN SOCIETY FOR TESTING AND MATERIALS

C886-98, *Standard Test Method for Scleroscope Hardness Testing of Carbon and Graphite Materials*

D256-10, *Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics*

D638-14, *Standard Test Method for Tensile Properties of Plastics*

D1505-10, *Standard Test Method for Density of Plastics by the Density-Gradient Technique*

D3028-95, *Standard Test Method for Kinetic Coefficient of Friction of Plastic Solids (Withdrawn 2000)*

INDUSTRY

Aerazur Technical Manual 256-722, *Type H45-200 Retractable Hook Cable System*

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APPENDIX B GLOSSARY

B-1 ACRONYMS

A7	Directorate of Installations and Mission Support
AAS	Aircraft Arresting System
AC	Advisory Circular (FAA)
AF/A4C	Air Force Director of Civil Engineers
AFCEC	Air Force Civil Engineer Center
AFCEC/COS	AFCEC Engineering Division
AFCEC/COSC	AFCEC Civil Branch
AFCENT	Air Forces Central (Command)
AFEMS	Air Force Equipment Management System
AFI	Air Force Instruction
AG	above ground (AAS installation notation)
AGM	Arresting Gear Marker
AOI	Airfield Operating Instruction
ASTM	American Society for Testing and Materials
ATC	Air Traffic Control
BAK	Barrier Arresting Kit
BCE	Base Civil Engineer
BEMO	Base Equipment Management Office
BG	below ground (AAS installation notation)
BIA	Bilateral Infrastructure Agreements
CAGE	Commercial and Government Entity
CE	Civil Engineer
CFR	Code of Federal Regulation

CHAG	Chain Absorber Arresting Gear
CONUS	Continental United States
cu ft	cubic foot
DoD	Department of Defense
DoT	Department of Transportation
EMAS	Engineered Materials Arresting Systems
EPH	Effective Pendant Height
ER	1200-foot runout (AAS installation notation)
EX1	expeditionary system (BAK-12) (AAS installation notation)
EX2	expeditionary system (MAAS) (AAS installation notation)
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FC	Facility Criteria
FLIP	Flight Information Publications
ft	foot
ft-lb	foot-pound
g/cm	gram per centimeter
gal	gallon
GSE	Government-Supplied Equipment
HMA	Hot Mix Asphalt
HNFA	Host Nation Funded (Construction) Agreements
HQ ACC	Headquarters Air Combat Command
HQ USACE	Headquarters United States Army Corps of Engineers
IC	barrier interconnected with a hook cable (AAS installation notation)
ICAO	International Civil Aviation Organization

In	inch
IO&M	installation, operation, and maintenance
kg	kilogram
kPa	kilopascal
L	liter
lb	pound
lb ft	pound foot
LF	linear foot
M	meter
M	meter
MAAS	Mobile Aircraft Arresting System
MAJCOM	Major Command
MAJCOM/A3	Major Command Directorate of Operations
MAJCOM/SE	Major Command Directorate of Safety
mm	millimeter
MO	manually operated barrier net (raised and lowered) (AAS installation notation)
N•m	Newton meter
NAVFAC	Naval Facilities Engineering Command
NI	net interconnect
NOTAM	Notice to Airmen
NSN	National Stock Number
NSR	nonstandard runout (indicate runout in feet following code entry) (AAS installation notation)
O	out of service, inoperative (AAS installation notation)
OCONUS	Outside the Continental United States

ORM	Operational Risk Management
oz	ounce
PACAF	Pacific Air Forces
PCC	Portland Cement Concrete
psi	pound per square inch
QDR	Quarterly Data Report
RCS	Report Control Symbol
RCS HAF-ILE	Report Control Symbol - Headquarters Air Force - Civil Engineer
RDS	Records Disposition Schedule
RH	remote hard-wired control (AAS installation notation)
RR	remote radio control (AAS installation notation)
RSA	Runway Safety Area (FAA term)
SBSS	Standard Base Supply System
SE	Safety
SOFA	Status of Forces Agreement
SR	950-foot runout (AAS installation notation)
SRAN	Stock Record Account Number
T.O.	Technical Order
U.S.	United States
UFC	Unified Facilities Criteria
UFGS	Unified Facilities Guide Specification
UHMW	ultra-high-molecular-weight
UNC	Unified National Coarse (thread pitch)
USAF	United States Air Force
USAFE	United States Air Forces in Europe

UV	ultraviolet
WR-ALC	Warner Robins Air Logistics Center
Z	owned by another service, country, or agency (AAS installation notation)

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B-2 DEFINITION OF TERMS

Active Runway—One or more runway(s) used simultaneously for takeoff or landing operations on an airfield or airport. When multiple runways are used, they are all considered active runways.

Aircraft Arresting Barrier—A device, not dependent on an aircraft arresting hook, used to stop an aircraft by absorbing its forward momentum in an emergency landing or aborted takeoff. (Joint Publication 1-02, *Department of Defense Dictionary of Military and Associated Terms*)

Aircraft Arresting Cable—The part of an aircraft arresting system (AAS) that spans the runway surface or flight deck landing area and is engaged by the aircraft arresting hook.

Aircraft Arresting System (AAS)—A series of components used to engage and absorb the forward momentum of a routine or emergency landing or an aborted takeoff.

Arrestment-Capable Aircraft—Aircraft with flight manual procedures for an arrestment.

Cycle Time—A measure of time between engagement of an aircraft, and the point in time when the arresting system is certified fully operational and ready for another engagement.

Effective Pendant Height (EPH)—The vertical distance in inches from the underside of the pendant cable to a projected surface representing undamaged runway surface.

Energy Absorber—The component of the arresting system that dissipates the kinetic energy of the arrested aircraft.

Location Identification—A description identifying the location of arresting systems by the approach or departure end, runway designation, and position in hundreds of meters/feet from the threshold. For example, the location identification extended runout BAK-12 at +457.2 meters (+1500 feet) on approach runway 36 indicates a 365.7-meter (1200-foot) runout BAK-12 located 457.2 meters (1500 feet) beyond the threshold of runway 36.

Missed Engagement—Any unsuccessful attempt to engage an AAS hook cable with a successfully deployed aircraft tail-hook or Barrier System (net system).

Mobile Aircraft Arresting System (MAAS)—A self-contained, trailer-mounted BAK-12 AAS that accommodates rapid installation during contingencies.

Movement Area (USAF/FAA)—The runways, taxiways, and other areas of an airport/heliport used for taxiing/hover taxiing, air taxiing, take-off, and landing of aircraft, exclusive of loading ramps and parking areas. At airports/heliports with a tower, specific approval for entry onto the movement area must be obtained from Air Traffic Control (ATC). For USAF, the movement area is determined by the airfield operations flight

commander and defined in the installation airfield operations and airfield driving instructions in accordance with AFI 13-204V3 and AFI 13-213.

Movement Area (ICAO)—That part of an airport used for the take-off, landing and taxiing of aircraft, consisting of the maneuvering area and the apron(s).

Overrun (USAF)—An area beyond the take-off runway designated by the airport authorities as able to support an airplane during an aborted take-off. The FAA/ICAO term for this is “stopway.” UFC 3-260-01 identifies this area as one that prevents serious damage to aircraft that overrun or undershoot the runway.

Pendant—The part of an AAS that spans the runway surface or flight deck landing area and is engaged by the aircraft tail-hook.

Reset Time—The time required to ready the arresting system for another engagement after aircraft release. (This does not include time to disengage the aircraft from the arresting system but does include the time required to inspect and certify the system as fully operational.)

Stopway (FAA/ICAO)—An area beyond the take-off runway designated by the airport authorities as able to support an airplane during an aborted take-off. The Air Force term for this is “overrun.”

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APPENDIX C LETTER OF AGREEMENT WITH THE FEDERAL AVIATION ADMINISTRATION (FAA)

In cases where a military activity needs to install an arresting system on a civil or jointly used airfield, the following example may be used as a guide in developing the agreement.

AGREEMENT: The [FAA office and address] and [designated MAJCOM] agree to the following provisions for the operation and use of aircraft arresting equipment installed on [designated runway, airport name, and address].

General Provisions:

This agreement describes FAA functions and responsibilities concerning the remote-control operation of arresting systems by FAA air traffic controllers. It governs use of arresting barriers and hook cable arresting systems for military aircraft and, in an emergency, at pilot request for civil aircraft.

The conditions and procedures described in this agreement become effective when it is signed and dated by the parties and the tower chief receives written notice from the installation commander that one of the following conditions exists:

The arresting system has been accepted from the contractor and is commissioned and fully operational.

The arresting system is available for emergency use only. If the arresting system has not been accepted from the contractor, this notification must come with a written statement from the contractor authorizing emergency use of the system and waiving any claim against the FAA for damage to the system as the result of such use.

A NOTAM has been issued specifying one of the above conditions. Before receiving the letter from the installation commander, the military crew de-energizes the tower arresting system controls and the chief controller labels them "Inoperative." Tower personnel may not energize the controls under any circumstances.

Automatic arresting systems may be installed on the runway or in the overrun. Control tower personnel raise or lower the barrier or hook cable through a remote-control panel in the control tower.

Air traffic controllers operate the tower arresting system controls at the request of:

The pilot of any military aircraft (regardless of the Service concerned, type of aircraft, or nature of the operation).

The pilot of a civil aircraft in an emergency, when in commission or emergency use status as described above.

A mobile control unit, the airfield manager, or a designated representative.

The military crew originates NOTAMs covering operational or outage status of a barrier or hook cable. During a NOTAM outage for repair or maintenance, tower personnel operate the controls, provided that the outage NOTAM contains the statement "available for emergency use" and the tower possesses a copy. Otherwise, the military crew deenergizes the tower controls and the chief controller labels them "Inoperative." In this event, tower personnel may not energize the controls under any circumstances.

During NOTAM outages due to failure of controls or when tower personnel advise of malfunction of the system, the military crew at the system site has full and final responsibility for operating the arresting device. The arresting system crew maintains a listening watch on air and ground frequencies and has transmitting and receiving capability with the tower on the ground control frequency keeping personnel informed of the position of the system.

Operations:

Typically, all military aircraft take off and land toward an operational arresting system in the "ready" configuration. The pilot asks the control tower operator to raise or lower the barrier or hook cable. For example, the pilot says "Duluth Tower, Joy 32 on base, gear down and locked, raise cable."

For normal landings, the request involves the approach-end cable.

For normal takeoffs, the request involves the departure-end barrier and cable.

When tower personnel receive a request to raise or lower the barrier or cable, they must inform the pilot of the intended barrier or cable position as part of takeoff or landing information. For example, they say "Joy 32 cleared for takeoff, barrier indicates up."

The pilot may request barrier or cable operating status at any time.

The barrier and cable controls are in the down position except when pilots or other authorized personnel request that either or both be raised.

Tower personnel raise the departure-end barrier and both approach- and departure-end cables for known or suspected radio failure landing by any military arrestment-capable aircraft. Activate the arresting system even if you doubt the aircraft's ability to engage the system.

The standard phraseology for emergency requests to raise the barrier is "barrier, barrier, barrier." The standard phraseology for emergency requests to raise the cable is "cable, cable, cable."

Tower personnel start normal crash procedures when an aircraft engages the barrier or cable if these procedures are not in progress.

When there is a malfunction of the barrier, hook cable mechanism, or remote control system, the tower personnel notify airfield management immediately.

Executed at _____ Dated _____

For the FAA For the Air Force

(Signed)

(Signed)

(Title)

(Title)