BY ORDER OF THE
SECRETARY OF THE AIR FORCE

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Civil Engineering

MANAGING, OPERATING, AND MAINTAINING AIRCRAFT ARRESTING SYSTEMS

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

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OPR: HQ AFCESA/CESC (Mr. Michael Ates)

Certified by: HQ AFCESA/CC (Col Bruce R. Barthold)

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This instruction implements Air Force Policy Directive (AFPD) 32-10, *Installations and Facilities.* It gives procedures for managing, installing, maintaining, and operating United States Air Force (USAF) aircraft arresting systems. **Attachment 1** lists references, abbreviations, acronyms, and terms used in this instruction.

SUMMARY OF REVISIONS

This document is substantially revised and must be completely reviewed.

This revision incorporates substantive changes and numerous additions to Air Force Instruction (AFI) 32-1043. These changes revise the requirements for managing, operating, and maintaining aircraft arresting systems. This revision adds a table of contents and changes aircraft arresting systems logistics and technical management responsibilities from San Antonio Air Logistics Center to Warner Robins Air Logistics Center (WR-ALC). It changes major commands' (MAJCOM) reporting requirements and clarifies qualification criteria for military and other personnel engaged in aircraft arresting system activities. It adds general information on operations and maintenance of aircraft arresting systems, provides inspection information, certification criteria, certification weights and speeds, criteria for evaluating maintenance crews, and standard phraseology for communication with air traffic control (ATC) and ground control. It adds guidelines for constructing and installing hook-cable tie-downs. This revision also adds standard hand signals for maintenance crewmembers and aircrew, and instructions for installation of ultra-high molecular weight (UHMW) polyethylene panels under aircraft arresting system cables. Metric dimensions are included in this revision. Generally, these are rounded conversions of inch-pound units. Exceptions are made in cases where specific dimensions or values have the potential to impact aircraft safety. In this case, metric units are soft conversions of inch-pound units. The location and configuration reporting requirements for aircraft arresting systems given in **Attachment 4** do not include metric conversions because DOD reports airfield data in inch-pound units. System performance characteristics provided in

Attachment 2 are given in the units provided by the original equipment manufacturers and do not include metric conversions.

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Chapter 1

RESPONSIBILITIES

1.1. Headquarters USAF and Field Operating Agencies.

1.1.1. The Civil Engineer, Headquarters USAF (HQ USAF/ILE), develops maintenance policy and oversees execution of the USAF aircraft arresting system program. See AFPD 32-10.

1.1.2. The Air Force Civil Engineer Support Agency, Directorate of Technical Support (HQ AFCESA/CES), provides technical guidance for all phases of aircraft arresting system programs. It also validates requirements for new systems and helps resolve technical difficulties between the MAJCOMs and the WR-ALC.

1.1.3. The Deputy Chief of Staff for Plans and Operations (HQ USAF/XO) develops operational policy and oversees execution.

1.1.4. The Air Force Flight Standards Agency (AFFSA) provides technical support to the Air Staff on operational issues relating to installation, maintenance, and use of these systems. It also helps to plan, develop, review, and recommend standards for siting, installing, operating, and maintaining aircraft arresting systems.

1.2. MAJCOM. The MAJCOM civil engineer (CE) representative manages arresting system programs and enforces Air Force policy. The representative must also perform the following tasks.

1.2.1. Submit an *Aircraft Arresting Systems Report* (RCS: HAF-ILE [AR] 7150) to:

HQ AFCESA/CESC

139 Barnes Drive Suite 1

Tyndall AFB, Fl 32403

The reports must be accomplished according to the guidelines provided in **Attachment 4**. Submit the report any time you change the location of an arresting system for any runway.

1.2.2. Submit (or ensure that each base submits) an *Aircraft Arrestment Report* (RCS: HAF-ILE [M&AR] 8403) to:

HQ AFCESA/CESC

139 Barnes Drive Suite 1

Tyndall AFB, Fl 32403

NOTE: Do not submit the report during periods of inactivity or emergency. The report must be submitted for each engagement or attempted engagement (see **Attachment 1**, *Glossary of References and Supporting Information,* for the definition of a missed engagement).

1.2.3. In the report, include:

1.2.3.1. Base name.

1.2.3.2. Arresting system type.

1.2.3.3. Aircraft type.

1.2.3.4. Reason for engagement or attempted engagement.

1.2.3.5. Approximate speed and weight of aircraft.

1.2.3.6. Damage to aircraft or equipment (if any).

1.2.3.7. Problems (if any) and the suspected cause.

1.2.3.8. A focal point and phone number at the base.

1.2.3.9. Details of each engagement or attempted engagement.

NOTE: Do not submit classified information. Discontinue reporting during emergency conditions but maintain records for later submission.

1.2.4. Ensure that command personnel engaged in aircraft arresting system activities meet the following minimum requirements for the associated tasks:

1.2.4.1. To perform after arrestment inspection and certify an aircraft arresting system back in service after arrestment, personnel must be task certified Power Production 5-level (or higher skill level) journeyman or the civilian Wage Grade (WG) 5378 equivalent.

1.2.4.2. To perform maintenance on an aircraft arresting system, personnel must be task certified Power Production 3-level (or higher skill level) Apprentice or the civilian WG 5378 equivalent.

1.2.4.3. Personnel other than Power Production (AFSC 3E0X2) or civilian equivalent (WG 5378) that augment Power Production personnel to perform daily inspections or assist during engagements must be specifically designated by the base civil engineer (BCE) in writing, and must be certified annually by the designated lead Power Production technician or the civilian equivalent on an Air Force (AF) Form 483, **Certificate of Competency**.

1.2.4.4. For new installations or for cases where major civil works have been accomplished that may affect system alignment, a task-certified Power Production 7-level technician or the civilian WG 5378 equivalent must certify the system ready for use.

1.2.5. Submit waiver requests to WR-ALC if deviation from the 35E8-series technical orders (T.O.) is required at base level. Send T.O. waiver requests to:

WR-ALC/LDE

295 Byron St.

Robins AFB, GA 31098-1611

1.2.6. Establish a record of dates when all arresting systems under the command's authority last underwent an overhaul that included a brake change.

1.2.7. Develop an overhaul plan and schedule that prevents unnecessary runway closures and waiver requests and provide a copy of the schedule to the Ground Support Equipment Division at WR-ALC (WR-ALC/LESG). Include all systems within the command, even those designated as war reserve materiel, such as the Mobile Aircraft Arresting System (MAAS).

1.2.7.1. If the plan requires WR-ALC depot to do overhauls, send them a copy of the schedule at least two years before the earliest requirement on the schedule.

1.2.7.2. Provide WR-ALC with updates at least once a year, but not more often than once every 6 months.

1.2.8. Review all new aircraft arresting system project installation drawings for functional and technical correctness before contract award (or start of the project if accomplished in-house). All projects must comply with siting criteria in this AFI, Unified Facilities Criteria (UFC) 3-260-01, *Airfield and Heliport Planning and Design*, the applicable 35E8-series T.O., and the typical installation drawings for the specific system. In cases where criteria cannot be met, a waiver must be established according to UFC 3-260-01 and/or the applicable T.O., as appropriate.

1.2.9. Coordinate Air Force Equipment Management System (AFEMS) requests (formerly AF Form 601, **Equipment Action Request**)*,* which authorize new systems with the directorate of operations.

1.2.10. Communicate with all other MAJCOMs that have a flying mission before decommissioning any arresting system. MAJCOMs with flying missions include an activity that uses the base in question as a possible divert facility during exercises or contingencies. This does not apply to bases within the United States Air Forces in Europe (USAFE) and Pacific Air Forces (PACAF). Follow MAJCOM procedure for Notices To Airmen (NOTAM) and updates to Flight Information Publications (FLIP).

1.2.11. If you decommission and remove an arresting system and no longer need it within the command, return it to WR-ALC.

1.2.12. Coordinate with the MAJCOM Director of Operations (MAJCOM/DO) and flying units to ensure certification engagements are conducted according to paragraph **2.3.**

1.2.13. Ensure that systems that do not comply with the requirements of this instruction or the applicable T.O. are programmed for replacement and identified in the USAF Airfield Obstruction database, if appropriate.

1.3. Base Civil Engineers.

1.3.1. The BCE must ensure that personnel engaged in aircraft arresting system operation and maintenance activities meet the following minimum requirements for the associated tasks:

1.3.1.1. To perform after arrestment inspection and certify an aircraft arresting system back in service after arrestment, personnel must be task-certified Power Production 5-level (or higher skill level) journeyman, or the civilian WG 5378 equivalent.

1.3.1.2. To perform maintenance on an aircraft arresting system, personnel must be task certified Power Production 3-level (or higher skill level) Apprentice or the civilian WG 5378 equivalent.

1.3.1.3. Personnel other than Power Production (AFSC 3E0X2) or civilian equivalent (WG 5378) that augment Power Production personnel to perform daily inspections or assist during engagements must be specifically designated by the BCE in writing, and must be certified annually by the designated lead Power Production technician or the civilian equivalent on an AF Form 483.

1.3.1.4. For new installations or for cases where major civil works have been accomplished that may affect system alignment, a task-certified Power Production 7-level technician or the civilian WG 5378 equivalent must certify the system ready for use.

1.3.2. BCEs also approve AFEMS requests and work with representatives from operations (DO) and safety (SE) to:

1.3.2.1. Recommend that additional systems be installed to meet new or revised mission requirements (see **Attachment 3**).

1.3.2.2. Recommend to the MAJCOM decommissioning of systems no longer needed to support the mission.

1.3.2.3. Request that Airfield Management update the Department of Defense (DOD) FLIP before removing any system from service.

1.3.2.4. Determine siting requirements for new systems and obtain MAJCOM/DO and SE coordination for nonstandard and midfield installations. Ensure that Airfield Management reviews and coordinates on proposed siting of any new systems.

1.3.2.5. Determine annually if nonstandard arresting system installations can continue in use without compromising operational efficiency and safety. Non-standard installations are installations that do not comply with the siting and grading requirements given in this instruction and UFC 3-260-01.

1.3.2.6. Initiate projects to replace deck sheaves and 2-roller fairlead beams with 3-roller deck sheaves or fairlead beams to eliminate the longitudinal wheel abutment these devices create along the runway shoulder.

1.3.2.7. Comply with all other provisions within this instruction.

1.3.3. The BCE's representative (Power Production aircraft arresting systems maintenance section supervisor) must accomplish the following items:

1.3.3.1. Request and obtain waivers from the WR-ALC through the MAJCOM CE representative before modifying these systems from the prescribed T.O. configuration.

1.3.3.2. Submit AFEMS requests through appropriate channels to obtain authorization for new arresting systems.

1.3.3.3. Ensure that installation, operation, and maintenance actions comply with all criteria listed in this instruction, the typical installation drawings, MAJCOM and local instructions, and the appropriate 35E8-series T.O.

1.3.3.4. Conduct inspections according to 35E8-series work cards and maintain an accurate historical log and maintenance records for each aircraft arresting system assigned. Locally developed forms and logs are authorized.

1.3.3.5. Develop and implement local procedures and instructions in writing to clearly delineate responsibilities of all personnel engaged in aircraft arresting system activities during and after normal duty hours. These instructions must clearly define the different responsibilities of power production and fire protection personnel involved during emergencies, and should address coordination with the other work centers involved during operations such as snow and ice control. They must include procedures to clear aircraft from the runway and inspect and reset the system immediately after each engagement. The BCE must approve the operating instruction. A signed copy must be forwarded to the MAJCOM representative and another maintained in the Power Production section.

1.3.3.6. Submit all requested information to the MAJCOM for inclusion in the *Aircraft Arresting Systems Report* as described in paragraph **1.2.1.**

1.3.3.7. Submit aircraft engagement information according to paragraphs **1.2.2.** and **1.2.3.** and MAJCOM supplemental direction. Include all missed engagement attempts. (See **Attachment 1** for the definition of a missed engagement.) Reports should be sent as soon as possible after the engagement. Electronic submittals are authorized and encouraged.

1.3.3.8. Develop local procedures and lesson plans to thoroughly train all personnel (including non-Power Production personnel) who use, operate, or maintain an arresting system to the appropriate task level in the Career Field Education and Training Plan (CFETP), and ensure that all personnel are task-certified for their assigned duties. Document training and certification of civilian employees on AF Form 971, **Supervisors Record of Employee**, and other training records as appropriate.

1.3.3.8.1. Training for non-Power Production personnel must be provided at not less than quarterly intervals. Maintain a record for each training class that identifies the instructor and all trainees.

1.3.3.8.2. Provide a copy of the record to the trainee's regular duty section for their use.

1.3.3.9. Report all deficiencies discovered with arresting systems and components to Base Supply according to T.O. 00-35D-54, *USAF Material Deficiency Reporting and Investigating System*.

1.3.3.10. Establish and maintain a record of the effective pendant height (EPH) according to **Attachment 6** for each hook-cable arresting system installed (except retractable cable systems such as BAK-14).

1.3.3.11. Ensure that systems that do not comply with the requirements of this instruction or the applicable T.O. are programmed for replacement and identified in the USAF Airfield Obstruction database, if appropriate.

1.3.3.12. Ensure that copies of applicable aircraft arresting system technical orders and work cards, Air Force instructions, MAJCOM supplements or instructions, and local instructions are maintained in the work center and are available for all personnel engaged in arresting systems activities.

1.3.3.13. Ensure that all non-Power Production personnel engaged in daily aircraft arresting system activities are certified on an AF Form 483, on an annual basis. A copy of the AF Form 483 should be maintained in each individual's AF Form 623, **Individual Training Record**.

1.3.3.14. Establish and maintain a "special level" on critical replacement items for aircraft arresting systems. Examples of items that should be maintained at special levels include (but are not limited to) purchase tapes, tape connectors, pendants, control valves, shuttle valves, special fittings, brake sets or kits, and replacement modules for Textile Brake arresting systems.

1.4. HQ Air Force Materiel Command (AFMC).

1.4.1. The Air Armament Center (AAC) manages engineering development of new requirements and oversees initial production. Once the initial production quantity is complete, responsibility for item management, engineering, and procurement support is consigned to WR-ALC.

1.4.2. WR-ALC provides logistic and engineering support and item management for these systems and components. WR-ALC is also responsible for the following:

1.4.2.1. Procures systems and spare parts.

1.4.2.2. Provides technical assistance and consultation on maintenance, product improvement, modifications, testing, inspections, and installation of all arresting systems in the Air Force inventory.

1.4.2.3. Compiles and documents all information from the monthly aircraft arrestment reports to ensure availability of the data for analysis of specific system performance and use.

Chapter 2

OPERATION, MAINTENANCE, CERTIFICATION, AND INSPECTION

2.1. General Information.

2.1.1. This chapter provides basic information on inspection, maintenance, certification, operation, maintenance records, and deficiency reporting for aircraft arresting systems. Information contained in this chapter is intended to be general in nature. Specific technical information may be found in the applicable 35E8-2 series T.O.s.

2.1.2. T.O.s for BAK-12 and BAK-13 provide alternate procedures for removing an aircraft from the cable after engagement. These alternate procedures are commonly referred to as "slingshotting" the aircraft. Potential for aircraft damage is high when using these methods; therefore, use these procedures only during contingencies when conditions warrant rapid cycling of the arresting system.

2.2. Inspection and General Maintenance.

2.2.1. Inspections must be performed in accordance with the applicable T.O., information contained within this instruction, and the 35E8-2 series work cards.

2.2.2. In-service pendant cables must be inspected daily and after each engagement. Spare pendants should be stored indoors.

2.2.3. Crop exposed tape between the runway edge sheave (fairlead beam) and the tape connector on BAK-9 and BAK-12 systems every 6 months. Crop tape between the absorber base and the tape connector every 6 months on expeditionary systems if a tape tube is not used. Reverse (end-for-end) tapes on all systems every 24 months. No nylon tapes should be retained in service longer than 48 months, or if usage exceeds the maximum allowable for engagements and pull-outs or tape stack height in the applicable 35E8-2 series T.O. Due to the negative effects of ultra violet light on nylon, every effort should be made to protect tapes from direct sunlight. For this reason, all spare nylon tapes must be stored indoors.

2.2.4. For MA-1A, a new webbing assembly must be installed after each engagement. See T.O. 35E8-2-2-1, *USAF Types MA-1 and MA-1A Runway Overrun Barrier*, Section 1, for details. Also, inspect pendant cables and replace if conditions are indicated. Reposition the energy absorber chain to service position (T.O. 35E8-2-2-1, Figure 1-1). If it is necessary to recover the chain from a wet area after an engagement, care should be taken to keep the vehicle on the paved surface. A motor-grader or other heavy-duty pneumatic tire vehicle should be used on the paved surface during recycle operations.

2.2.5. The 60 meters (200 feet) of pavement on both the approach and departure sides of the arresting system pendant for a width equal to the off-center engagement capability of the system are critical areas. Protruding objects, excessive paint build-up, excessive joint sealant material, warped sacrificial panels, and undulating surfaces are detrimental to successful tailhook engagements and are not allowable. 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 and panels beneath the cable must be inspected more closely, and increased attention will be necessary after each freeze-thaw cycle.

2.2.5.1. Problem areas must be immediately identified to the base pavements engineer for a more thorough inspection and corrective action. The airfield manager must also be notified so that

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

2.2.5.2. Perform more detailed inspections of suspect areas with a 4-meter (12-foot) straight edge. Begin on the runway centerline and check the pavement in the immediate area of the cable for high spots, depressions, or other undulations, out to a point beyond the first transverse pavement joint, or for a minimum longitudinal distance of 6 meters (18 feet), whichever is more. 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 distance equal to the off-center engagement capability of the system. Grind flush any high spots exceeding 3 millimeters ($^1/_8$ inch), Report depressions exceeding 3 millimeters ($^1/_8$ inch) in depth to the base pavements engineer for corrective action.

2.3. System Certification.

2.3.1. All Air Force arresting gear excluding MA-1A, E-5, BAK-15, Textile Brake, and soft ground arrestor systems (such as the Engineered Material Arresting System [EMAS]) that have not been engaged for the past 12 months must be certified by an aircraft engagement using speeds and weights listed in **Table 2.1.** Certification engagements will be made toward the center of the runway. This may require the aircraft starting position to be in the over-run area. This requirement also applies to initial system installations, after a brake change, overhaul, or replacement of any hydraulic component in the braking system. It does not apply to War Reserve Materiel systems in storage.

Table 2.1. Certification Weights and Speeds.

Aircraft Arresting System	Approximate Aircraft Weight	Minimum Speed Required
BAK-9	9,072 kg (20,000 lbs)	90 knots
	13,608 kg (30,000 lbs)	75 knots
BAK-12, BAK-13, and MAAS	9,072 kg (20,000 lbs)	105 knots
	13,608 kg (30,000 lbs)	85 knots
	18,144 kg (40,000 lbs)	75 knots

2.3.2. If extenuating circumstances prevent certification by engagement, a certification inspection must be performed or the system must be removed from service. The certification inspection must be performed by a MAJCOM designated representative on or before the anniversary of the last system engagement. The inspection must include (but is not limited to) all requirements in Section 5 of the applicable 35E8-series T.O. The period between aircraft engagements must not exceed 24 months. The assigned base maintenance personnel may not perform the inspection.

2.3.3. Maintenance crews will also be evaluated during certification engagements. The following factors will be considered:

2.3.3.1. Evaluate crew proficiency in disconnecting the aircraft and returning the system to service.

2.3.3.2. Evaluate adequacy of maintenance records and data.

2.3.3.3. Evaluate availability of necessary tools, spare parts, and equipment.

2.3.4. Responsibility for assuring that certification is accomplished according to this instruction rests with the host command. Base 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 by each base and MAJCOM for not less than 2 years.

2.4. Operation.

2.4.1. Disconnect and remove unidirectional barrier nets and pendant cables located in overruns on the approach end of the runway. Also disconnect and remove BAK-9 cables located on the runway on the approach end. Full-size net systems such as the BAK-15 may remain in place in the overrun in the down position; however, the energy absorbers must be disconnected and the BCE's designated representative must inform the airfield manager and the MAJCOM/DO and SE when the net will be left in place. Do this to publicize the potential hazard to aircrew.

2.4.1.1. If environmental conditions require frequent changes in the configuration of MA-1A/MA-1A Modified net systems (runway changes), the nets may be left in place on the approach end of the runway to avoid excessive wear from abrasion; however, the non-standard configuration must first be recommended by the installation commander and approved by the MAJCOM DO, SE, and CE.

2.4.1.2. Additionally, the energy absorbers must be disconnected from the engaging device(s) before operations commence in the opposite direction (toward the unidirectional system).

2.4.2. Maintain BAK-12 and BAK-13 operational arresting systems in the ready position on the approach and departure ends of the runway unless the installation commander directs otherwise. You may remove barriers and hook cables from the overrun and runway during snow and ice removal operations, but coordinate removal with airfield management first, and return the barriers and hook cables to operational status as soon as possible.

2.4.2.1. The BAK-14 and the Type H hook cable support systems were 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.

2.4.2.2. Low-speed taxi rollovers must also be kept to a minimum to prevent degradation of system performance. In the event the aircraft arresting system is not required to stop the aircraft, air traffic control (ATC) should lower the BAK-14 or Type H prior to rollover.

2.4.3. When performing duties associated with aircraft arresting systems and barriers in the airfield environment, it will be necessary to communicate with ATC, ground control, fire rescue, and base operations by way of two-way radio. Follow local procedures established within the Airfield Operating Instruction (AOI) and the base flight line driving regulation and program. General terms to be used for radio communication are provided in AFI 13-203, *Air Traffic Control*, AFI 13-213, *Airfield Management*, and Federal Aviation Administration Handbook (FAAH) 7110.65N, *Air Traffic Control, Pilot/Controller Glossary*. The most common terms for use and their definitions are provided in paragraphs **2.4.3.1.1.** through **2.4.3.1.7. Attachment 1** 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.

2.4.3.1. Common phrases used in radio communication and their meanings are provided below. The phrase "clear" must not be used when communicating with tower personnel.

2.4.3.1.1. "Acknowledge" — Request that you have received and understand the message.

2.4.3.1.2. "Affirmative" — Yes.

2.4.3.1.3. "Negative" — No.

2.4.3.1.4. "Say Again" — Request to repeat the message.

2.4.3.1.5. "Roger" — I have received and understand the last transmission.

2.4.3.1.6. "Hold Short" — Do not proceed per the tower's instructions.

2.4.3.1.7. "Wilco" — I have received and will comply with your message.

2.4.3.2. There is no standard phraseology for reporting system status to ATC; however, use "operational" and "not operational," and "in-service" and "out of service" consistently when reporting status to the airfield authority. These terms are easy to understand descriptions of airfield systems. The specific terms selected for each base should be specified within the local AOI.

2.4.3.3. When communicating the location of an aircraft arresting system on the active runway, use the active runway designation and refer to the system in question by approach, midfield, or departure end cable, or approach or departure end barrier. In this case, it is important to differentiate between cables and barriers. BAK-12, BAK-13, and BAK-14 systems are cable systems, not barriers. Net systems such as MA-1A and BAK-15 systems are barriers. See the definition of terms in **Attachment 1**. 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.

2.5. Standard Hand Signals.

2.5.1. Standard hand signals for use between aircraft arresting system crewmembers and aircrew members are provided in AFI 11-218, *Aircraft Operations and Movement on the Ground*. Standard hand signals for use between aircraft arresting system crewmembers are shown in **Figure 2.1.**

Figure 2.1. Standard Hand Signals For Rewind Operations.

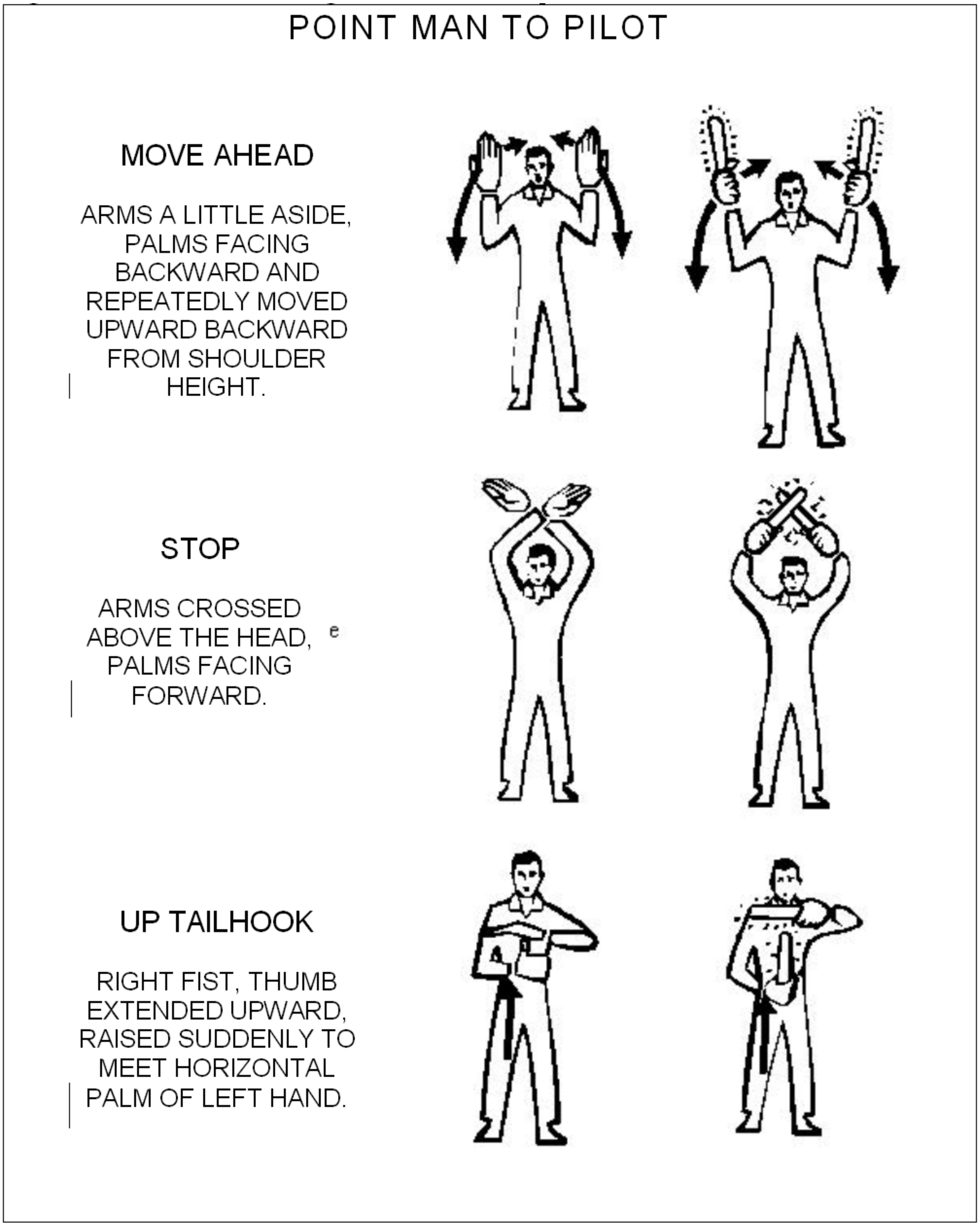


Figure 2.1. Continued.

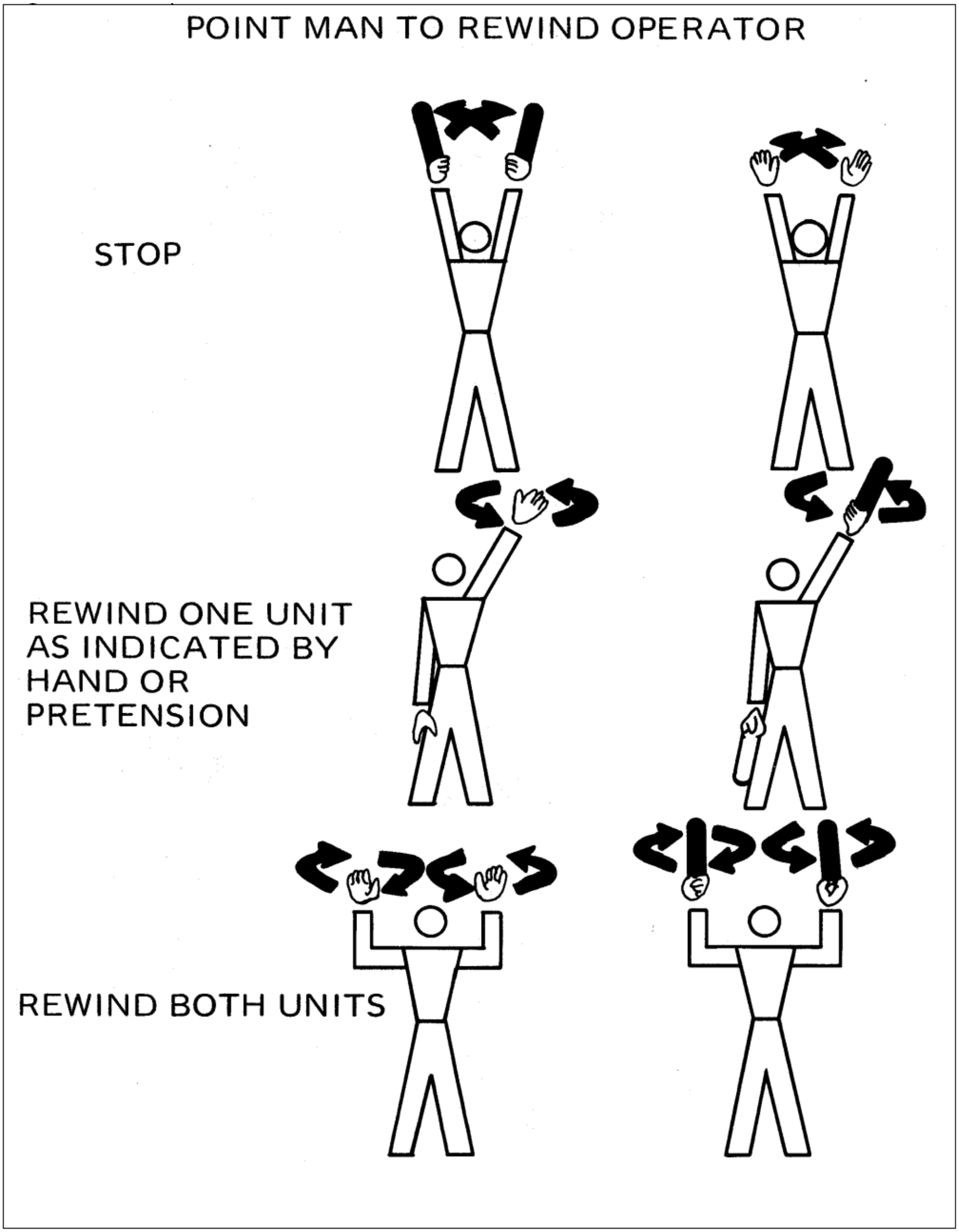


Figure 2.1. Continued.

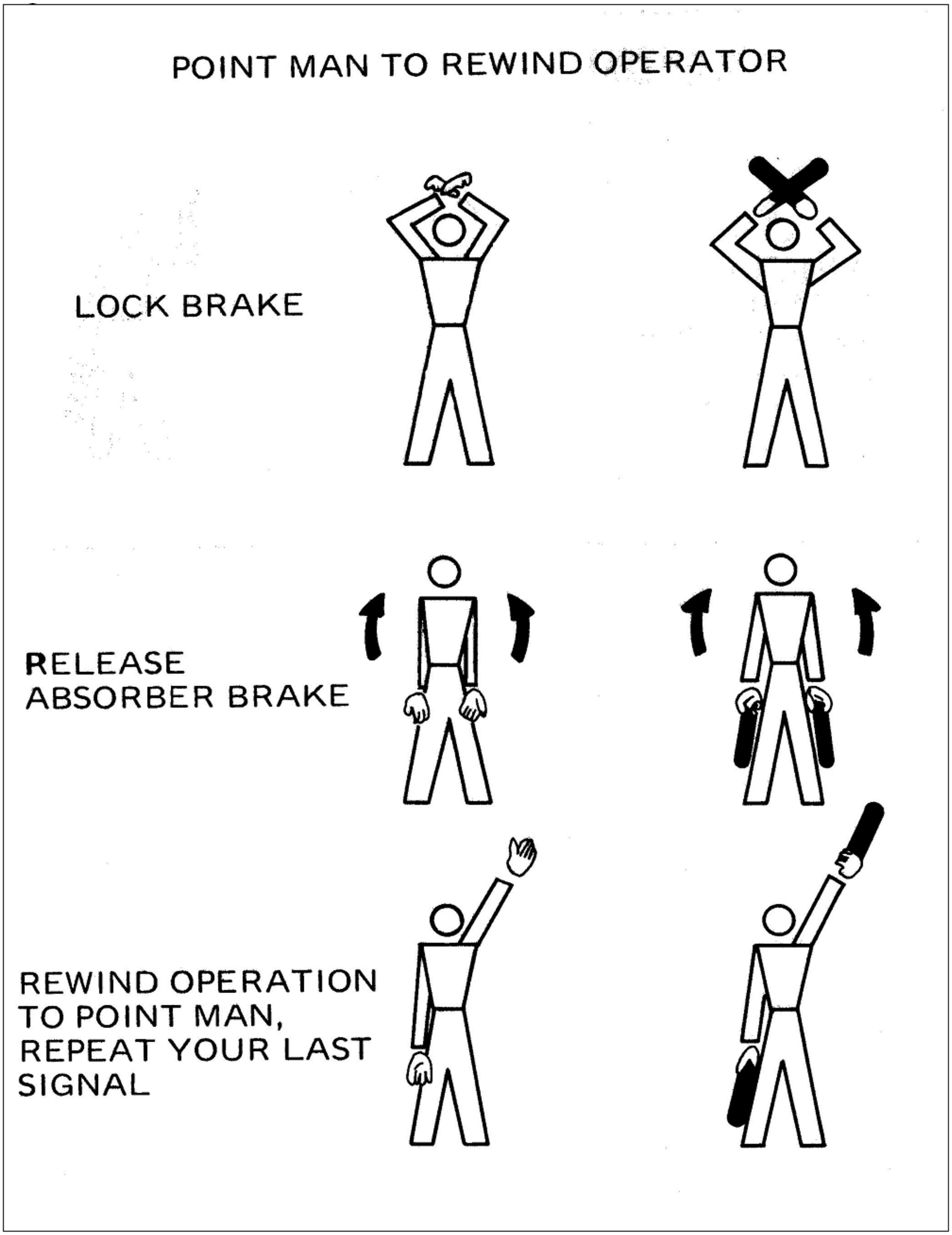
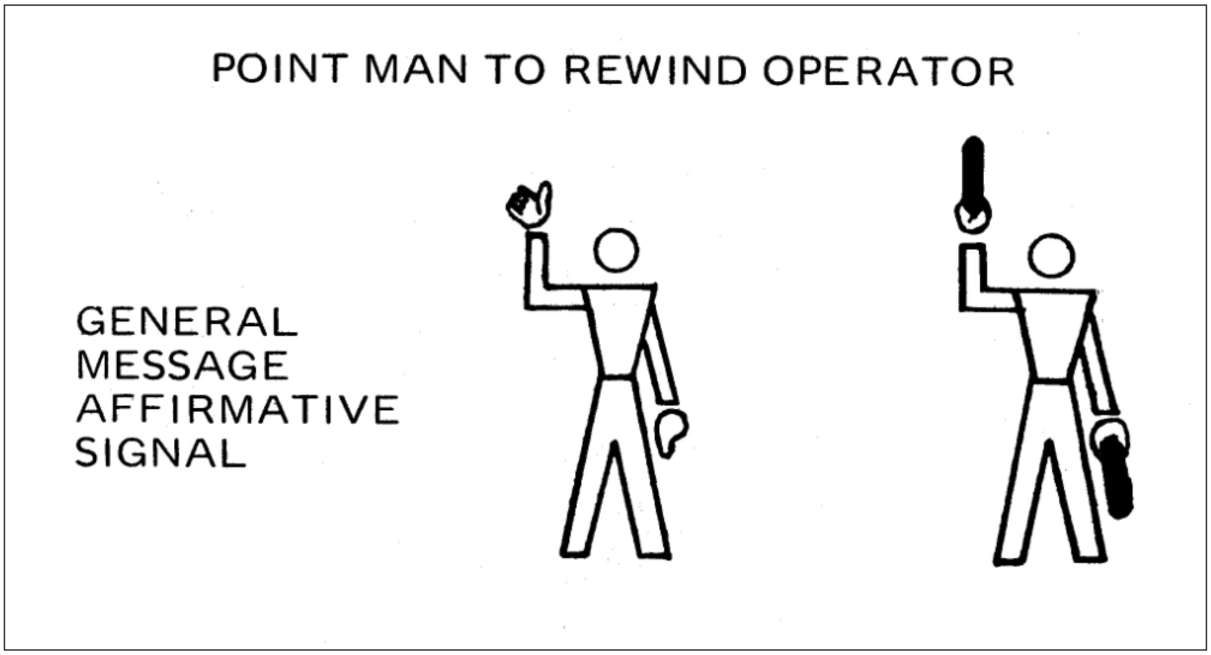


Figure2.1. Continued.



2.6. Maintenance Records. The following records will be maintained on each aircraft arresting system for the overhaul service life of the system, and returned to the overhaul facility when the system is changed out. This includes War Reserve Material systems in storage and systems designated for training use only, as applicable.

2.6.1. Daily inspections.

2.6.2. Weekly inspections.

2.6.3. Monthly inspections.

2.6.4. Tape data (date installed, contract number, manufacturer, and usage data).

2.6.5. Cable replacement data (date installed and contract number).

2.6.6. Semi-annual inspections.

2.6.7. Qualification and task certification of personnel.

2.6.8. System certifications and certification inspections.

2.6.9. Brake type, date installed, and number of engagements on BAK-12, MAAS, and BAK-9.

2.6.10. Engagement data (length of run out, maximum brake pressure, and aircraft weight and speed).

2.7. Deficiency Reporting.

2.7.1. Deficiency reporting will be accomplished according to T.O. 00-35D-54.

Chapter 3

OBTAINING NEW SYSTEMS, SITING, AND INSTALLATION REQUIREMENTS

3.1. Obtaining New Systems.

3.1.1. Identify new system requirements to the MAJCOM and AFCESA, in turn, at least 2 years in advance, or as soon as new requirements are known, to allow sufficient lead-time for budgeting, manufacturing, and delivery.

3.1.2. The BCE's representative processes new requirements by first coordinating with the MAJCOM functional manager for aircraft arresting systems. The MAJCOM functional manager coordinates the new requirement with the MAJCOM DO, SE, and CE, and responds to the base request. Once command endorsement is received, the base representative submits an AFEMS request to the Base Equipment Management Office (BEMO).

3.1.3. Semiannually, the MAJCOM CE representative must identify all new requirements to HQ AFCESA/CES during the call for new requirements.

3.1.4. HQ AFCESA/CES Civil Engineering Division (HQ AFCESA/CESC) validates the new requirements with WR-ALC for budgeting and procurement.

3.1.5. Upon approval of the AFEMS request, base-level personnel should requisition the system and any other components not included in the Government Supplied Equipment (GSE) kit, such as the pendant.

3.2. Siting New Systems.

3.2.1. General Information. Aircraft arresting systems and overrun barriers are installed in several configurations. Typically, overrun barriers (nets) and emergency arrestors such as MA-1A, BAK-15, E-5 chain gear, Textile Brake, or soft ground arrestor systems 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 (to direct the purchase tape path) 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 to allow an aircraft to roll over them smoothly. Arresting gear that is installed on grade must have a frangible structure built over it to protect the equipment from environmental degradation. Design should be in compliance with typical installation drawings 67F2011 or 67F2012, as applicable, this instruction, the applicable 35E8-2 series T.O., and frangibility requirements detailed within UFC 3-260-01 (see Chapter 3 and Attachment 14). Shelters must also contain adequate ventilation and have windows located so operators can see the arrestment area and directly across the runway. Do not install any arresting system where the runout will conflict with any other arresting system or any obstacle such as elevated airfield lights or signs. In cases where criteria cannot be met, a waiver must be established according to UFC 3-260-01 and/or the applicable T.O., as appropriate.

3.2.2. Siting Operational Systems. The large rectangular pavement markings (Fixed Distance Markings) located 300 meters (1,000 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 (1,000 feet) from the threshold. This ensures a minimum threshold crossing height of at least 11 meters (35 feet). Since stabilizing the tailhook 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 (1,500 to 1,800 feet) from the threshold. Runways used extensively during instrument meteorological conditions may require that the system be sited as much as 670 meters (2,200 feet) from the threshold; however, if aircraft that are not compatible with trampling of 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. It is critical that the runout area for an aircraft engaging the system from either direction not conflict with other aircraft arresting systems or 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 midfield siting after coordinating the plan with the host MAJCOM DO, SE, and CE.

3.2.3. Siting Emergency Systems. Locate unidirectional arresting systems 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 accommodate full system runout. 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 threshold markings.

3.3. Installation Requirements.

3.3.1. Comply with the following standards when locating, configuring, installing, or repairing an arresting system. BCEs must get the installation commander's approval and coordinate with MAJCOM DO, SE, and CE organizations before deviating from these standards. Waiver to UFC 3-260-01 or the applicable 35E8-2 series T.O. will be required if these standards cannot be met.

3.3.2. The BCE's designated representative determines the configuration and location of arresting systems in cooperation with representatives from DO and SE. Design must conform to the criteria in section 3 of the appropriate 35E8-series T.O., the typical installation drawings, as well as the requirements in this instruction and UFC 3-260-01. In cases where criteria cannot be met, a waiver must be established according to UFC 3-260-01 and/or the applicable T.O., as appropriate.

3.3.2.1. Locate all energy absorbers below grade or at least 84 meters (275 feet) from the runway centerline. Provide paved transitions and buried crushed stone ramps around the arresting system components and a service road to the site from the runway, as well as a location other than the runway. Pit-type installations may be sited closer to the runway as long as they meet the minimum split-distance required; 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 in accordance with USAF ETL 02-1, *Design of Drainage Structures for Heavy Aircraft Loading*.

3.3.2.2. Where fairlead beams 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. Existing tape tubes must be steel or ductile iron capable of supporting a 34,000-kilogram (75-kip) wheel load. For new installations, select tape tubes that will comply with design requirements within Engineering Technical Letter (ETL) 02-1, *Design of Drainage Structures for Heavy Aircraft Loading*.

3.3.2.3. Provide obstruction marking and lighting and arresting system location marking and lighting according to the provisions of AFI 32-1042, *Standards for Marking Airfields,* and AFMAN 32-1076, *Visual Air Navigation Systems.*

3.3.2.4. Use frangible protective shelters for above-grade systems to comply with the frangibility requirement in UFC 3-260-01, Attachment 14. Also provide a removable roof or end to facilitate major maintenance or replacement of the equipment inside.

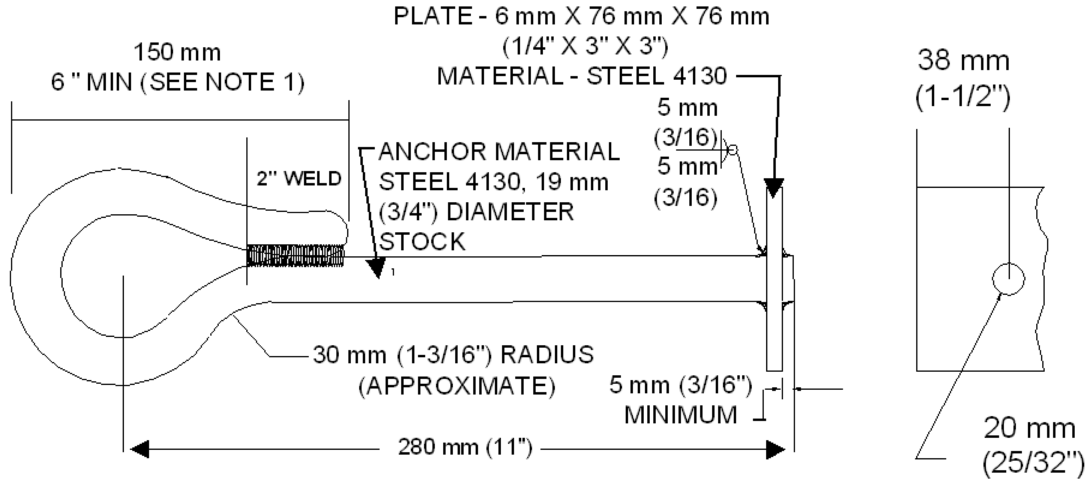
3.3.2.5. The 60 meters (200 feet) of pavement on both the approach and departure sides of the arresting system pendant are critical areas. Protruding objects, excessive paint build-up, and undulating surfaces are detrimental to successful tail hook engagements and are not allowable. The maximum permissible longitudinal surface deviation in this area is plus or minus 3 millimeters (0.125 inch) in 4 meters (12 feet). This does not apply to grooved pavement surfaces. Grooving to improve surface drainage and surface friction characteristics may be accomplished to within 3 meters (10 feet) of arresting system cables. Changes in pavement type or an interface between rigid and flexible pavements are not permitted within 60 meters (200 feet) of arresting system cables (this does not apply to installation of sacrificial polyethylene panels or to emergency systems located within the overrun). Rigid inlays must not be used as a surface repair material beneath the cable in a flexible runway system. 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 for sacrificial pads installed beneath aircraft arresting system cables in both rigid and flexible pavement systems.

3.3.2.6. Install cable tie down anchors beneath operational systems (systems located between the runway thresholds) to limit cable bounce and potential aircraft damage during aircraft rollover. Install 8 anchors for F-16 operating bases, and 4 anchors at all other locations. Install anchors at 6-meter (20-foot) intervals centered on the runway width for 4-point tie downs, or at 3-meter (10-foot) intervals centered on the runway width for 8-point tie downs. Offset anchor locations at least 600 millimeters (2 feet) from all pavement joints. If sacrificial panels are, or will be installed, see **Attachment 8** for anchor spacing. See **Figure 3.1.**, **Figure 3.2.**, and **Figure 3.3.** for cable tie-down anchor installation. Either installation may be used for flexible or rigid runway pavements. Specific designs must be developed for each runway system to ensure adequate holding strength.

3.3.2.6.1. Secure the cable to the anchors with a length of 10 millimeters ($^3/_8$-inch) diameter, three-strand nylon rope (NSN 4020-00-968-1356) approximately 1,200 millimeters (48 inches) long (2,200 kg [5,000 lbs] breaking strength). The rope must be fastened to the anchor with a simple overhand knot, and then tied to the cable with a square knot.

3.3.2.6.2. 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 3.3.** and **Figure 3.4.**

Figure 3.1. Cable Tie-down Anchor.



NOTE:

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

Figure 3.2. Cable Tie-down Anchor Installation.

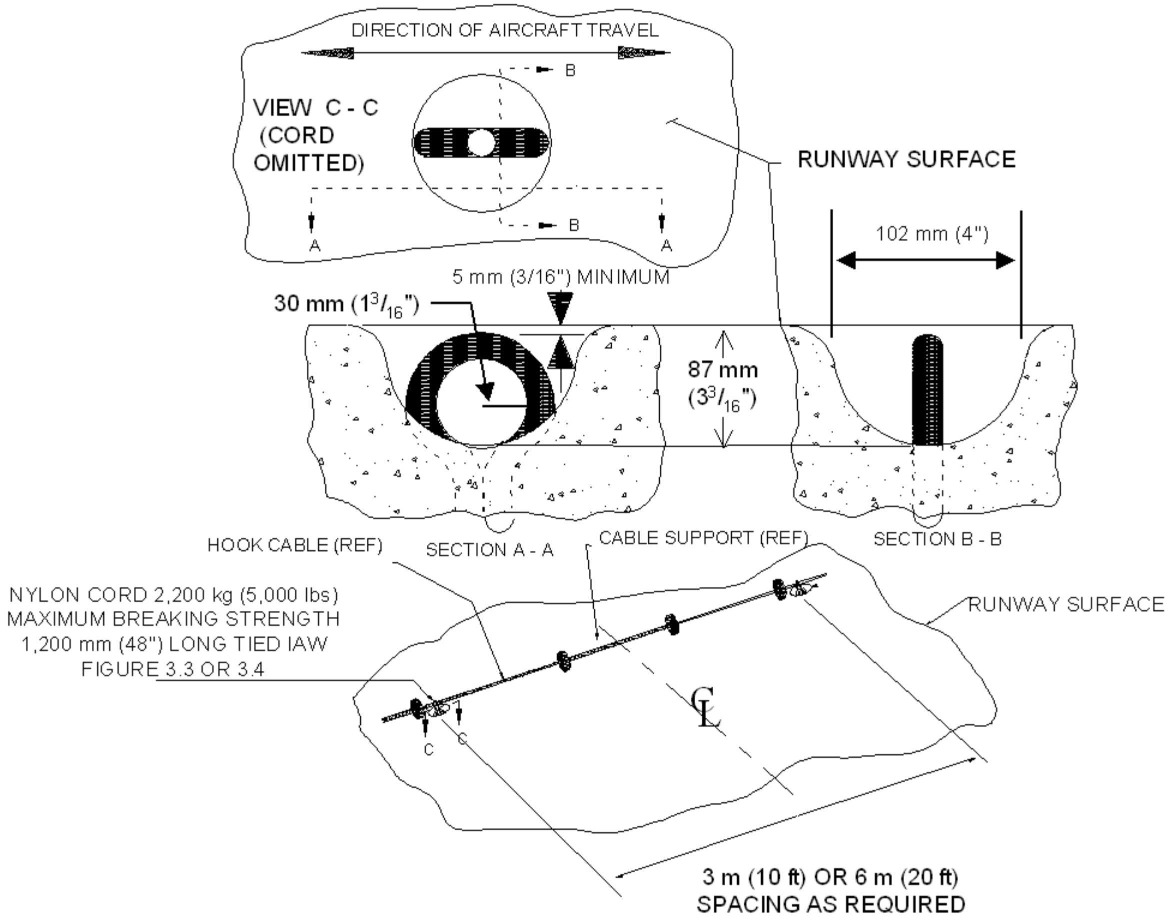
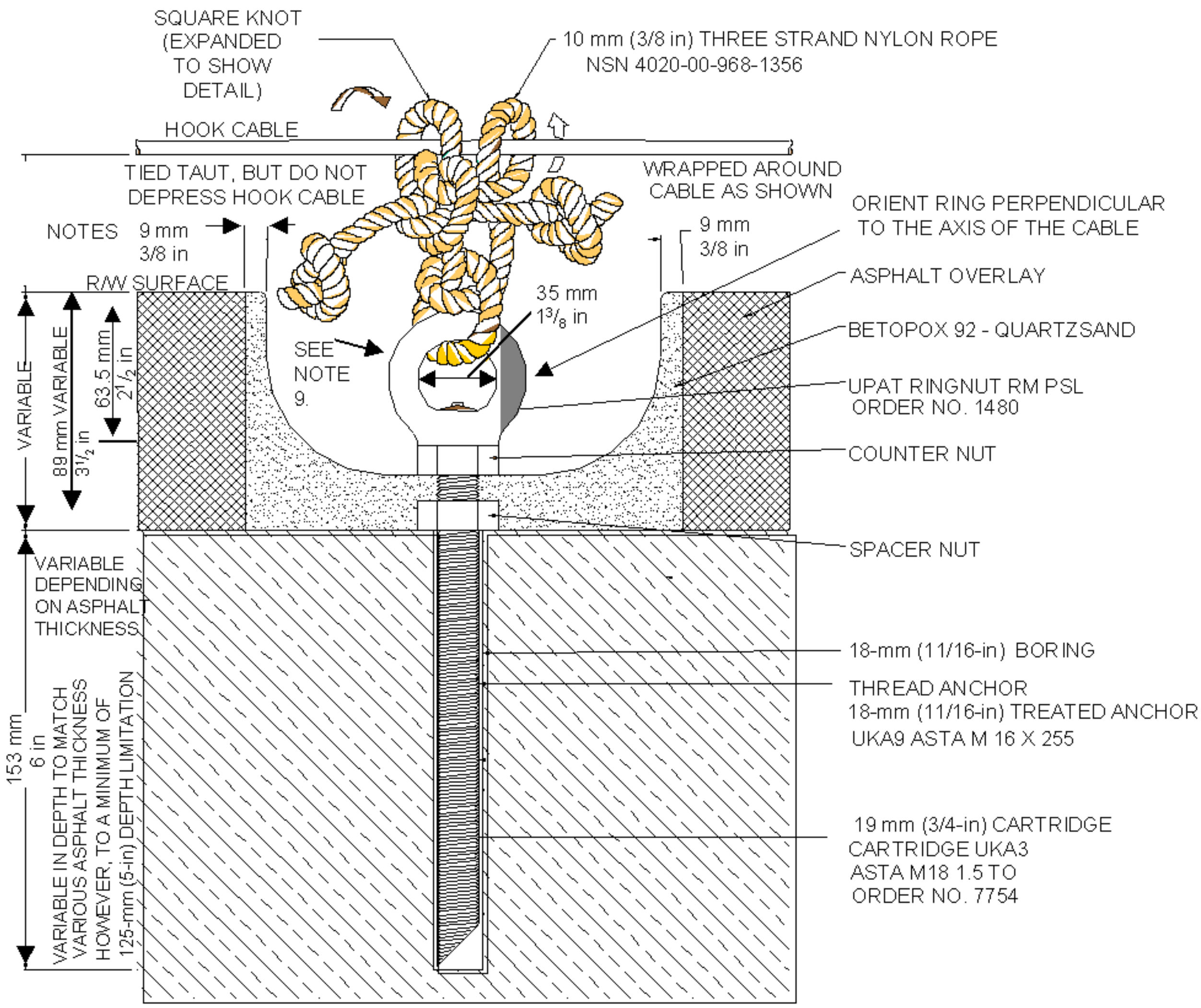


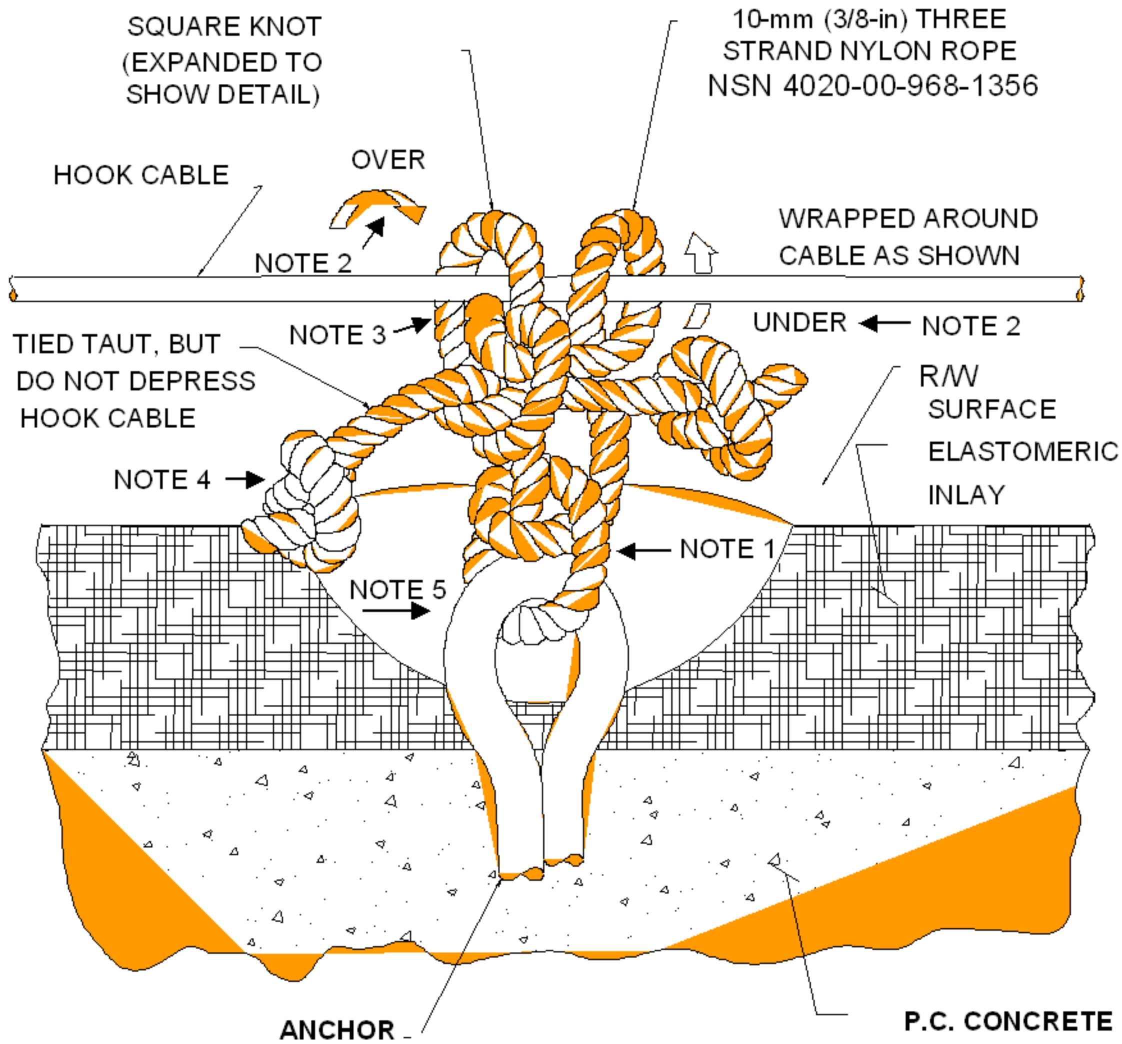
Figure 3.3. Alternate Cable Tie-down Anchor Installation.



NOTE:

1. See paragraph 3.3.2.6 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 sub-base 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 Loctite or equivalent.
7. Threaded anchors shall be set with an impact type drilling machine.
8. DO NOT place anchors within 600 millimeters (2 feet) of pavement joints.
9. Top of ring nut shall be recessed approximately 12 millimeters (0.5 inch) below the runway surface.

Figure 3.4. Securing Cable With Tie-down Rope.



NOTE:

1. Tie one half of a square knot on the anchor.
2. One end of the rope comes over the cable on the long side of the runway. The other end of the rope comes over the cable from the threshold side.
3. After the ropes are looped over the cable, tie a square knot underneath the cable.
4. Tie knots in end of rope.
5. Orient ring perpendicular to the axis of the cable.

3.3.2.7. The BCE's aircraft arresting system representative reviews the construction drawings and contract specifications at the 35 percent and 65 percent completion stages and approves at the 90 percent design completion phase. Other entities with a stake in the project, such as SE and DO, should also be asked to review the project drawings and contract specifications. The BCE's representative also ensures that installation contracts stipulate that:

3.3.2.7.1. The construction superintendent, project engineer, or other authority experienced in installing arresting systems is on site during construction and installation of each system.

3.3.2.7.2. The contractor corrects any deficiencies in the installation until at least 2 pullouts of the purchase tape are accomplished in each direction of intended operation and the contracting officer officially accepts the system.

3.4. Grandfathered Systems. On-grade BAK-12 systems installed prior to 1 July 1977 that are sited at least 76.2 meters (250 feet) from runway centerline do not have to be relocated to meet the minimum set back requirement of 84 meters (275 feet) from runway centerline; however, all systems equipped with deck sheaves or 2-roller fairlead beams must be programmed for retrofit with 3-roller fairlead beams to eliminate the longitudinal wheel abutment along the runway shoulder. Replacement foundations must be constructed as described in paragraphs **3.3.2.1.**, **3.3.2.2.**, and the typical installation drawings to comply with the 1V:30H (3 percent) maximum slope requirement along the runway shoulder (see UFC 3-260-01, Table 3.2).

3.5. Installing Systems at Jointly Used Airports.

3.5.1. The Federal Aviation Administration (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 US military aircraft.

3.5.2. 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 for Joint Civil/Military Airports.* Order this Advisory Circular from:

US Department of Transportation

General Services Section

M-443.2

Washington DC 20590

3.5.3. 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.

3.5.4. If construction involves a lease agreement that does not allow placement of additional structures on the leased premises, contact the MAJCOM.

3.5.5. Third-party claims presented for damage, injury, or death resulting from the 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*).

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

3.5.7. 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 **Attachment 5** for a sample letter of agreement.

3.6. Military Rights Agreements for Non-Continental US Locations and Use by Non-US Government Aircraft .

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

3.6.2. In an emergency, the pilot of a non-US Government aircraft may request and use arresting systems at Air Force bases and jointly used airports within the continental US (CONUS) and overseas.

3.7. Forms Adopted: AF Form 483, **Certificate of Competency**; AF Form 601, **Equipment Action Request**; AF Form 623, **Individual Training Record**; and AF 971, **Supervisor's Employee Brief**.

MICHAEL E. ZETTLER, Lt General, USAF
Deputy Chief of Staff, Installations and Logistics

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

Air Force Publications

AFPD 32-10, *Installations and Facilities*

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

AFI 13-203, *Air Traffic Control*

AFI 13-213, *Airfield Management*

AFI 32-1042, *Standards for Marking Airfields*

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

AFMAN 32-1076, *Visual Air Navigation Facilities*

ETL 02-1, *Design of Drainage Structures for Heavy Aircraft Loading*

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

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

T.O. 35E8-2-5-1/-4, *BAK-12*

T.O. 35E8-2-7-11, *Operation and Maintenance Instructions, Aircraft Arresting System, Type BAK-13A/F48A*

T.O. 35E8-2-8-1, *Operation, Maintenance, and Installation Instructions With Illustrated Parts Breakdown, Hook Cable Support System, Model BAK-14*

T.O. 35E8-2-9-2, *Maintenance and Operation Instructions, Quick Erect Stanchion System, Models 61QS and 61QSII*

T.O. 35E8-2-10-1, *Operation and Maintenance Instructions, Arresting Systems, Aircraft, Mobile*

T.O. 35E8-2-13-1, *Textile Brake and Hook Cable Aircraft Arresting System, Type MB50.9.9.C*

Department of Defense Documents

Joint Publication 1-02, *Dictionary of Military and Associated Terms*

Unified Facilities Criteria Documents

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

Federal Aviation Administration Documents

FAA Advisory Circular (AC) 150/5220-9, *Aircraft Arresting Systems for Joint Civil/Military Airports*

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

FAA Handbook (FAAH) 7110.65N, *Air Traffic Control, Pilot/Controller Glossary*

Federal Aviation Regulation (FAR) 14 Code of Federal Regulation (CFR) Part 77, *Objects Affecting Navigable Airspace*

Standards Documents

American Society for Testing and Materials (ASTM) D256-02, *Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics*, Test Method A.

ASTM D638-02, *Standard Test Method for Tensile Properties of Plastics*

ASTM D696-98, *Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between –30 Degrees Celsius and 30 Degrees Celsius with a Vitreous Silica Dilatometer*

ASTM D1505-98e1, *Standard Test Method for Density of Plastics by the Density-Gradient Technique*

ASTM D3028, *Standard Test Method for Kinetic Coefficient of Friction of Plastic Solids* (Discontinued 2000)

ASTM D2240-02a, *Standard Test Method for Rubber Property—Durometer Hardness*

Private Companies

Aerazur Technical Manual 256-721, *Textile Brake and Hook Cable Aircraft Arresting System, Model MB 100.10.C.*

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

Aerazur Technical Manual 256-726, *Textile Brake and Hook Cable Aircraft Arresting System, Model MB 100.12.C.*

Abbreviations and Acronyms

AAC—Air Armament Center

AF—Air Force (as used on Forms)

AFCESA—Air Force Civil Engineer Support Agency

AFCESA/CES—AFCESA Directorate of Technical Support

AFCESA/CESC—AFCESA/CES Civil Engineering Division

AFEMS—Air Force Equipment Management System

AFFSA—Air Force Flight Standards Agency

AFI—Air Force Instruction

AFMC—Air Force Materiel Command

AFPD—Air Force Policy Directive

ANG/CETSC—Air National Guard Civil Engineer Technical Support Center

AOI—Airfield Operating Instruction

AR—As Required (used in report control symbols)

ASTM—American Society for Testing and Materials

ATC—Air Traffic Control

BCE—Base Civil Engineer

CE—Civil Engineer

CENTAF—US Central Command

CFETP—Career Field Education and Training Plan

CFR—Code of Federal Regulation

CONUS—Continental US

DOD—Department of Defense

EPH—Effective Pendant Height

FAA—Federal Aviation Administration

FAAH—Federal Aviation Administration Handbook

FAR—Federal Aviation Regulation

FLIP—Flight Information Publications

ft—Foot

HQ ACC—Headquarters Air Combat Command

ICAO—International Civil Aviation Organization

lbs—Pounds

kg—Kilograms

m—Meters

M & AR—Monthly and As Required (used in report control symbols)

MAJCOM—Major Command

MAJCOM/DO—Major Command Director of Operations

MAJCOM/SE—Major Command Safety

MAAS—Mobile Aircraft Arresting System

mm—Millimeters

Nm—Newton meter

NOTAM—Notice to Airmen

PACAF—Pacific Air Forces

psi—Pounds per square inch

RCS HAF-CE—Report Control Symbol - Headquarters Air Force - Civil Engineer

T.O. —Technical Order

UHMW—Ultra high molecular weight

USAF—United States Air Force

USAFE—United States Air Forces in Europe

WG—Wage Grade

WR-ALC—Warner Robins Air Logistics Center

Terms

Active Runway—Any runway or runways currently being used for takeoff or landing. 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)

Aircraft Arresting Cable—The part of an aircraft arresting system that spans the runway surface or flight deck landing area and is engaged by the aircraft arresting hook. (Joint Publication 1-02) (Also see "Pendant.")

Aircraft Arresting Complex—An airfield layout comprising one or more arresting systems.

Aircraft Arresting System—A series of components used to engage and absorb the forward momentum of a routine or emergency landing or an aborted takeoff. (Joint Publication 1-02)

Arrestment Capable Aircraft—An aircraft whose flight manual specifies arrestment procedures.

Cycle Time—A measure of time between engagement of an aircraft and the point 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 (1,500 feet) on approach runway 36* indicates a 365.7-meter (1,200foot) runout BAK-12 located 457.2 meters (1,500 feet) beyond the threshold of runway 36.

Missed Engagement—Any unsuccessful attempt to engage an aircraft arresting system hook cable with a successfully deployed aircraft tailhook.

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

Movement Area (USAF/FAA)—The runways, taxiways, and other areas of an airport/heliport that are utilized for taxiing/hover taxiing, air taxiing, take-off, and landing of aircraft, exclusive of loading ramps and parking areas. At those airport/heliports with a tower, specific approval for entry onto the movement area must be obtained from ATC. For USAF, the movement area is determined by the Airfield Operations Flight Commander, and is defined in the base airfield operations and flightline driving instructions in accordance with AFI 13-204, *Functional Management of Airfield Operations*, and AFI 13-213, *Airfield Management*.

Movement Area (ICAO)—That part of an airport to be 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 aircraft arresting system that spans the runway surface or flight deck landing area and is engaged by the aircraft arresting 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 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 USAF term for this is “overrun.”

Attachment 2

TYPES OF USAF AIRCRAFT ARRESTING SYSTEMS

A2.1. General Information. 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 Aerazur 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-9 and BAK-12), or rotary hydraulic systems (such as the BAK-13). Table A2.1. and Table A2.2. below show the leading particulars for USAF energy absorbing systems.

Table A2.1. USAF Aircraft Arresting System Energy Absorber Leading Particulars (except Textile Brake)*.

System Type	BAK-9	BAK-12 60-Inch Reel	BAK-12 66-Inch Reel	Dual BAK-12 66-Inch Reel	BAK-13	MAAS 990-Foot Runout***
Nominal Aircraft Weight	40,000 lbs	40,000 lbs	50,000 lbs	100,000 lbs	50,000 lbs	40,000 lbs
Energy Capacity (Ft Lbs)	55×10^6	65×10^6	85×10^6	170×10^6	85×10^6	40×10^6
Nominal Runout	950'	950'	1,200'	1,200'	950'	990'
Tape Strength	65,000 lbs	105,000 lbs	105,000 lbs	105,000 lbs	130,000 lbs	105,000 lbs
Cable Strength	84,000 lbs	130,000 lbs	130,000 lbs	130,000 lbs	129,000 lbs	130,000 lbs
Maximum Speed**	180 knots	180 knots	180 knots	180 knots	180 knots	150 knots

* The operating characteristics given in this table are described in inch-pound units as reported by the original equipment manufacturers.

** 190 knots is the dynamic limit for steel cables used in aircraft arresting systems. Random failures will occur at 190 knots and above; therefore, 180 knots is established as the working limit for cable-engagement systems.

*** MAAS configured for 1,200 feet runout in the 31-stake, Portland Cement Concrete, or set-back anchoring schemes have the same technical characteristics as a 66" BAK-12.

Table A2.2. USAF Textile Brake Aircraft Arresting System Leading Particulars*.

System Type	MB 60.9.9.C	MB 100.10C	MB 100.12.C**
Cable Diameter/ Strength	1.25 inches/ 130,000 lbs	1.25 inches/ 130,000 lbs	1.25 inches/ 130,000 lbs
STAGE 1 Runout (Length of available braking force)	551 feet	N/A	N/A
Energy Capacity Stage 1 (Ft Lbs)	26 X 10^6	N/A	N/A
Total System Energy Capacity (Ft Lbs)	52 X 10^6	44 X 10^6	52 X 10^6
System Runout (Total length of available braking force)	1000 feet	889 feet	889 feet
Energy Capacity calculated at 160 knots.			
NOTE: 12% 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.			
** The MB 100.12C can produce hook loads that exceed the working limit for pre Block 40 F-16 aircraft. Therefore, it should not be used at installations that host this model aircraft (mission, tenant, or transient support). Block 40 model F-16 and later are fully compatible with the MB100.12 Textile Brake Arresting System.			

A2.2. Types of USAF Systems.

A2.2.1. 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 A2.1.**). 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 A2.3.** (or Chart 1-1 of T.O. 35E8-2-2-1) will result in a runout greater than 305 meters (1,000 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 ships' 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. The MA-1A may also be complemented with a hook-cable interconnect to accommodate hook engagement. This arrangement is shown in **Figure A2.2.** 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 A2.1. MA-1A Barrier.

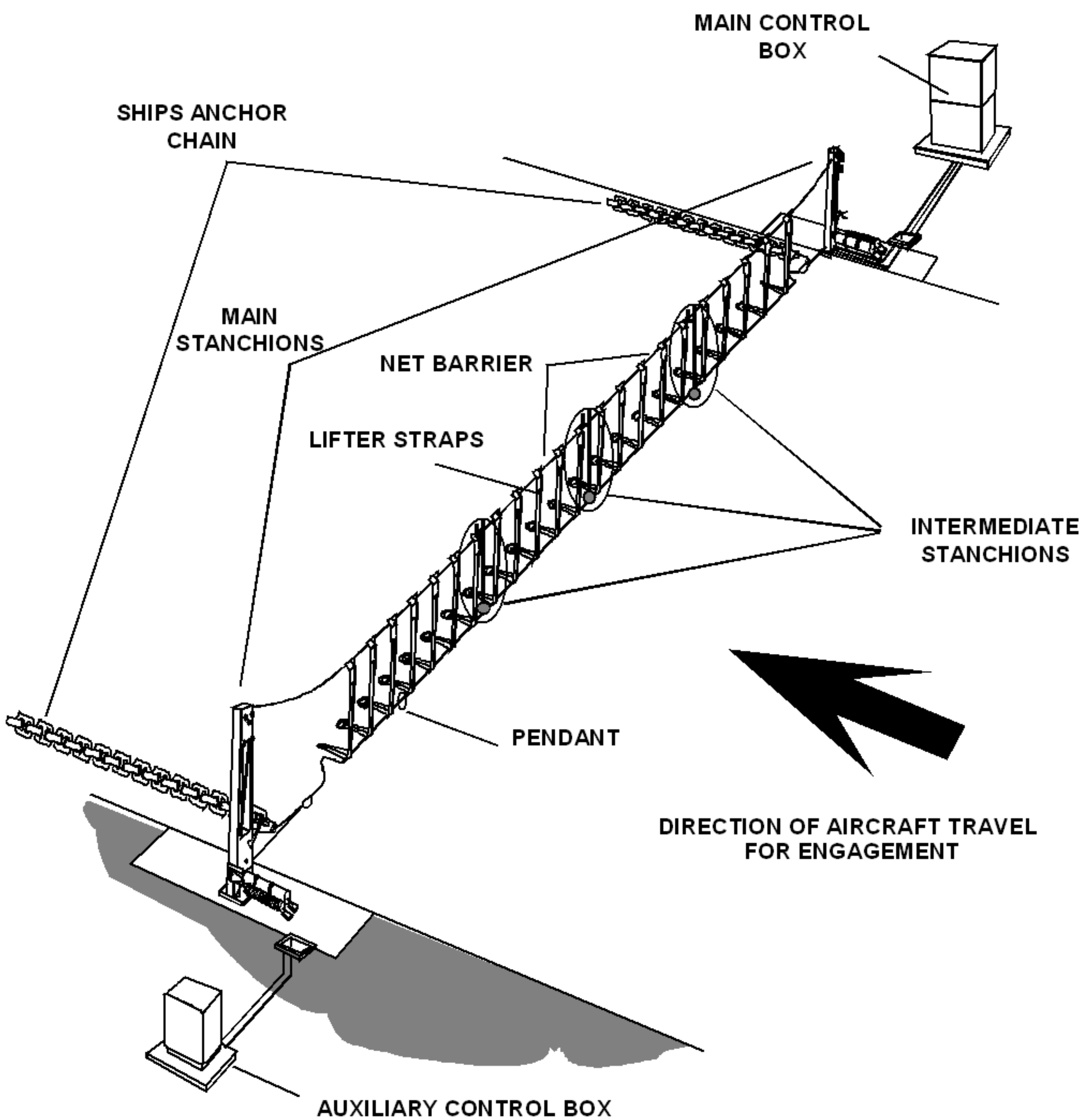


Figure A2.2. MA-1A Modified Barrier With Hook Cable Interconnect.

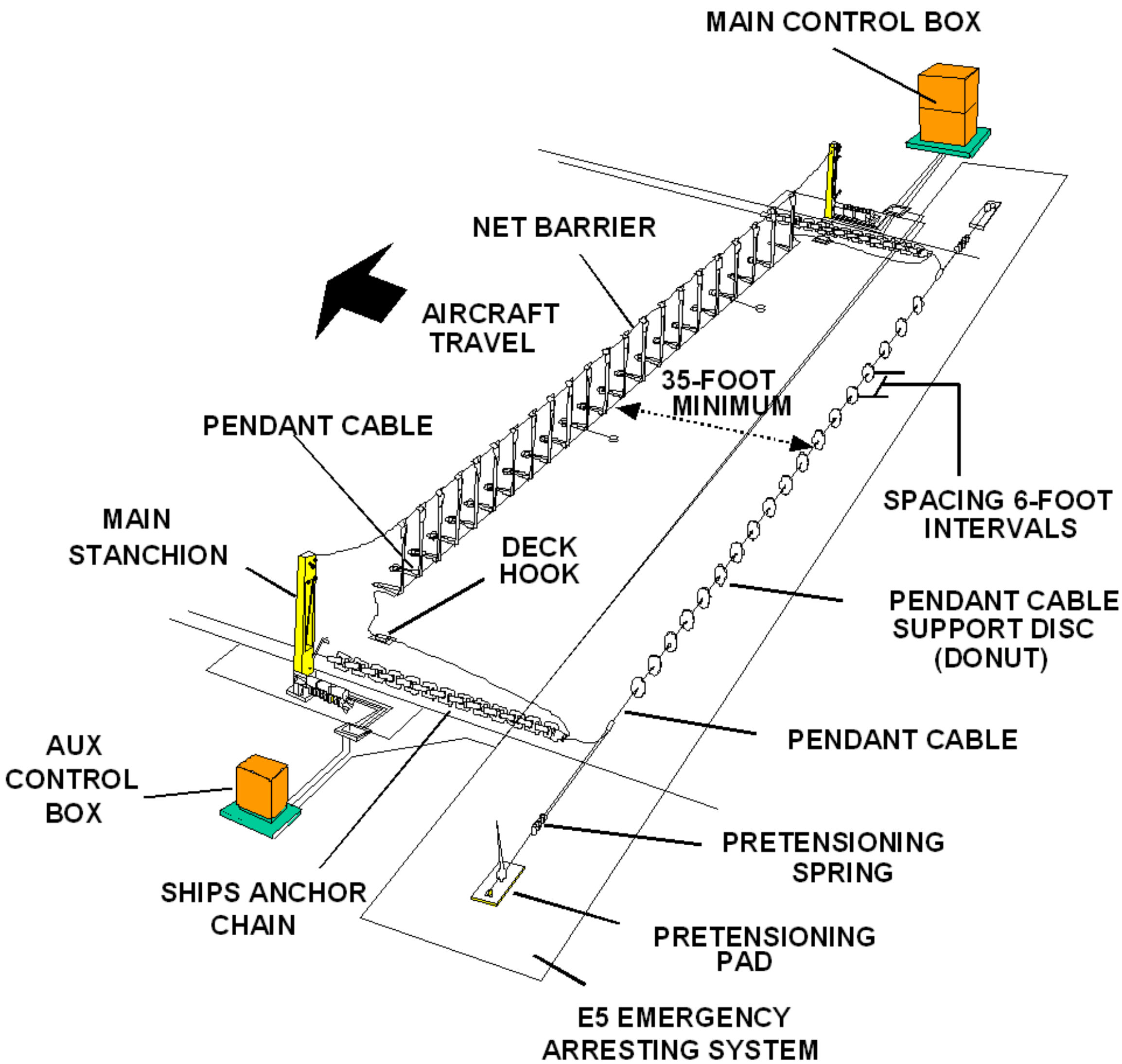
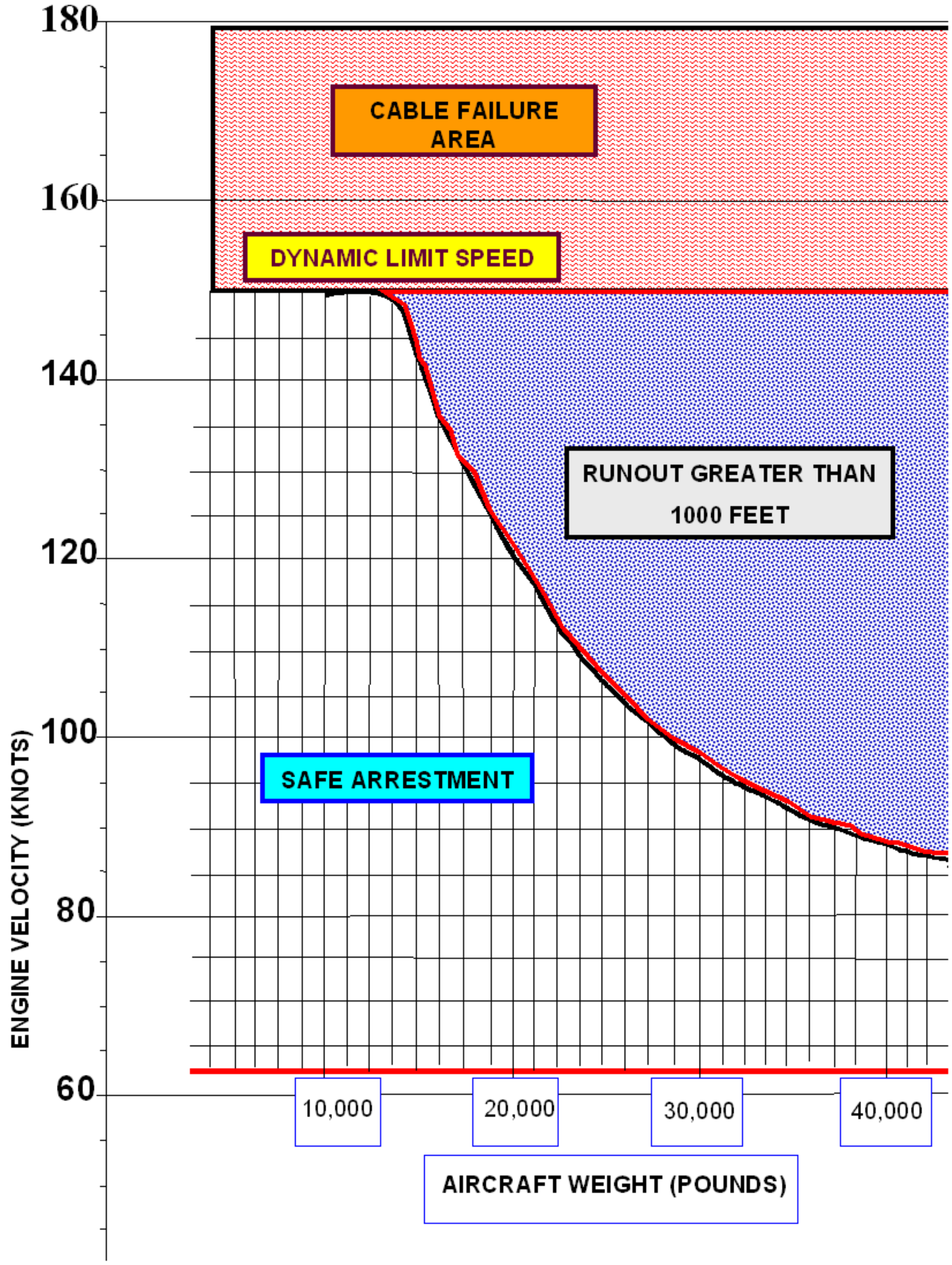
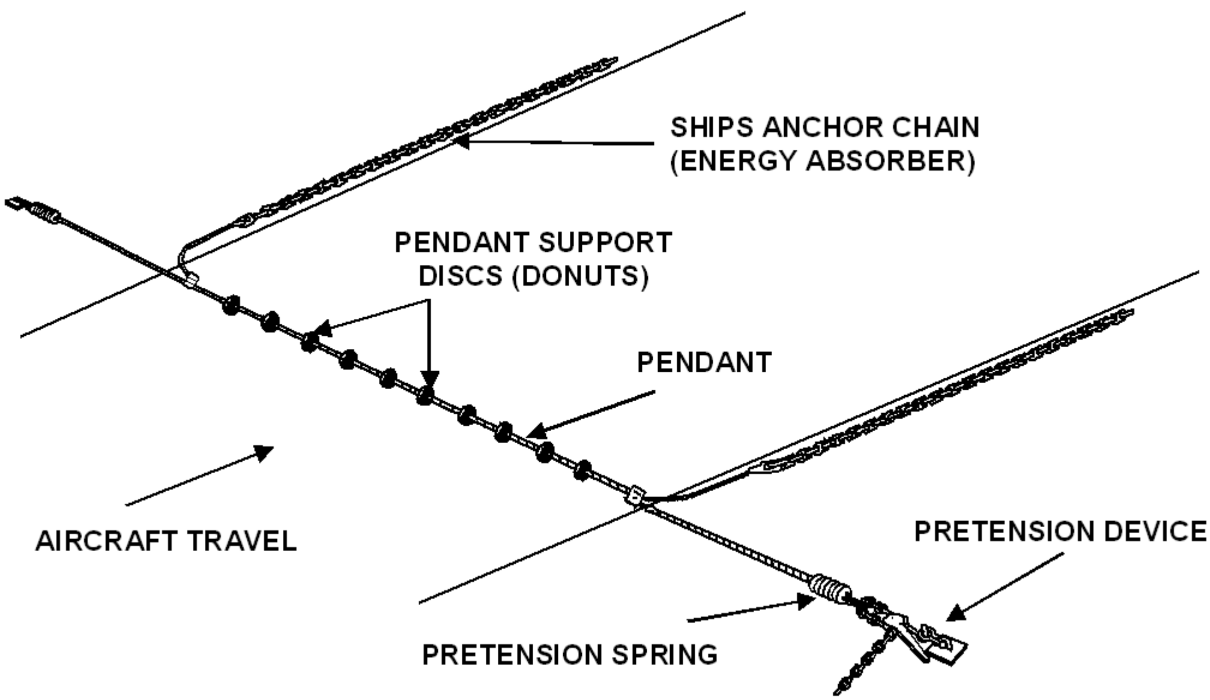


Figure A2.3. Speed and Weight Chart for Chain Gear.



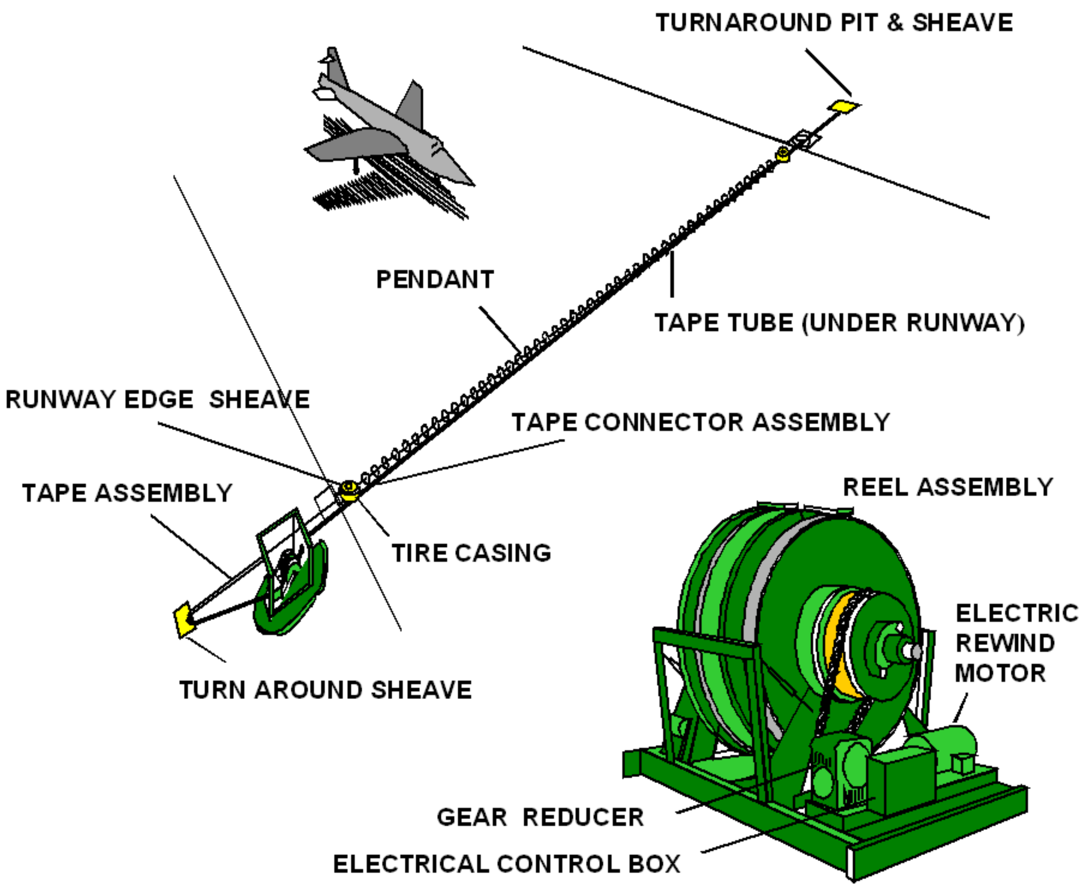
A2.2.2. E-5. This unidirectional emergency arresting system is a US Navy design and designation. Much like the MA-1A, this system uses several shots of ships' anchor chain as the energy absorber, but these systems are never connected with a barrier (net). For the Navy or Marine Corps, these systems can have from 1 to 4 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, NJ. For USAF, these systems use only 1 pendant and are sited and maintained as MA-1A. They are designated as an E-5 (**Figure A2.4.**).

Figure A2.4. E-5 Hook Cable Arresting System.



A2.2.3. BAK-9. The BAK-9 (**Figure A2.5.**) is an obsolete bi-directional emergency arresting system. It consisted of 1 energy absorber that employed 2 rotary friction brakes and purchase-tape reels mounted on a common shaft. The reels were mechanically connected at the midpoint by a third brake that acted as a clutch. This allowed each reel to turn at different speeds during off-center engagements and helped steer the aircraft toward the center of the runway. The energy absorber for these systems was installed below grade on 1 side of the runway and the purchase tape was routed to the opposite side of the runway through deflector sheaves and duct. The other purchase tape (near side) was routed to a turnaround sheave located in a pit sited to allow both purchase tapes to be of equal length. The BAK-9 is not currently in production as a system and should not be considered as a suitable system for a new requirement. Obtain further technical information on this system from T.O. 35E8-2-4-1, *Aircraft Arresting Gear, Model BAK-9.*

Figure A2.5. BAK-9 Aircraft Arresting System.



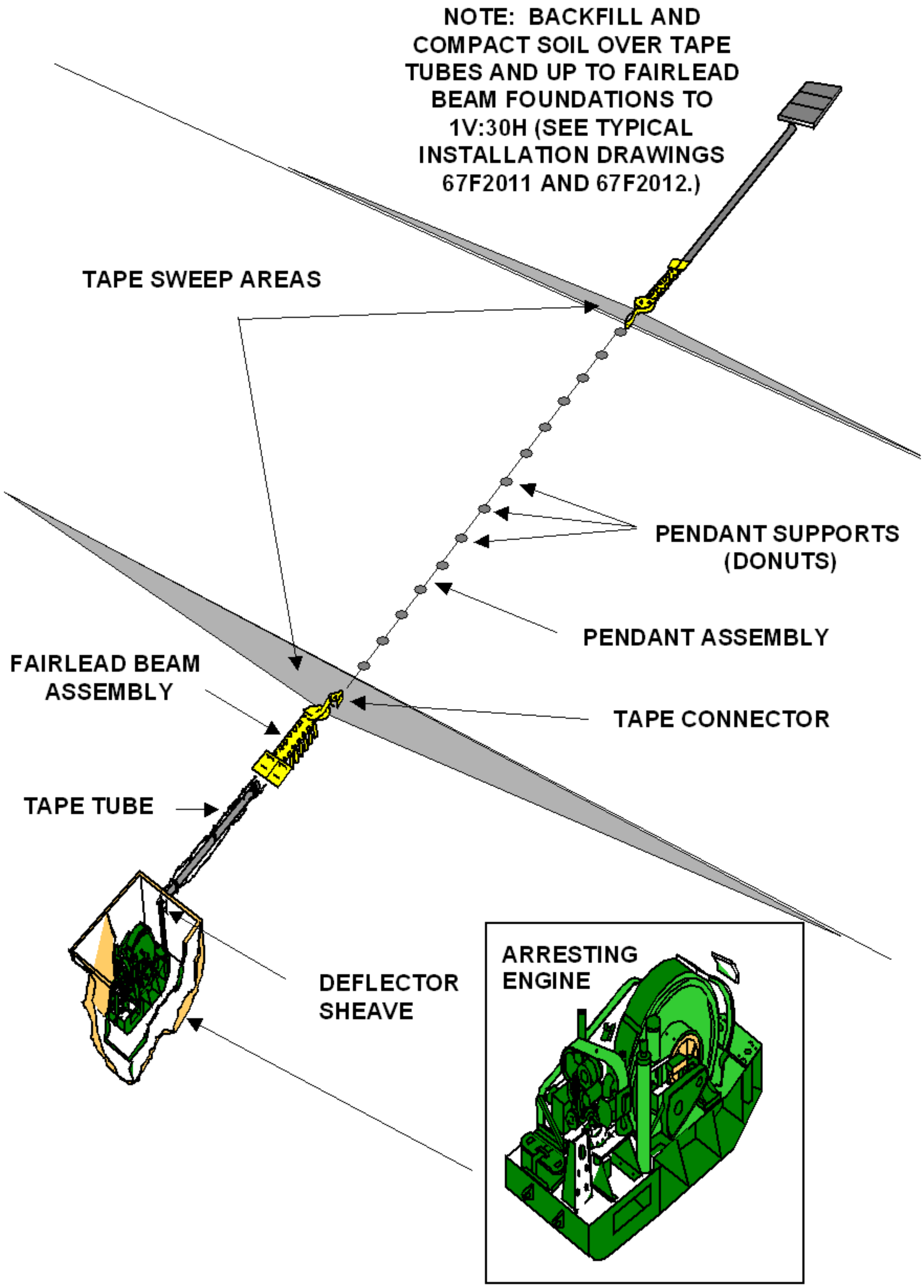
A2.2.4. BAK-12. The BAK-12 (**Figure A2.6.**) is the standard USAF operational aircraft arresting system. This bi-directional system employs 2 energy absorbers. Each absorber consists of 2 multi-disc rotary friction brakes mounted on either side of the purchase-tape reel on a common shaft. The energy absorbers are located on opposite sides of the runway, connected to a 32-millimeter (1.25-inch) disc-supported pendant by the purchase tape. 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 deck 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 1 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 USAF T.O. 35E8-2-5-1, *BAK-12*. Typical installation drawings for pit-type installations (drawing number 67F2012) and semi-permanent installations (drawing number 67F2011) are available from HQ AFCESA/CESC and WR-ALC/LESG.

A2.2.4.1. 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. They retrofitted the energy absorbers with larger 66-inch or 72-inch tape storage reels to accommodate increased runout, thus increasing the total energy capacity of the system. Although some BAK-12 systems have 60-inch tape storage reels, new and upgraded BAK-12 systems (part numbers 52-W-2291-801, 52-W-2291-801A, 52-W-2291-901, and 52-W-2291-901A) have 66-inch reels. These systems require 366 meters (1,200 feet) plus the length of the aircraft for maximum runout. The 72-inch reel systems are special-purpose systems configured for 610 meters (2,000 feet) of runout.

A2.2.4.2. The standard BAK-12 is configured for cross-runway separations of up to 61 meters (200 feet) (distance between fairlead beams or deck 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.s 35E8-2-5-1 and 35E8-2-5-4 to identify the part number for the correct replacement cam and installation procedures. Also, select a pendant length of between 80 and 90 percent of the distance between the fairlead beams to avoid adverse cable dynamics.

A2.2.4.3. 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 4 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 (2,000 feet) of runout. You need special tape connectors and edge sheaves for these installations. For details of these components and other special considerations, see section 8 of T.O. 35E8-2-5-1.

Figure A2.6. BAK-12 Aircraft Arresting System.

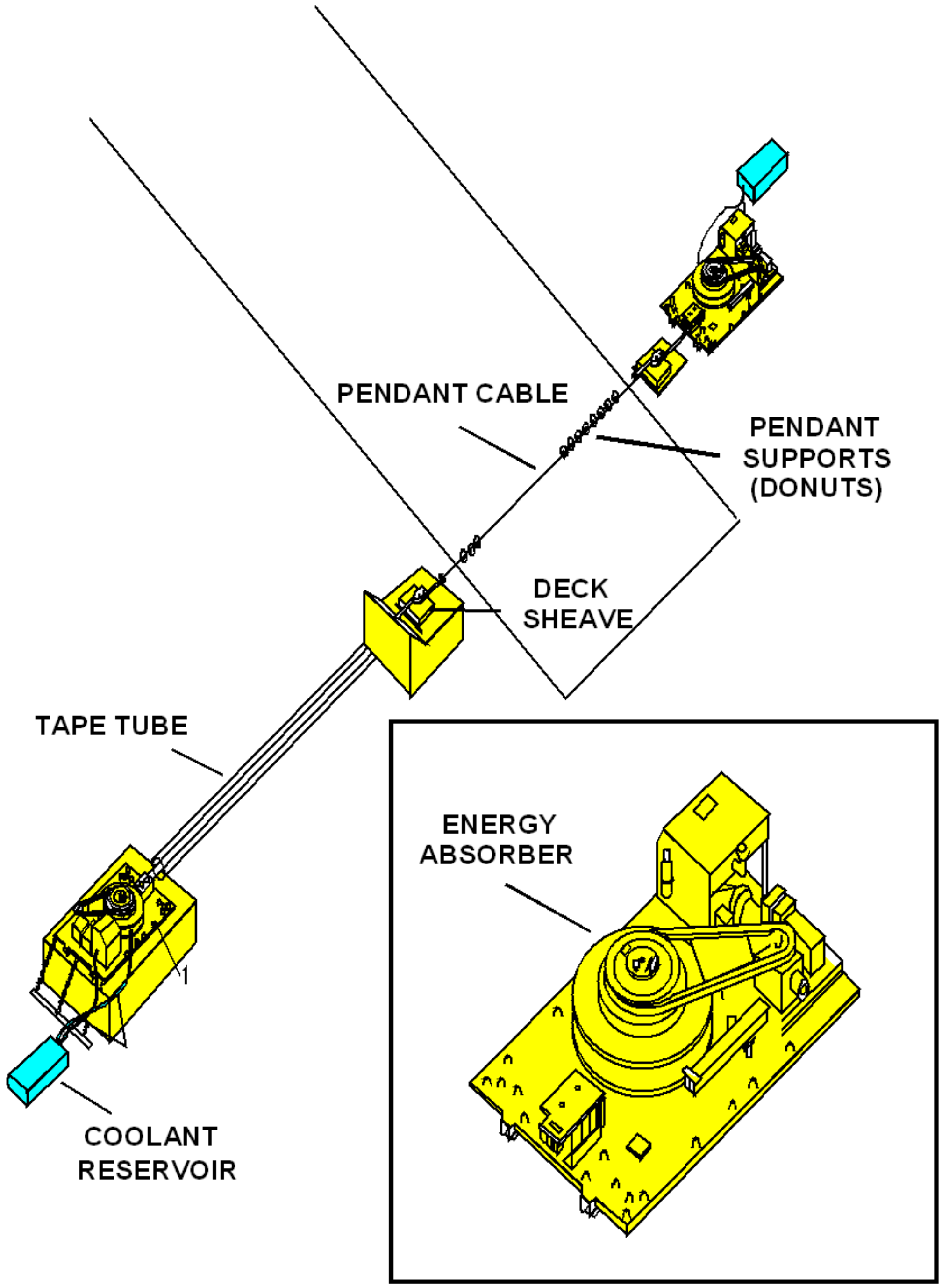


A2.2.5. BAK-13. The BAK-13 (**Figure A2.7.**) is a bidirectional aircraft arresting system. It employs 2 velocity-sensitive energy absorbers installed on opposite sides of the runway, interconnected by nylon purchase tapes and a 32-millimeter (1.25-inch) disc-supported pendant. The energy absorbers are made from a steel weldment base that incorporates a tape-storage reel mounted on a vertical shaft and a vaned rotor assembly enclosed within a vaned stator assembly (also called a tub) that contains a water and glycol mixture. A rewind engine, transmission assembly, and an operator control panel are also included along with necessary hydraulic system components.

A2.2.5.1. The energy imparted during an aircraft arrestment converts to heat through the turbulence developed by rotation of the vaned rotor within the vaned stator. An external cooling reservoir permits rapid cycle of this system.

A2.2.5.2. Siting and grading requirements are provided in section 3 of T.O. 35E8-2-7-11, *Operation and Maintenance Instructions, Aircraft Arresting System, Type BAK-13A/F48A*. The site requirements are essentially the same as for the BAK-12; however, the low-profile units may be located as close as 46 meters (150 feet) from the runway edge if installed in a semipermanent configuration. These systems require 290 meters (950 feet) plus the length of the aircraft for maximum runout. The BAK-13 is not currently in production as a system. It should not be considered as a suitable system for a new requirement due to the potentially high hook loads generated during engagement.

Figure A2.7. BAK-13 Aircraft Arresting System.



A2.2.6. BAK-14 and Type H Hook cable Support Systems.

A2.2.6.1. The BAK-14 hook cable support system (**Figure A2.8.**) is a bidirectional hook cable (pendant) support system used in conjunction with the BAK-12, BAK-13, or a comparable arresting system to engage and safely stop a hook-equipped aircraft. It provides the means to support the pendant at least 2 inches above the runway surface while giving ATC 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 150, 200, and 300 foot-wide runways, but you order the system to suit the specific application. The control side BAK-12 pit or protective shelter and foundation must be expanded to house the compressed air and control systems needed to operate this supplemental system. 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*.

A2.2.6.2. The Type H hook cable support system (**Figure A2.9.**) 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 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 ATC the means to operate the system and to monitor its operational status. It mainly consists of Retraction Modules (from 14 to 18, depending on runway width) 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 that is located in a concrete pit on one side of the runway. Detailed information (Description – Operation – Maintenance – IPL), are provided in AERAZUR Technical Manual 256-722, *Type H45-200 Retractable Hook Cable System*. Installation drawings are available from the manufacturer.

Figure A2.8. BAK-14 Cable Support System.

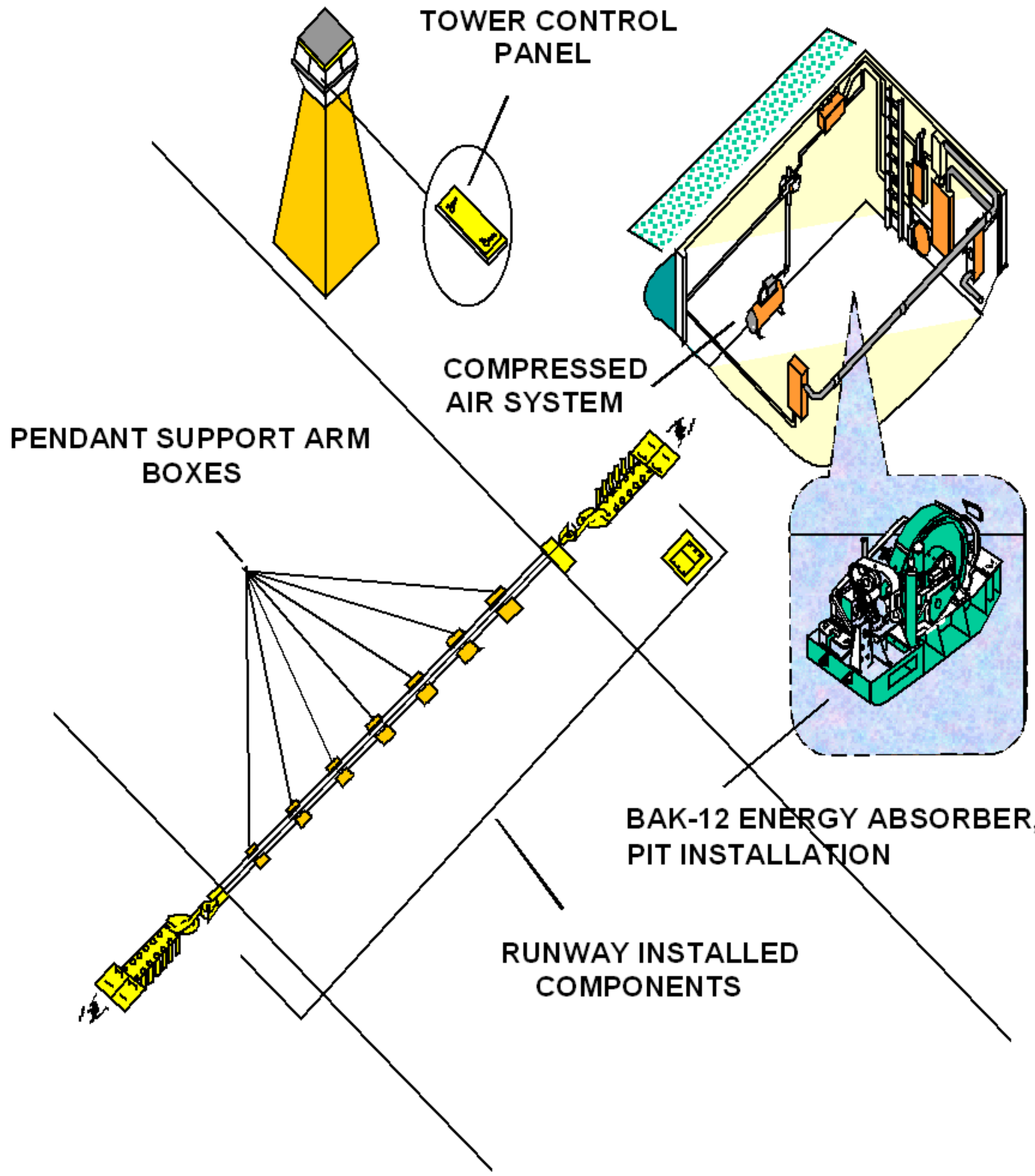
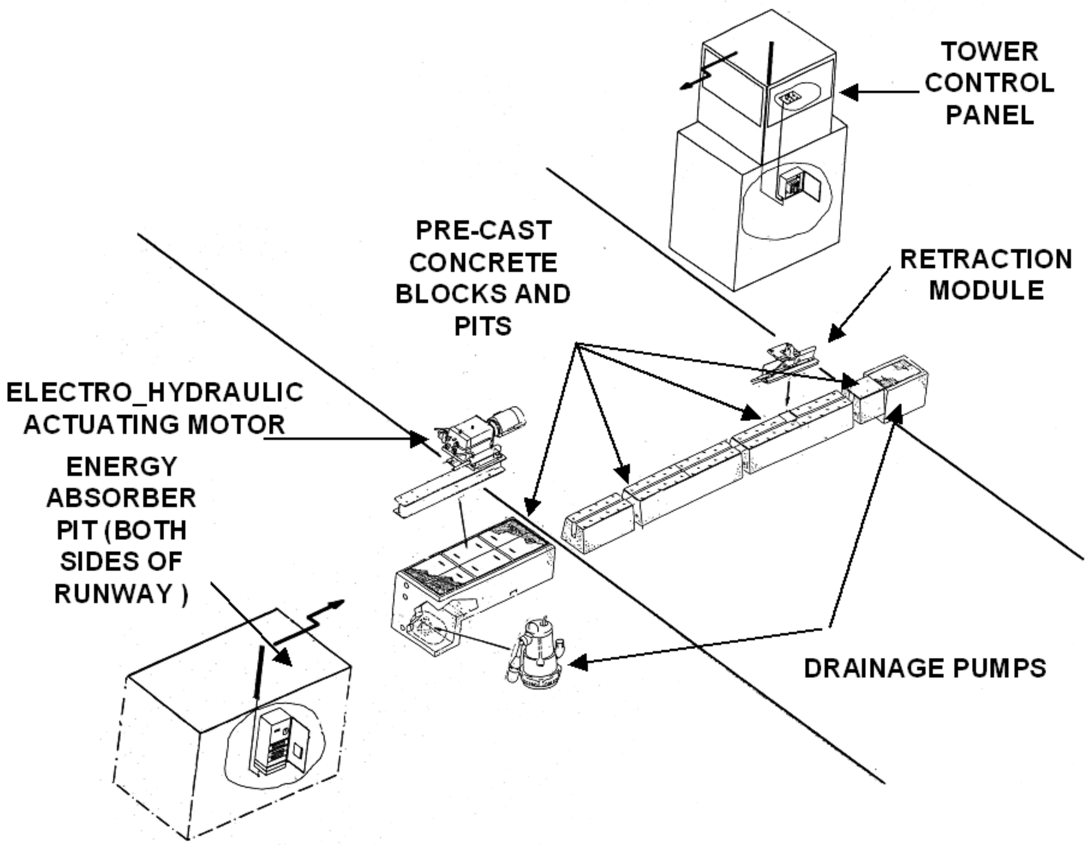


Figure A2.9. Type H Hook Cable Support System.

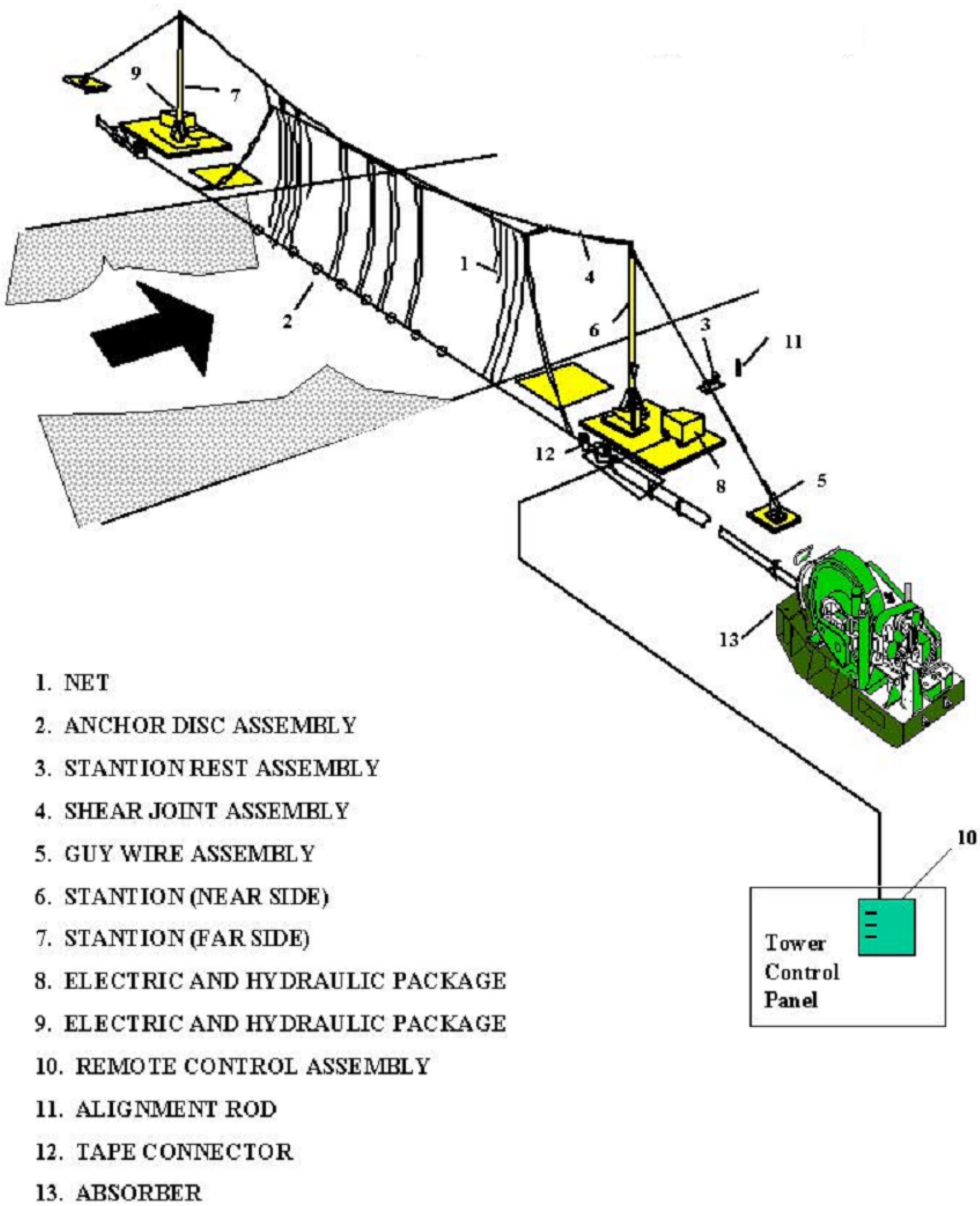


A2.2.7. BAK-15 (61QSII). The BAK-15 aircraft arresting barrier consists of a pair of electrohydraulically powered steel masts that provide support and remote-controlled movement for a unidirectional nylon net barrier (**Figure A2.10.**). The masts are installed on opposite sides of the runway overrun on concrete foundations. The ATC tower contains a remote-control panel, which can be hard-wired but most commonly is radio controlled.

A2.2.7.1. 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.

A2.2.7.2. You can complement the system 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. 35E8-2-9-2, *Maintenance and Operation Instructions, Quick Erect Stanchion System, Models 61QS and 61QSII*. Obtain installation drawings from the manufacturer through the procuring activity at the time of procurement.

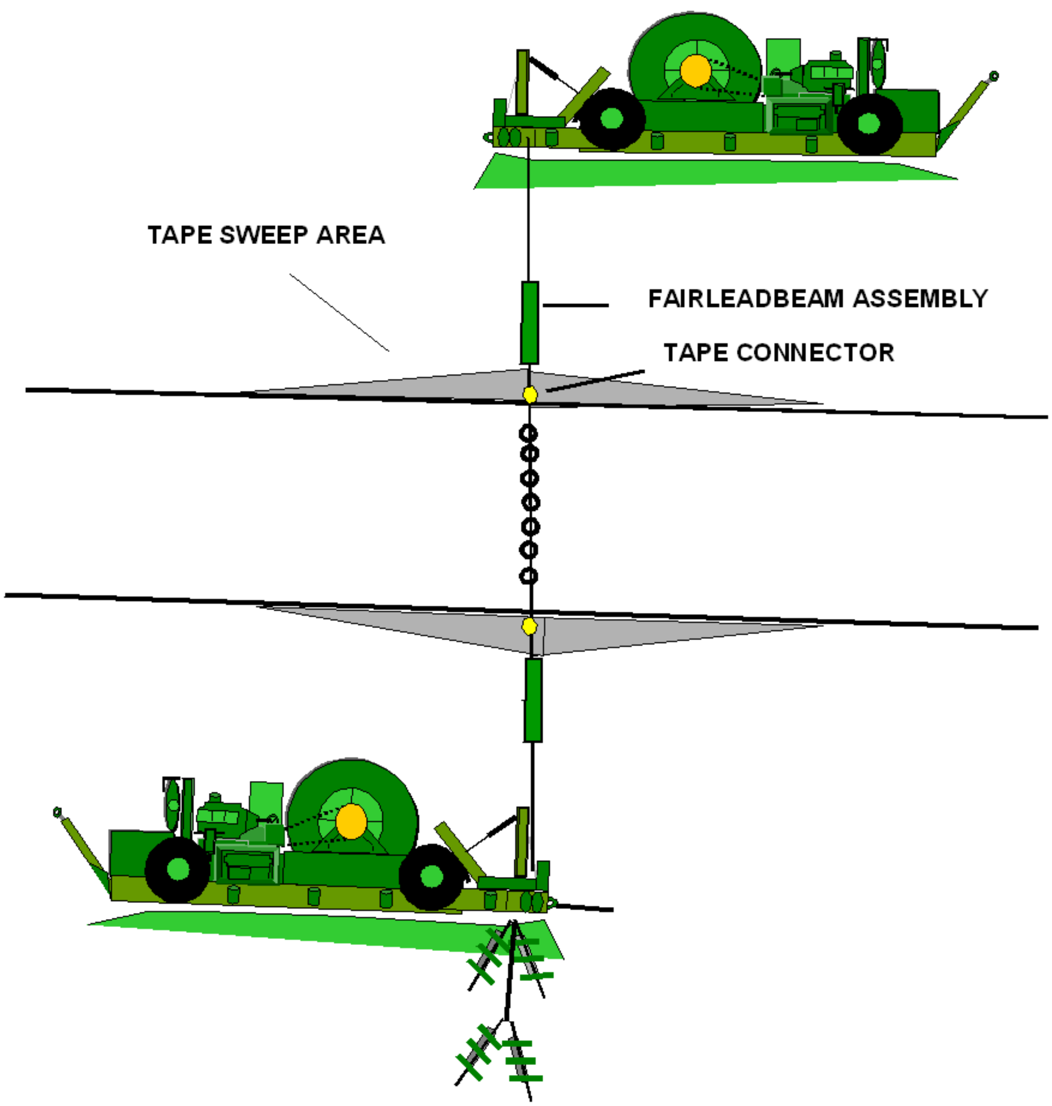
Figure A2.10. BAK-15 Net Barrier (Pictured with BAK-12 Absorbers, BAK-15/12).



A2.2.8. Mobile Aircraft Arresting System (MAAS). The MAAS (**Figure A2.11.**) is essentially a BAK-12 aircraft arresting system 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 the above scenario. When installed for this purpose, the MAAS is installed using a 19-stake anchoring scheme. This configuration is limited to unidirectional engagement capability with a maximum aircraft weight and speed of 18,144 kilograms (40,000 pounds) at 150 knots (**Table A2.1.**). For detailed instructions on this system, refer to T.O. 35E8-2-10-1, *Operation and Maintenance Instructions, Arresting Systems, Aircraft, Mobile.*

Figure A2.11. Mobile Aircraft Arresting System (MAAS) in Set-Back Configuration.



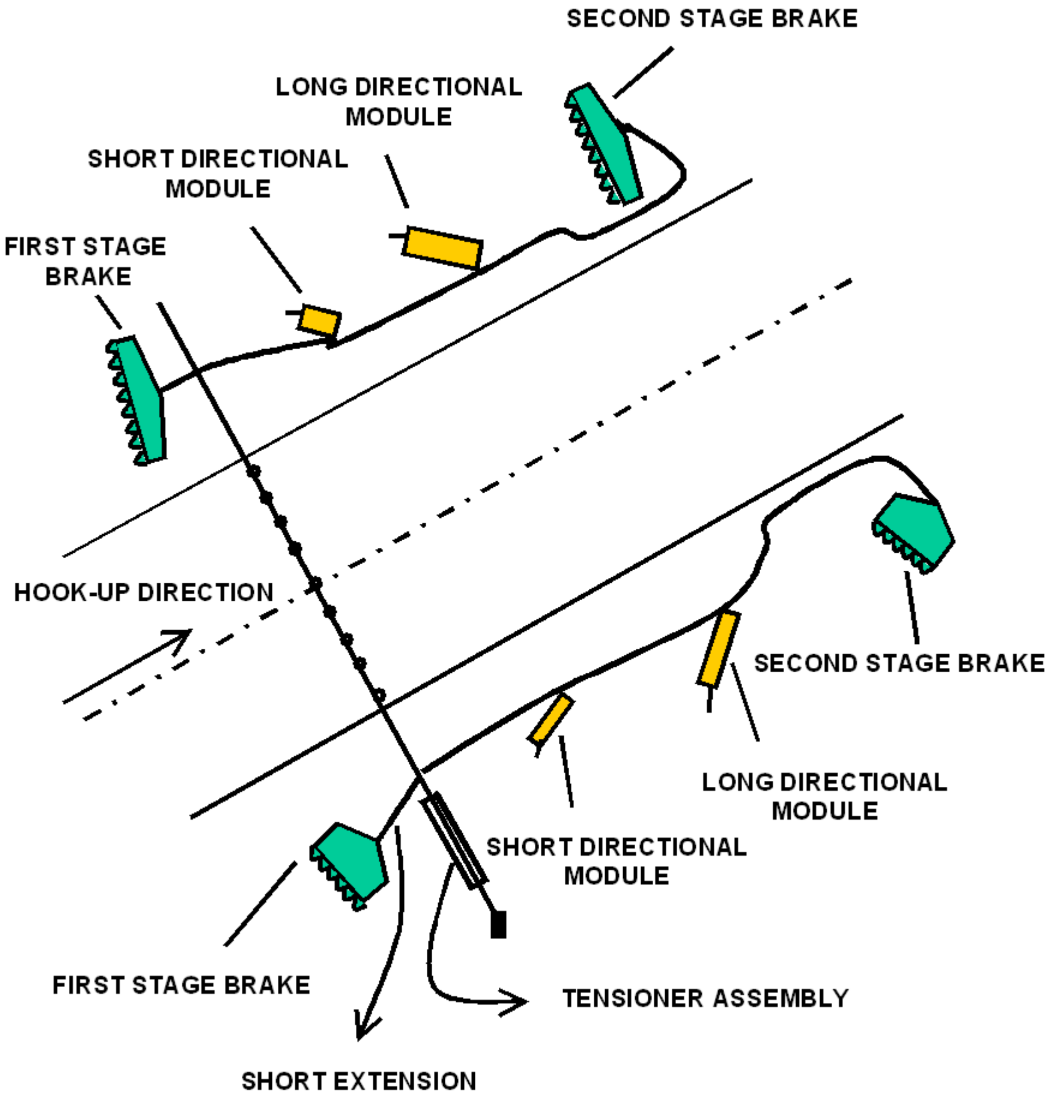
A2.2.9. The MAAS can be upgraded to accommodate bi-directional engagements with the full capacity of a standard BAK-12 aircraft arresting system (**Table A2.1.**). This is accomplished by increasing the total number of cruciform stakes used to anchor the system from 19 to 31, extending the runout to 366 meters (1,200 feet), and synchronizing the system for higher brake pressure. The system may also be installed in a set-back configuration to accommodate wide body aircraft operations through use of a fairlead beam (**Figure A2.10.**). For detailed information, see T.O. 35E8-2-10-1, Section VIII, *Difference Data Sheets*.

A2.2.10. Textile Brake. This modular arresting system is primarily intended as an emergency back up system for standard operational systems. It is comprised of multiple modules arranged in equal numbers on both sides of the overrun 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 positioned across the runway. The system is available in a 2-stage unidirectional configuration (**Figure A2.13.**) or as a single stage bi-directional system (**Figure A2.13.**). See **Table A2.2.** and T.O. 35E8-2-13-1, *Textile Brake and Hook Cable Aircraft Arresting System, Type MB50.9.9.C,* for information on the model MB 60.9.9.C. For information on the MB 100.10.C and MB 100.12.C, see **Table A2.2.** and Aerazur Technical Manuals 256-721, *Textile Brake and Hook Cable Aircraft Arresting System, Model MB 100.10.C,* and 256-726, *Textile Brake and Hook Cable Aircraft Arresting System, Model MB 100.12.C.* Note that the MB 100.12.C can produce hook loads that exceed the working limit for pre Block 40 F-16 aircraft; therefore, it should not be used at installations that host this model aircraft (mission, tenant, or transient support). Block 40 model F-16 and later, are fully compatible with the MB100.12 Textile Brake Arresting System.

A2.2.10.1. The advantages of the 2-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/cable interconnect system. They may also be configured for expeditionary or temporary installations.

A2.2.10.2. 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 or BAK-13), and is not intended for approach end engagements.

Figure A2.12. Textile Brake, Model MB.60.9.9.C.



A2.2.11. Soft-Ground Type Aircraft Arresting Systems. 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 strengths 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) safety area and other alternatives are not feasible. See **Figure A2.14.** 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, *Objects Affecting Navigable*

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

Figure A2.13. Textile Brake, Model MB.100.10.C.

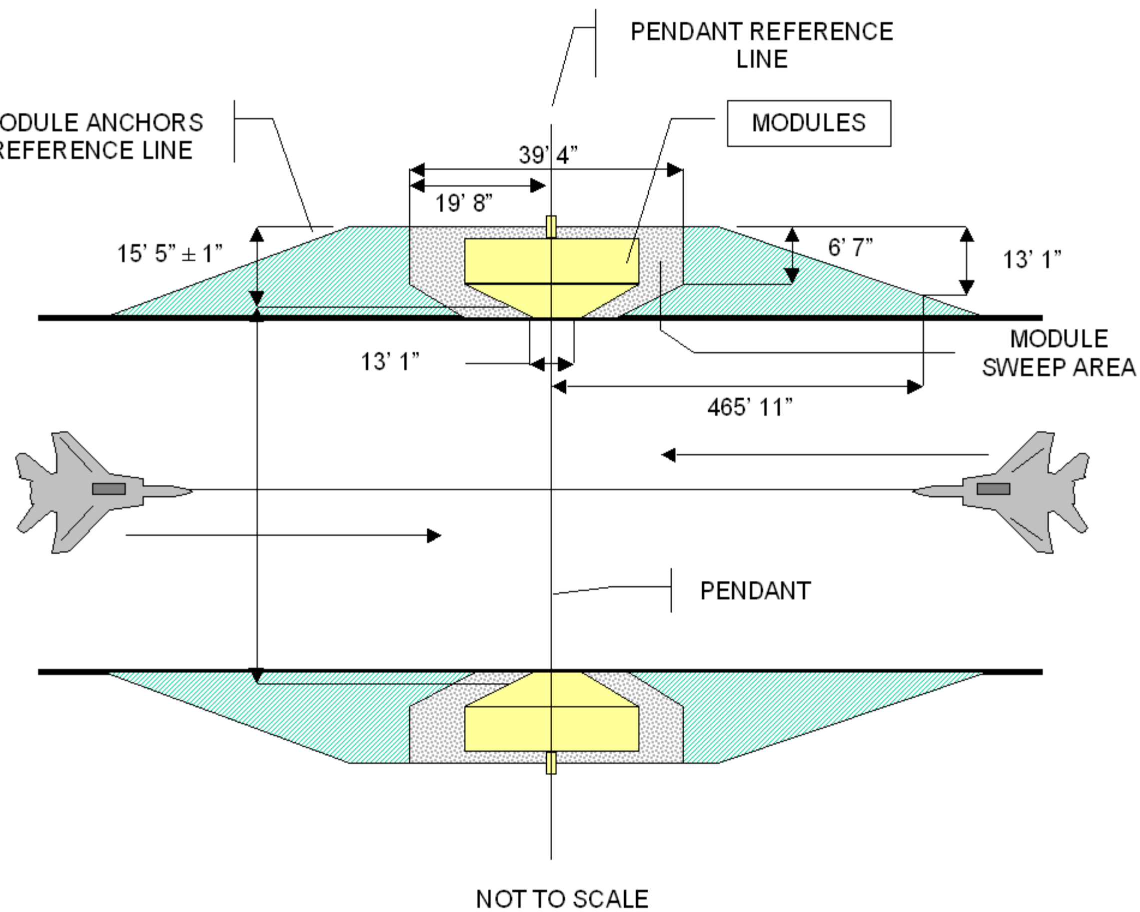
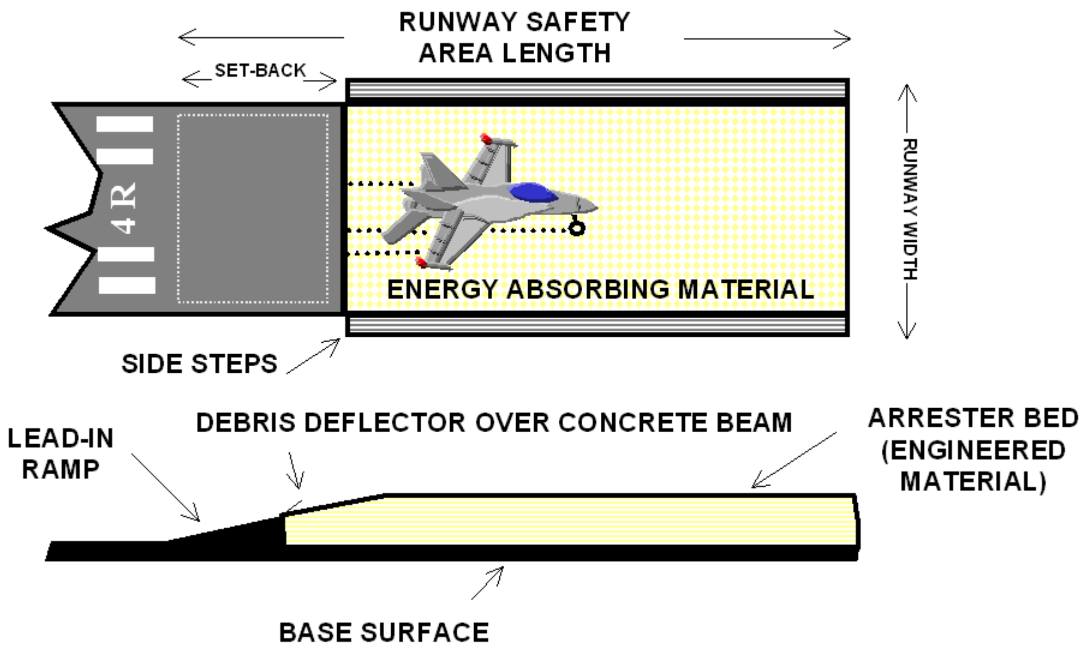


Figure A2.14. Typical Soft Ground Aircraft Arrestor System.



Attachment 3

TYPICAL ARRESTING SYSTEM AND BARRIER CONFIGURATIONS, AND DECOMMISSIONING

A3.1. Configurations. The primary mission aircraft dictates the total number, type, and location of aircraft arresting systems required. The owning MAJCOM of the tailhook-equipped aircraft (or aircraft compatible with net barrier systems) can determine through operational risk management, runway configuration, proximity to other airfields, and other factors, that the typical configuration of both a runway and overrun system may not be required. Use the following examples for guidance:

A3.1.1. A runway intended primarily for operating tactical or training tailhook-equipped aircraft should typically have an emergency system in each overrun and an operational system at each end of the runway for redundant capability. For some locations at forward operating bases or where snow and ice accumulation warrants, however, two operational systems may be necessary for each runway end and a midfield installation may be needed as well.

A3.1.2. Runways that are prime divert facilities for bases operating tactical or training tailhook-equipped aircraft should typically have an emergency system in each overrun and an operational system on each end of the primary runway.

A3.1.3. 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.

A3.2. Decommissioning. If the mission aircraft assigned to an installation does not require an arresting system complex and removal will not have an impact on other USAF activities, consider decommissioning; however, follow coordination procedures in **Chapter 1** first.

Attachment 4

SAMPLE FORMAT FOR THE AIRCRAFT ARRESTING SYSTEMS REPORT

A4.1. Reporting Guidelines.

A4.1.1. The DOD needs an accurate accounting of all aircraft arresting systems to determine worldwide operational capabilities. BCE representatives must ensure that the status and locations of their arresting systems are correct in the Worldwide Aircraft Arresting System Summary and in the DOD FLIP. Report changes in the arresting system array promptly so that others can validate and publish the correction. Report all information in inch-pound units.

A4.1.2. Submit arresting system information to AFCESA at the following address:

HQ AFCESA/CESC

139 Barnes Drive, Suite 1

Tyndall AFB FL 32403-5319

A4.2. Report Contents.

A4.2.1. Submit the following information, along with a diagram similar to the diagram in **Figure A4.1.**:

A4.2.1.1. Base name.

A4.2.1.2. MAJCOM or sponsor.

A4.2.1.3. Runway designations

A4.2.1.4. System type (see **Attachment 2**).

A4.2.1.5. Length of runway to the nearest 100 feet (threshold to threshold).

A4.2.1.6. Width of runway, in feet.

A4.2.1.7. Length of overrun, in feet (threshold to end of overrun).

A4.2.1.8. 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).

A4.2.2. Describe the arresting system installation characteristics for each system indicated on the airfield scheme using the following notations:

A4.2.2.1. AG—above ground.

A4.2.2.2. BG—below ground.

A4.2.2.3. EX1—expeditionary system (BAK-12).

A4.2.2.4. EX2—expeditionary system (MAAS).

A4.2.2.5. IC—barrier interconnected with a hook cable.

A4.2.2.6. RR—remote radio control.

A4.2.2.7. RH—remote hard-wired control.

A4.2.2.8. MO—manually operated barrier (raised and lowered).

A4.2.2.9. Z—owned by another service, country, or agency.

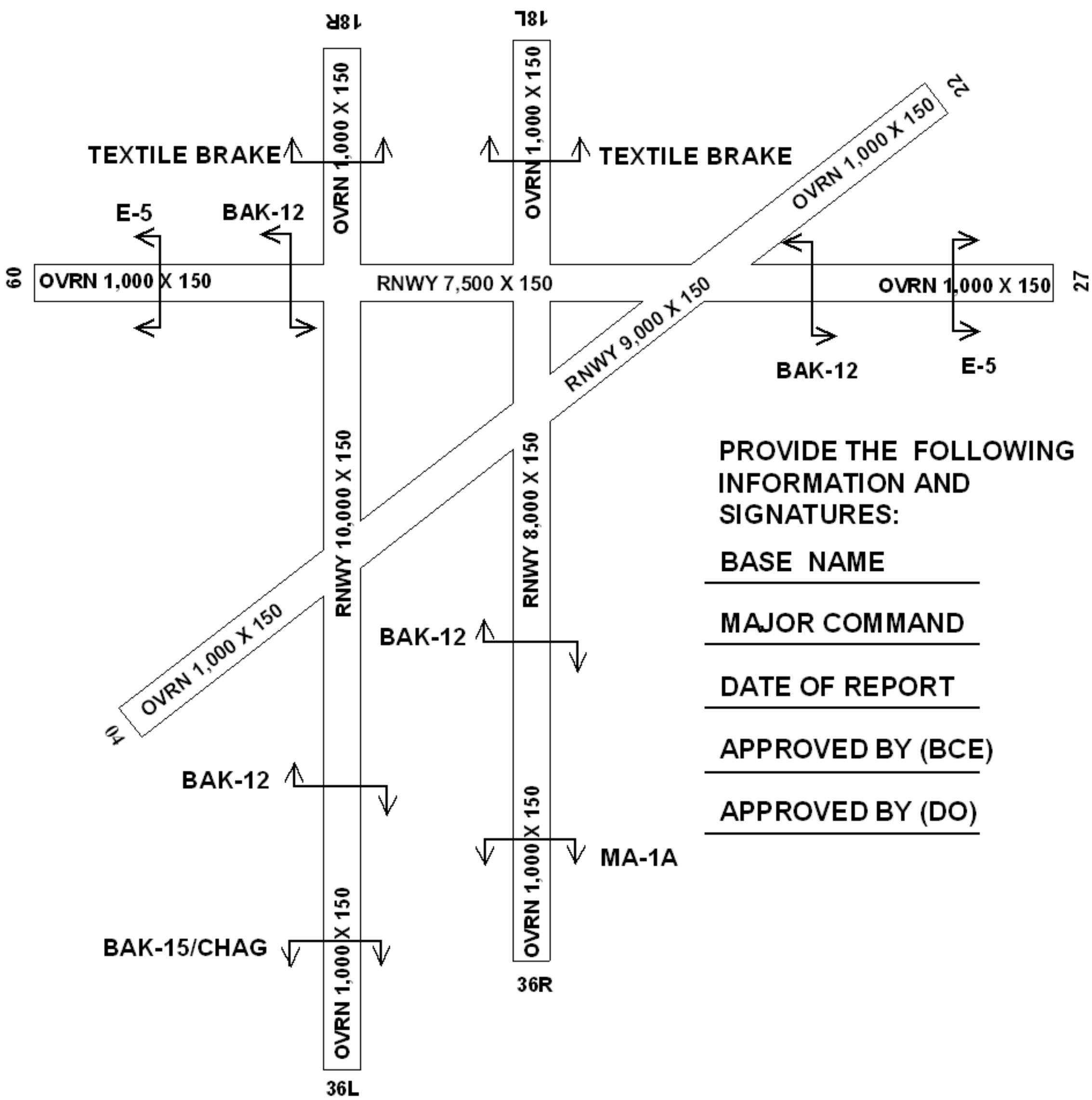
A4.2.2.10. O—out of service, inoperative.

A4.2.2.11. SR—950 feet runout.

A4.2.2.12. ER—1,200 feet runout.

A4.2.2.13. NSR—nonstandard runout (indicate runout in feet following code entry).

Figure A4.1. 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).

Attachment 5

SAMPLE LETTER OF AGREEMENT WITH THE FEDERAL AVIATION ADMINISTRATION (FAA)

AGREEMENT: The (FAA office and address) and (designated command) 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 governs the use of arresting barriers and hook cable arresting systems for military aircraft and, in an emergency, for civil aircraft at pilot request.

This agreement becomes effective when the tower chief receives written notice from the base commander that one of these situations applies:

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 deenergizes 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.

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 base operations officer, 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 the NOTAM outages due to failure of controls or when tower personnel advise of malfunction of the system (see paragraph A5.2.8 for notice), 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 base operations immediately.

Executed at________________ Dated__________________________

For the FAA For the Air Force

__________________________ ______________________________

(Signed) (Signed)

__________________________ ______________________________

(Title) (Title)

Attachment 6

EFFECTIVE PENDANT HEIGHT (EPH)

A6.1. General.

A6.1.1. Pendant discs must have proper pavement support to ensure adequate clearance between the underside of the pendant cable and the runway surface. Adequate clearance increases the probability that the aircraft tailhook will successfully engage with the arresting system pendant cable.

A6.1.2. The term for this clearance is the effective pendant height (EPH). The EPH is the vertical distance (in millimeters or inches) from the underside of the pendant to a projected surface representing the original runway surface. The EPH for an undamaged or ungrooved runway surface is approximately 60 millimeters (2.38 inches) for a 32-millimeter (1.25-inch) pendant cable and 64 millimeters (2.5 inches) for a 25-millimeter (1.0-inch) cable.

A6.2. EPH Measurements. 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 A6.1.**). Manufacture the tool locally for use by the power production shop.

A6.2.1. Start measuring when you notice pavement erosion or grooving, and repeat measurements at least monthly. As the EPH approaches 38 millimeters (1.5 inches), take and record measurements daily.

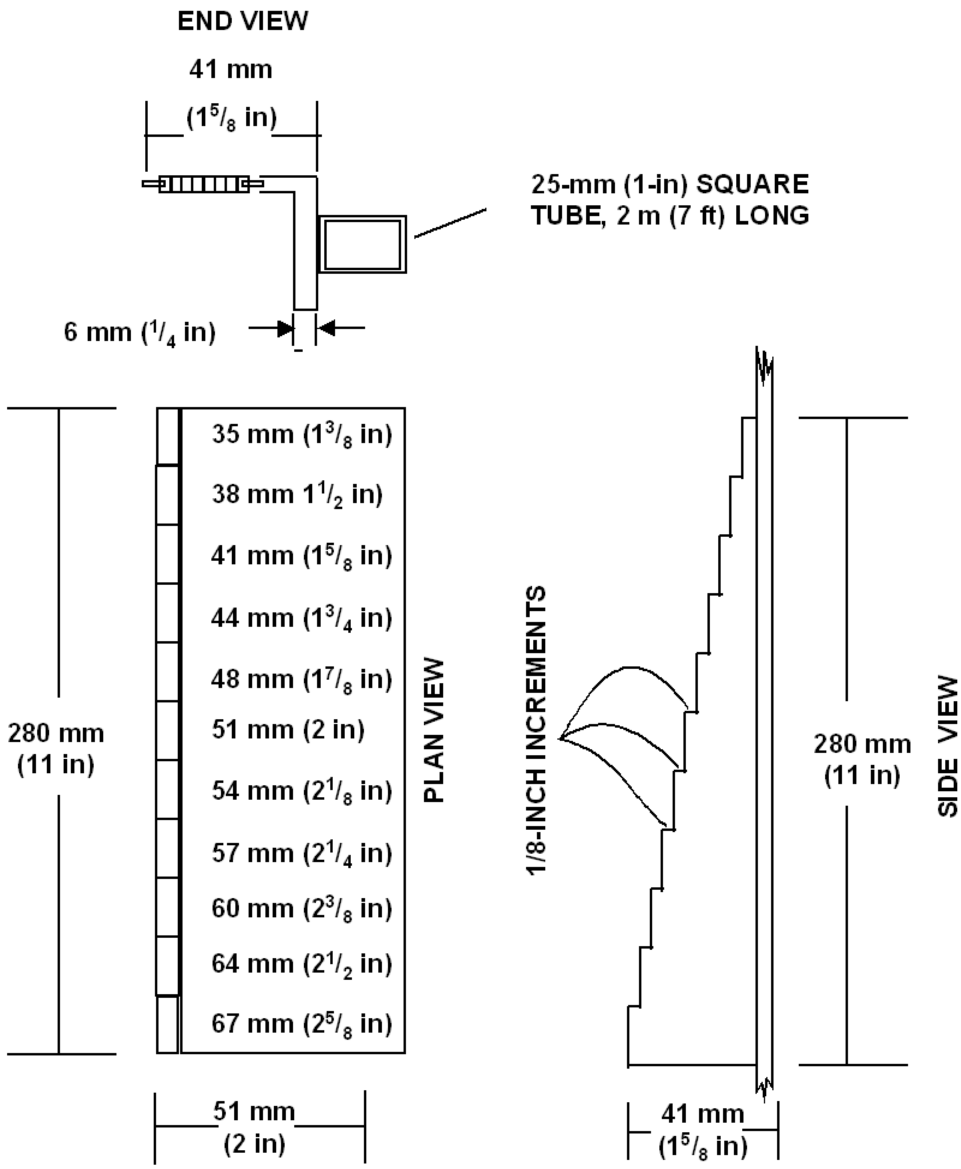
A6.2.2. Record EPH measurements in the arresting system maintenance log, using a sketch to demonstrate the EPH values and the distance to the location where the measurement was taken. Indicate the distance to the left and right of the runway centerline facing the runway approach.

A6.2.3. Arresting system maintenance personnel must notify the commander's designated representative when EPH measurements become necessary. Provide status reports as changes to the EPH occur.

A6.3. Pavement Repairs. 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).

A6.4. Notification of Reduced Engagement Reliability. When the EPH falls to less than 38 millimeters (1.5 inches), ask the airfield manager to issue an airfield advisory notifying pilots of the reduced arresting system reliability.

Figure A6.1. Effective Pendant Height Measuring Tool.



EPH MEASURING TOOL CONSTRUCTED FROM 51-mm (2-in) ANGLE STOCK

(NOT TO SCALE)

Attachment 7

OBTAINING A TEMPORARY ARRESTING SYSTEM

A7.1. For CONUS locations, submit requests for temporary use of expeditionary aircraft arresting systems to Headquarters Air Combat Command (HQ ACC) at least 2 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 (ANG/CETSC), Minot ND). Typically, HQ ACC only considers requests to support CONUS locations. Coordinate overseas requirements through the appropriate MAJCOM (US Central Command (CENTAF), PACAF, or USAFE). Give the following information in all requests:

A7.1.1. Number of systems you need.

A7.1.2. Reason you need the systems (including type of aircraft).

A7.1.3. Geographic location of the requirement.

A7.1.4. Date you need the systems to be operational.

A7.1.5. Date the systems can be removed.

A7.1.6. Point of contact and telephone number.

A7.2. In the request, specify the intended source and the number of qualified personnel who will operate and maintain the expeditionary system at the site. Qualified personnel must attend the systems during all hours of intended operation.

A7.3. The requesting activity must provide a fund citation to cover all costs associated with supporting the expeditionary installation. Include costs for:

A7.3.1. Shipment of the equipment.

A7.3.2. Temporary duty.

A7.3.3. Expendable materials.

A7.3.4. Repair or replacement of damaged items.

A7.3.5. Installation of equipment.

A7.4. Send the information to the appropriate MAJCOM at one of the addresses below:

HQ ACC/CEOI 129 Andrews Street Langley AFB VA 23665-2769	USCENTAF/A1-CEX 524 Shaw Drive Shaw AFB SC 29152-5029	ANG/CETSC 3230 2nd St NE Minot ND 58701-0527
HQ USAFE/CEOI Unit 3050 Box 10 APO AE 09094-3050	HQ PACAF/CEOO 25 E Street Hickam AFB HI 96853-5412	

A7.5. The appropriate MAJCOM evaluates each request on the basis of availability of personnel, equipment, and priority. It approves or disapproves requests within 10 working days.

Attachment 8

INSTALLATION OF ULTRA-HIGH-MOLECULAR-WEIGHT (UHMW) POLYETHYLENE PANELS UNDER AIRCRAFT ARRESTING SYSTEM CABLES (CONUS INSTALLATIONS)

A8.1. Purpose. This attachment provides instructions for installation of UHMW polyethylene panels under aircraft arresting system cables. It includes panel specifications and installation and inspection guidelines.

A8.2. Application. Requirements of this guide are mandatory for new construction. Designers should also consider thickened slabs under UHMW panels for new construction. Installation of UHMW panels is the preferred method of repair for existing pavements. Other repair options may be justified based on economy or mission.

A8.3. Specific Requirements. Aircraft arresting system cables impact underlying pavement, eroding grooves in the pavement; the pendant support disks (donuts) supporting the cable sink into the grooves, lowering the cable. When the EPH is below 38 millimeters (1.5 inches), the aircraft tailhook may miss the cable. These areas must be repaired to maintain a uniform pavement surface and the proper EPH to ensure reliability of the arresting system.

A8.4. Criteria for Repairs:

A8.4.1. Materials must (1) install easily; (2) not warp or erode.

A8.4.2. Method must be cost-effective.

A8.5. Options for Repair .

A8.5.1. Bonded Partial-Depth Inlays. The Air Force has used numerous cementitious, epoxy, and polyurethane-based materials under arresting system cables. Performance varies from satisfactory to very poor, even with the same material. Most of these repairs have been costly and/or eroded quickly.

A8.5.2. Preformed Panels. The Air Force has tested non-UHMW preformed panels with only limited success: panels warp and their edges protrude above the adjacent runway pavement, causing the aircraft tail-hook to skip over the cable. It is absolutely critical to keep panels flush, or preferably slightly recessed (1.6 to 3.2 millimeters [$^1/_{16}$- to $^1/_8$-inch]) below the adjacent pavement surface. Thermal compatibility of the panel material, the anchoring system, and the adjacent pavement is extremely important.

A8.5.2.1. When considering the installation of UHMW panels, it is important to verify thickness of the existing pavement. The panels must be anchored in a solid concrete bed. A typical anchor stud is 245 millimeters ($9^5/_8$) inches long and the receiving slot is drilled slightly deeper. A minimum slab thickness of 280 millimeters (11 inches) is recommended to properly anchor the panels.

A8.5.2.2. If the existing concrete is not thick enough, consider replacement with adequate thickness concrete prior to UHMW panel installation or alternative repair methods.

A8.5.3. For installation in asphalt pavement, saw-cut and remove a 635-millimeter (25-inch) wide section of the asphalt as well as the 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. Then pour the concrete foundation (approximately 570 millimeters [22.5 inches] thick) for panel installation. Care must be taken to ensure that the concrete foundation is finished level enough and at the proper depth for panel installation. Once the concrete is cured, proceed with installation and anchoring of panels as outlined in this publication.

A8.6. Technical Specifications for UHMW Polyethylene Panels.

A8.6.1. Referenced Documents. ASTM Standards:

A8.6.1.1. D256-02, *Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics*, Test Method A.

A8.6.1.2. D638-02, *Standard Test Method for Tensile Properties of Plastics*.

A8.6.1.3. D696-98, *Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between –30 Degrees Celsius and 30 Degrees Celsius with a Vitreous Silica Dilatometer*.

A8.6.1.4. D1505-98e1, *Standard Test Method for Density of Plastics by the Density-Gradient Technique*.

A8.6.1.5. D3028, *Standard Test Method for Kinetic Coefficient of Friction of Plastic Solids* (Discontinued 2000).

A8.6.1.6. D2240-02a, *Standard Test Method for Rubber Property—Durometer Hardness*.

A8.6.2. Panel Dimensions and Anchor Stud Locations.

A8.6.2.1. Panel Dimensions. Tolerance on panel length and width will be +/-3.2 millimeters ($^1/_8$ inch). Panel thickness will not be greater than 38.1 millimeters ($1^1/_2$ inches) or less than 36.5 millimeters ($1^7/_{16}$ inch).

A8.6.2.2. Anchor Stud Hole Locations and Dimensions. Each full-sized panel will have 6 anchor stud holes centered 102 millimeters (4 inches) from the edge of the panel. Each half-sized panel will have 4 anchor stud holes centered 102 millimeters (4 inches) from the edge of the panel. The anchor stud hole will be 1 inch for the through hole and 51 millimeters (2 inches) for the countersink hole. The countersink hole will be 22 millimeters ($^7/_8$-inch) deep with square shoulders for a flat washer to lay firmly against. **Figure A8.1.** shows dimensions and drilling details. Tolerances on dimensions for locations and diameters of anchor holes will be ± 1.6 millimeters ($^1/_{16}$-inch).

A8.6.3. Holes for Cable Tie-down Anchors. The agency ordering panels will specify if cable tie-down anchor holes are required and will specify the number of panels that will be furnished with cable tie-down anchor holes. The cable tie-down anchor hole will be 102 millimeters (4 inches) in diameter and will be drilled completely through the panel. Cable tie-down anchor holes will be located in the center of the panel. The location of the cable tie-down anchor hole is shown in **Figure A8.1.** The number of tie-down anchors required should be provided by the MAJCOM aircraft arresting system engineer. Cable tie-downs will not be located closer than 610 millimeters (2 feet) from existing pavement joints. Half-sized panels will not receive holes for cable tie-down anchors.

A8.7. Material.

A8.7.1. The panels will be fabricated from virgin and/or recycled UHMW polyethylene and will be black in color and be UV-stabilized. An antistatic additive will be added to the UHMW polyethylene.

A8.7.2. The UHMW polyethylene must meet the physical requirements of **Table A8.1.**

Table A8.1. Physical Requirements of UHMW Polyethylene.

Property	Test Method	Requirement
Density	ASTM D1505	0.92 – 0.94 g/cm
Tensile elongation at break	ASTM D638	400 – 500 percent
Tensile yield strength	ASTM D638	2,800 – 4,000 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 2 opposing 15-degree notches.

A8.8. Guidelines for Panel Sizing and Preparation .

A8.8.1. Panel Dimensions: Uncut panel stock is 1,220 millimeters (48 inches) wide by 3,048 millimeters (10 feet) long by 38 millimeters ($1^1/_2$ inches) thick. Size panels to avoid material waste.

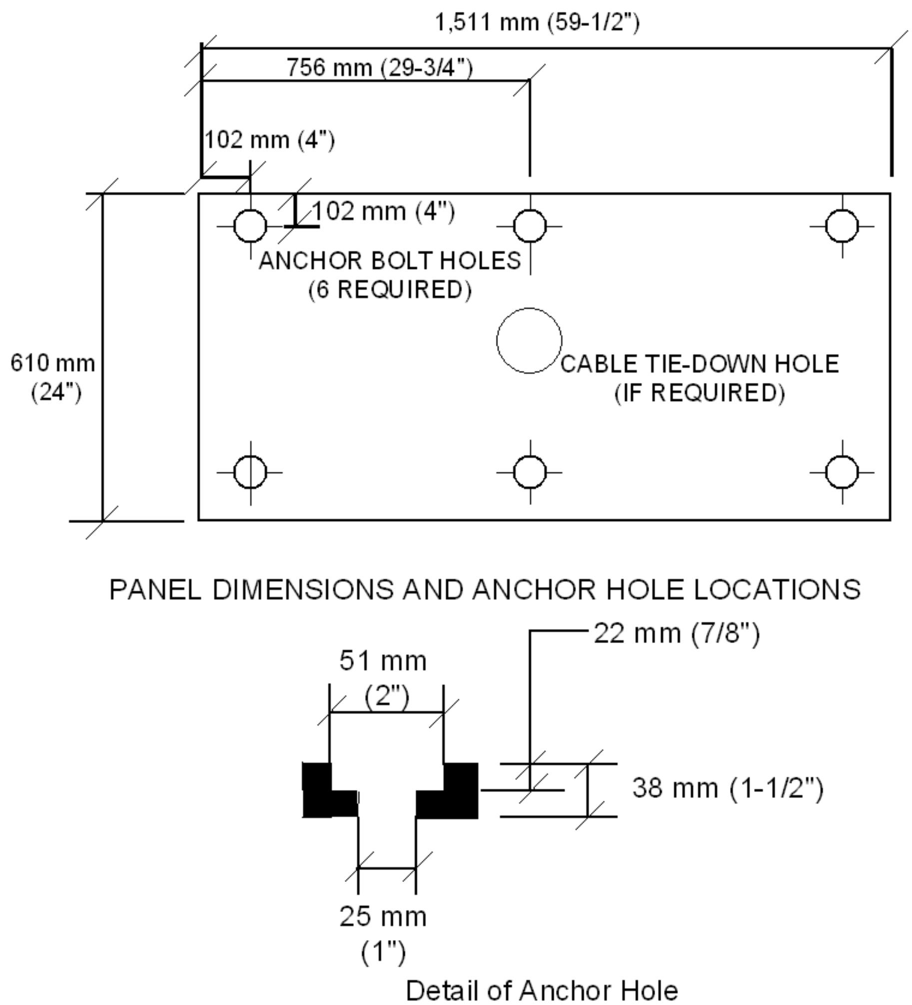
A8.8.2. Length. Cut panels to allow joints between panels to line up with runway pavement joints. For runways with slabs sized in 1,524-millimeter (5-foot) increments, such as those having 6-meter (20-foot) or 7.6-meter (25-foot) longitudinal paving lane joint spacing, panels should be 1,511 millimeters (4 feet, $11^1/_2$ inches) long. (Two panels can be cut from the 3,048-millimeter [10-foot] long stock with minimal waste.) Panels may be shorter, but must never exceed 1,524 millimeters (5 feet). Recommended joint space between panels is 13 millimeters ($^1/_2$ inch). In all cases, particularly at overseas installations, the existing slab sizes should be verified before ordering materials and the panels should be sized so that the joints between panels line up with the existing pavement joints. Panels should never straddle pavement joints and should not be positioned in a way that would allow the anchor studs to fall in existing pavement joints.

A8.8.3. Width. To reduce panel warping and damage to joints from cable impact, panels should be a nominal 610 millimeters (24 inches) wide for all installations.

A8.8.4. Thickness. Panel thickness should not be less than 36.5 millimeters ($1^7/_{16}$ inches) nor more than 38.1 millimeters ($1^1/_2$ inches).

A8.8.5. Panel Finishing. The panel supplier should predrill holes in panels (for anchor stud installation) in accordance with **Figure A8.1.**

Figure A8.1. Panel Dimensions and Anchor and Tie-down Locations.



A8.8.6. The MAJCOM aircraft arresting system engineer will specify the required number and spacing of tie-down anchors. If cable tie-down anchors are used, the supplier should predrill panel centers with 102-millimeter (4-inch) diameter holes to allow anchor installation.

A8.9. Guidelines for Pavement Preparation and UHMW Panel Installation.

A8.9.1. The procedure to install UHMW panels under arresting system cables involves the following major steps:

A8.9.1.1. Preparing the receiving slot.

A8.9.1.2. Placing a cementitious setting bed.

A8.9.1.3. Installing the UHMW panels.

A8.9.1.4. Installing panel anchor studs.

A8.9.1.5. Installing new cable tie-down anchors (if required).

A8.9.1.6. Sealing the joints.

A8.9.2. Preparing the Receiving Slot.

A8.9.2.1. Remove Concrete. Dimensions of the area of concrete removed depend upon the number of panels installed. For example, if each panel is 1,511 millimeters ($59^1/_2$ inches) long by 610 millimeters (24 inches) wide, the gap between panels is 13 millimeters ($^1/_2$ inch). Therefore, for a 12-meter (40-foot) long inlay of 8 panels (across the runway, 6 meters [20 feet] on each side of the runway centerline), the saw cut area must be:

A8.9.2.1.1. 12.2 meters (40 feet, $^1/_2$ inch) long

A8.9.2.1.2. 635 millimeters (25 inches) wide

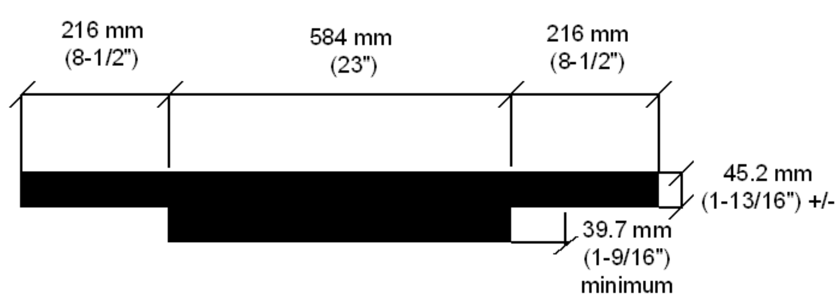
A8.9.2.1.3. At least 64 millimeters ($2^1/_2$ inches) deep.

A8.9.2.1.4. An installation extending completely across a 46-meter (150-foot) wide runway requires 30 panels.

A8.9.2.2. Perimeter Cuts. 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.

A8.9.2.3. Inspect Receiving Slot Following Concrete Removal. With a notched board (**Figure A8.2.**), check the depth of the concrete within the recessed setting bed. Use a chipping hammer to remove any portions less than 64 millimeters ($2^1/_2$ inches) from the surface of the adjacent pavement. Then check the concrete visually; sound it with a steel rod to identify any unsound portions; and remove all unsound concrete.

Figure A8.2. Notched Board Used to Check the Receiving Slot.



A8.9.2.4. Remove Existing Tie-down Anchors. Cut existing aircraft arresting system cable tie-down anchors flush with the bottom of the concrete substrate before placing the setting bed.

A8.9.2.5. Clean Concrete Substrate. Upon removal of concrete from the slot, it is important to adequately clean the slot to ensure that 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 sawcut walls. Sandblast or use wire brushes, followed by compressed air.

A8.9.3. Placing 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 Portland cement concrete; airfield strength (34,474 kPa [5,000 psi] compression/4,482 kPa [650 psi] flexural strength in 28 days) when several hours' cure time is available.

A8.9.3.1. As a suggested mix, use:

A8.9.3.1.1. A lean 7-bag mix with10-millimeter ($^{3}/_{8}$-inch) maximum size aggregate.

A8.9.3.1.2. Water-to-cement ratio not to exceed 0.3 : 1.

A8.9.3.1.3. Plasticizer admixture.

A8.9.3.1.4. Substitute fly ash for -50 sieve size sand as required.

A8.9.3.1.5. 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 will yield approximately 0.014 m^3 (0.5 cubic foot) of concrete when mixed with water (refer to **Table A8.3.** 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.

A8.9.3.2. Mixing Equipment Placement. Position 2 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 material used, drum mixers may not agitate the material enough to produce the desired workability when the recommended amount of water is used.

A8.9.3.2.1. Mixing and Placing Procedure for 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.

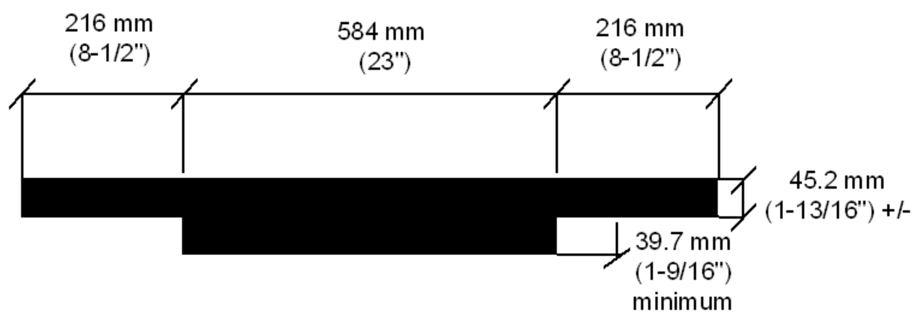
A8.9.3.2.2. Add 1 bag of Rapid Set Concrete Mix and mix for 2 to 3 minutes. Place the material within 10 minutes after mixing. If temperature is above freezing, wet the substrate first. If below freezing, do not wet the substrate.

A8.9.3.3. Finish the material from the center of the bed to the edges to achieve proper bonding along the side walls of the excavation.

A8.9.3.4. After initial set, when the surface becomes hard to the touch, fog or spray mist cure with water for one hour. 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.

A8.9.4. Leveling the Setting Bed. Mechanically vibrate or jitterbug the concrete before screeding 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 A8.3.**). Strike the screed periodically to ensure proper depth and uniform surface. The 39.7-millimeter ($1^{9}/_{16}$-inch) depth of the screed board is based upon a panel thickness of 38 millimeters ($1^1/_2$ inches). Measure the actual thickness of each panel upon delivery to ensure that 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 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 A8.3. Notched Screed.



A8.9.5. 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.

A8.10. Installing UHMW Panels. Install panels in accordance with the following:

A8.10.1. Allow the setting bed to harden (approximately 4 hours, depending on the type bed used) to the minimum strength that allows drilling without spalling the concrete.

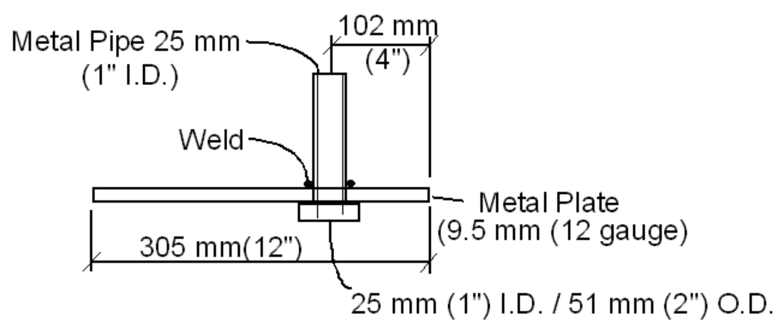
A8.10.2. Lay the panels in place and inspect to ensure that the top surface of the panel is at least 1.6 millimeters ($^1/_{16}$-inch) lower than the adjacent pavement surface. Grind the bedding material or panel edges as necessary so that the panel surface is slightly recessed (1.6 to 3.2 millimeters [$^1/_{16}$ to $^1/_8$ inch]) below the adjacent pavement surface. Panel height is especially critical in the center half of the runway.

A8.10.3. Set spacing between panels using a13-millimeter ($^1/_2$-inch) thick board and secure all panels in place with wood wedges (minimum 4 sets per panel) to prevent panels shifting during drilling of anchor stud holes. UHMW panels contract and expand greatly with temperature changes. The panels should be placed and anchored at the medium temperature for the given location to allow for movement either way with temperature changes.

A8.11. Installing Panel Anchor Studs. (For a list of required tools and equipment, reference **Table A8.2.**)

A8.11.1. Drill Holes. Position locally fabricated alignment tool (**Figure A8.4.**) over each predrilled hole in the panel and drill 22-millimeter ($^7/_8$-inch) diameter holes in 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 hole depth 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 A8.4. Alignment Tool (Anchor Drill Guide).



A8.11.2. Clean Drilled Holes. Thoroughly clean debris from the drilled hole with a round wire brush and compressed air. A 9- to 13-millimeter ($^3/_8$- to $^1/_2$-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 to ensure all particles are removed.

A8.11.3. Install Anchor Studs. Install each anchor stud as described below. To avoid work stoppage while adhesive cures, have at least 12 cap nuts available for setting anchors.

A8.11.3.1. 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 countersink. Drive the anchor stud slowly to the end of the hole and continue slowly rotating the stud in the hole for approximately 15 seconds to mix the adhesive and work it up the anchor. Once the anchor stud is in position, do not disturb it until the adhesive is cured. Allow the adhesive to cure (approximately 1 hour or as recommended by the manufacturer) to the point where the cap nut can be removed without disturbing the stud position.

A8.11.3.2. Remove cap nut and flat washer; seal around stud with silicone sealant; reinsert flat washer; attach lock washer and nut to top of anchor stud.

A8.11.3.3. Allow adhesive to fully cure according to manufacturer's instructions and then torque the nuts to 81 Nm (60 foot-pounds).

A8.11.3.4. Grind off any portion of a stud that protrudes above the panel surface.

A8.11.4. Installing New Cable Tie-down Anchors. The MAJCOM aircraft arresting system engineer will prescribe the number and spacing of cable tie-down anchors required. Each cable tie-down anchor hole will be located in the center of the appropriate installed panel. When installing cable tie-downs, ensure the top of the tie-down is at least 5 millimeters ($^{3}/_{16}$ inch) (recommend 13 millimeters [$^{1}/_{2}$ inch]) below the final panel surface height. 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. **Figure A8.5.** through **Figure A8.9.** depict recommended cable anchor tie-down locations when installing standard full-sized and half-sized panels in various slab sizes. The half-sized panels are required to permit acceptable tie-down spacing and to avoid overlapping joints in the existing slabs. For installation in slabs sized other than those shown, consult the MAJCOM aircraft arresting system engineer. Use 8-point tie-down configurations for F-16 aircraft operations. Use 4-point configurations for all other aircraft operations.

Figure A8.5. Cable Tie-down Locations for Panels Placed on 12.5-Foot Slabs.

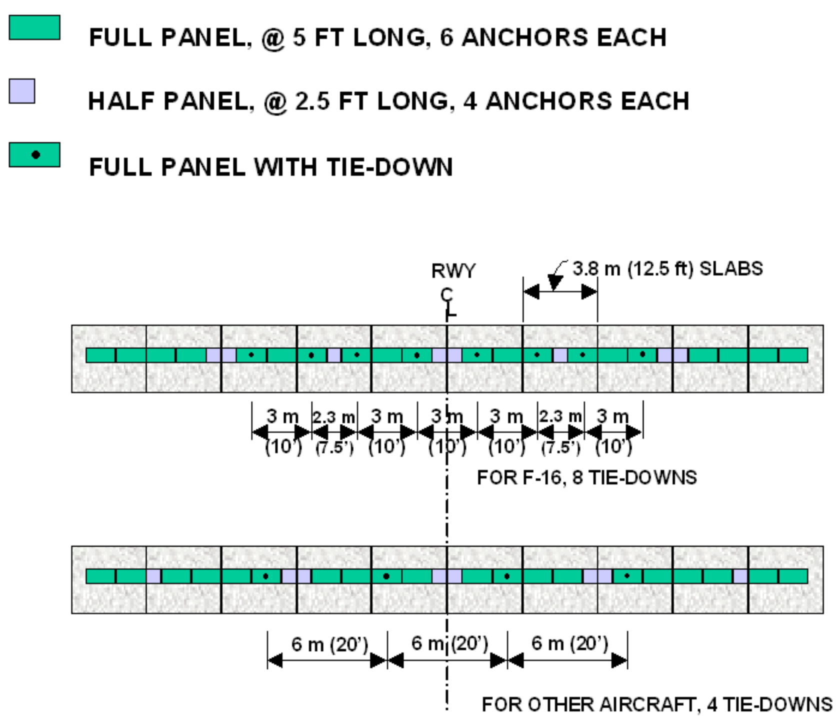


Figure A8.6. Cable Tie-down Locations for Panels Placed on 15-Foot Slabs.

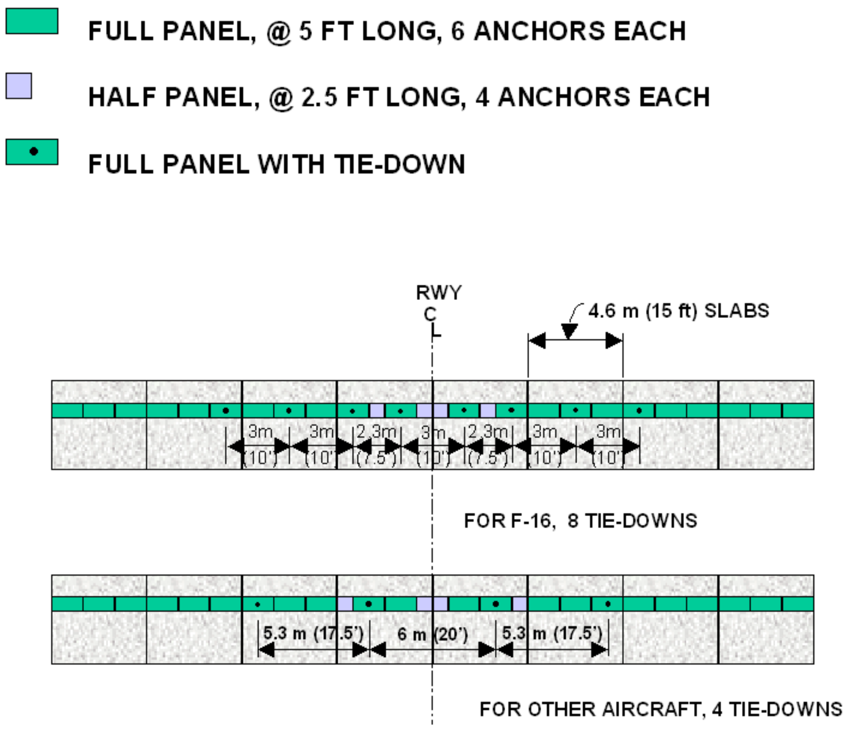


Figure A8.7. Cable Tie-down Locations for Panels Placed on 18.75-Foot Slabs.

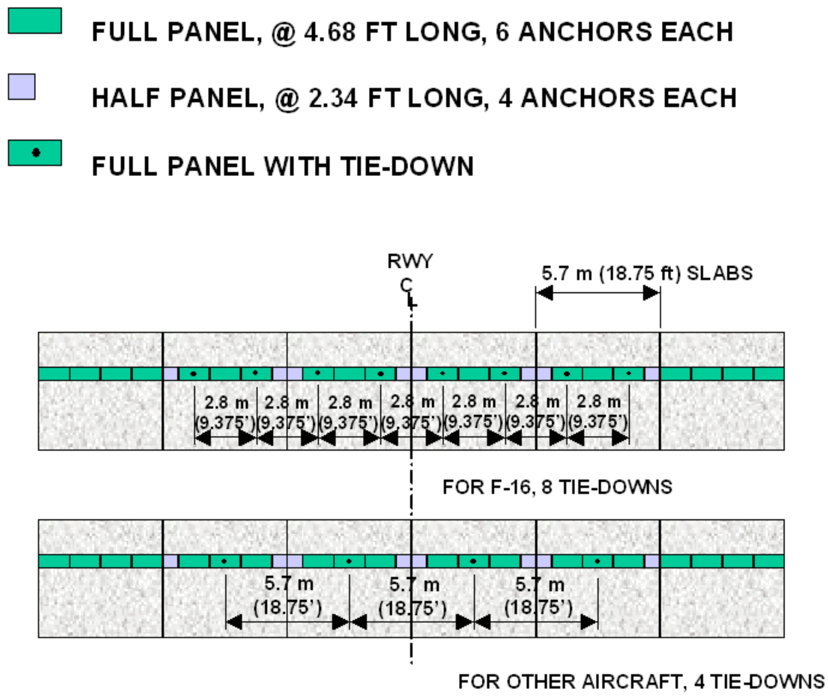


Figure A8.8. Cable Tie-down Locations for Panels Placed on 20-Foot Slabs.

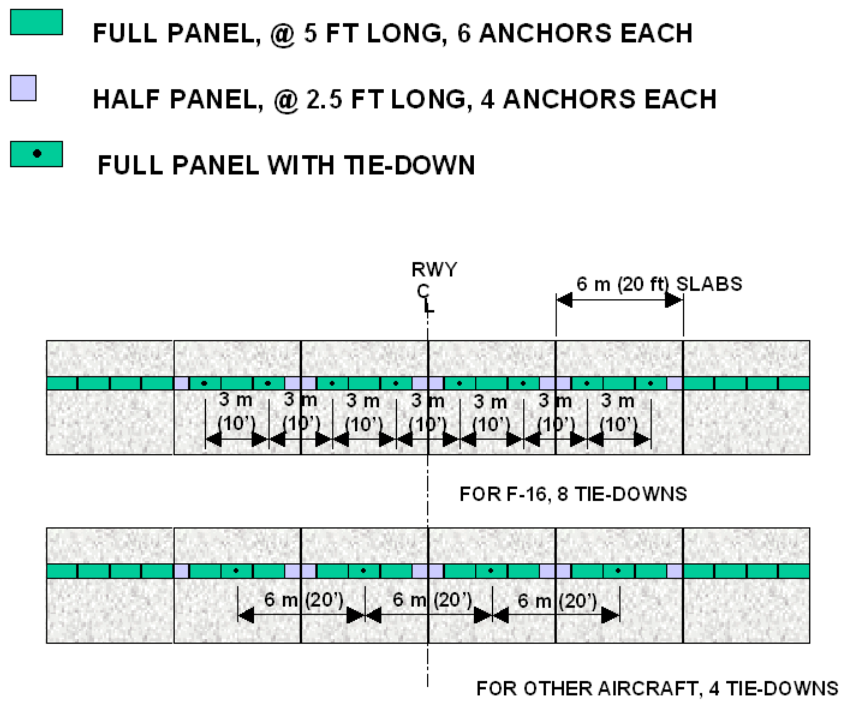
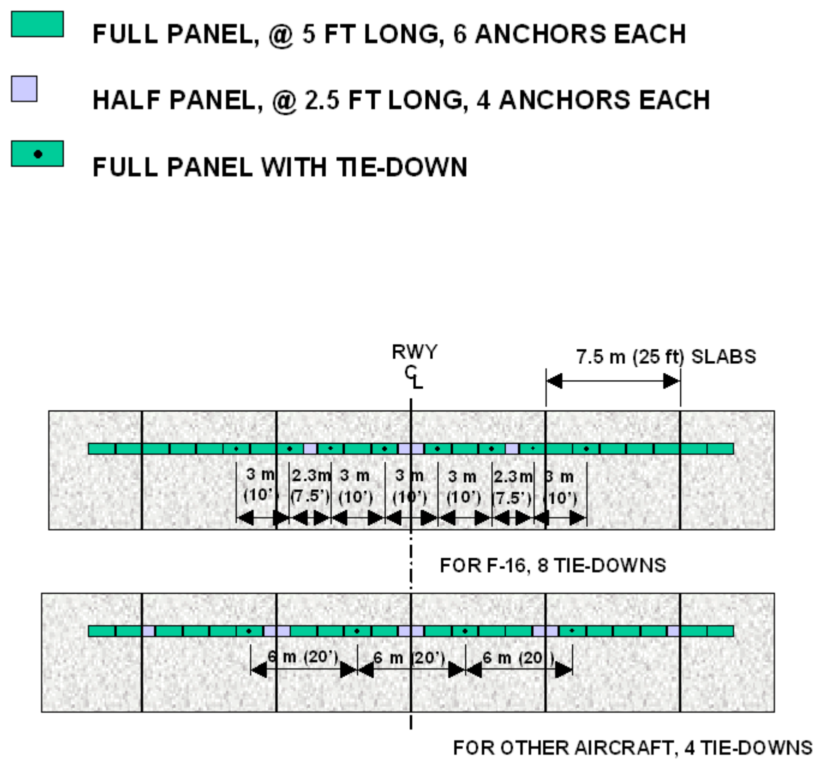


Figure A8.9. Cable Tie-down Locations for Panels Placed on 25-Foot Slabs.



A8.11.5. Sealing Joints. Apply joint sealant in spacing between and around panel edges, recessed 6.35 mm ($^{1}/_{4}$-inch) below the panel top surface. Joint sealants do not adhere well to UHMW panels and joints should be inspected frequently. Silicone sealants should be used in lieu of hot-pour asphalt or tar sealants. Silicone sealants are suitable for climates with wide temperature ranges and develop a low elastic modulus which allows good extension and compression recovery. This is important in light of the contraction and expansion properties of the panels.

A8.11.5.1. The size of the backer rod is also complicated due to the expansion properties of the panels. The spaces between panels should be noted while the panels are in their contracted state to prevent installation of undersized backer rods that allow the sealant to flow underneath.

A8.11.5.2. 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.

A8.11.6. Joints should be resealed just prior to onset of cold weather to prevent moisture accumulation and freezing below panels. Freezing below panels may result in panel failure, anchor failure, or excessive panel warping.

A8.12. Guidelines for Inspection. Bases 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.

A8.12.1. Daily Inspection. Panel inspection should be added to the daily arresting system inspection by power production personnel. Visually check for panel buckling, warping, and surface variations.

A8.12.2. Weekly Inspection. Check for panel buckling, warping, and surface variations by placing a steel straight edge on top of each panel parallel to the runway centerline at:

A8.12.2.1. Each joint between panels.

A8.12.2.2. At least two locations within each panel.

A8.12.2.3. Any other location that appears raised or irregular.

A8.12.2.4. 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 ($^{1}/_{8}$-inch) above the plane of the adjacent runway to the base pavements engineer and to the MAJCOM arresting systems engineer for further evaluation. Take color slides or photographs to document findings.

A8.12.3. Monthly Inspection. The base pavements engineer should participate once each month in the daily inspections with the power production personnel. Record all panel conditions, including (but not limited to):

A8.12.3.1. Erosion/EPH.

A8.12.3.2. Distresses.

A8.12.3.3. Warping/curling.

A8.12.3.4. Soundness.

A8.12.3.5. Delamination.

A8.12.3.6. Anchor stud effectiveness.

A8.12.3.7. Joint seal performance.

A8.12.3.8. Spalling.

A8.12.3.9. Anchor stud nuts may be over-torqued if tightened repeatedly. Consider using a thread locking or seizing compound such as Loctite® on nuts that continually loosen. Report any significant deterioration or problem to the MAJCOM immediately for further evaluation.

Table A8.2. Typical Tools and Equipment Required 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 $^1/_2$ in.)
3	each	Mortar mixer, 4 cubic feet (2 for use, 1 spare)
1	each	Sand blast 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 [$^3/_8$-inch])
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 inches x 4 inches x 40 inches)
1	board	Notched depth gauge, 51 mm x 102 mm x 1 m (2 inches x 4 inches x 40 inches)
30	panels	UHMW polyethylene, 610 millimeters (24 inches) wide, 1,511 millimeters (59$^1/_2$ inches) long, 38 mm (1$^1/_2$ inches) thick, predrilled with six 25-millimeter (1-inch) diameter anchor holes and 51-millimeter (2-inch) diameter countersinks
192	each	Anchor studs, 19-millimeter ($^3/_4$-inch) diameter, 245 millimeters (9$^5/_8$ inches) long, fully threaded, with nuts, flat washers and vinyl ester resin vials. (6 per panel plus spares)
12(min)	each	Cap nuts, 19-millimeter ($^3/_4$-inch), 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
2	each	Steel trowels
4	each	Shovels, square point
1	each	Electric drill, 13-millimeter ($^1/_2$-inch) drive
1	each	Torque wrench to apply 81 N·m (60 ft-lb) torque
1	each	Tymco Airfield sweeper
1	each	Air compressor

Quantity	Unit	Description
1	each	Front end loader
2	each	Dump trucks
2	each	Wheelbarrow, 4 cubic foot
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 890SL in 0.8-liter (29-ounce) tubes (96 tubes required) and a caulking gun for 0.8-liter (29-ounce) caulk tubes.
3	each	Electric impact drill (Hilti HE72 or equal) with 22-mm ($^{7}/_{8}$-inch) diameter by 530-mm (21-inch) long masonry bits.
1	each	Goose neck wrecking bar, 1,220 mm (4 feet) 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 depth of drilling
2	each	Alignment tools for drilling holes vertically
As req'd		Wood wedges to secure panels in position, at least 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, 13 mm ($^{1}/_{2}$-inch) thick by 102 mm (4 inches)by approximately 76 mm (3 inches), used to maintain spacing between panels during panel installation
As req'd		String line, spray paint, straight edge board, and a 30-meter (100-foot) tape to measure and mark for saw cuts

Table A8.3. Material Cost and Suggested Sources of Supply.

Quantity	Item	Suggested Source	Cost
30 each	UHMW polyethylene panels, predrilled with six counter-sunk anchor holes	Roechling Engineered Plastics PO Box 2729Gastonia, NC 28053Phone: (704) 922-7814 or Ultra Poly 2926 South Steele Tacoma, WA 98409 Phone: (800) 872-8469	$13,000
192 each	Anchor studs, 19 mm ($^3/_4$-inch) diameter, 245 mm ($9^5/_8$ inches) long, full-threaded (Hilti PN 686691) with vinyl ester bonding vials (Hilti PN 668129), nuts, and flat washers (Hilti HVA Adhesive Anchor System with HEA 19 mm [$/_4$-inch] capsule and HAS 19 mm [$^3/_4$-inch] rod)	Hilti Fastening Systems PO Box 21148 Tulsa, OK 74121 Phone: (800) 879-8000 or Williams Form EngineeringCorporation 1448 College Grand Rapids, MI 49507 Phone: (616) 452-3107	$1,500
4 each	Drive sockets	Hilti Fastening Systems	$50
4 each	Drive socket shafts	Hilti Fastening Systems	$210
4 each	Masonry drill bits, 22 mm ($^7/_8$-inch) diameter, 530 mm (21-inches) long	Hilti Fastening Systems	$500
25 each	Cap nuts, 19 mm ($^3/_4$-inch) diameter, 10 UNC (P/N 91875A036)	McMaster-CarrPO Box 440 NewBrunswick, NJ 08903-0440 Phone: (908) 329-3200	$125
150 bags	Rapid Set Concrete Mix	Rapid Set Products Midwestern Regional Office 1211 South 6th Street St. Charles, IL 60174 Phone: (312) 773-4949 1-800-929-3030	$3500

Quantity	Item	Suggested Source	Cost
96 tubes	Silicone joint seal (Dow Corning 890-SL)	The Fred R. Hiller Company 2696 Peachtree Square Road Atlanta, GA 30360 Phone: (404) 451-4661	$2500
NOTE: Costs do not include shipping. Suggestion of vendors is provided to assist in locating sources and does not constitute an endorsement of products from these companies.			

A8.13. Typical Schedule of Events For Installation of Eight Panels. See Table A8.4. for an example of a typical schedule of events for installing 8 panels.

Table A8.4. Typical Schedule of Events (For Installation of 8 Panels).

Date	Times	Event Description
24 Jun	1800-2200	Perimeter saw cutting, Runway 33. Crew size 2 men. Saw cuts 76 millimeters (3 inches) deep.
25 Jun	1500-1745	Excavation starts on Runway 33 inlay. Crew size 9 men. Concrete removed using three 40-kilogram (90-pound) jackhammers and one cold milling cutter drum on a "Bobcat 843" skid-steer loader. Debris loaded into a dump truck using a front end loader. Large rubble removed by hand and shovel; small debris removed using the suction wand of the "Tymco" airfield sweeper.
25 Jun	1745-1915	Excavation is complete. Slot cleaned with high pressure air. Substrate sounded and delaminated (unsound, hollow) material removed. Approximate final slot size: 30 meters (100 feet) long by 635 millimeters (25 inches) wide by 76 millimeters (3 inches) deep. Notched depth gauge board used to check depth in the center 12.2-meter (40-foot) area where panels are to be installed.
25 Jun	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.
25 Jun	2000-2230	Mixing and placing of the setting bed begins. Both concrete mixers used. Ten-person crew is used. No bonding agent used or needed. Notched board used to keep the setting bed at the correct level below the surrounding pavement surface.
25 Jun	2030-2242	Curing compound applied periodically as the setting bed is placed.
25 Jun	2242-2300	Cleanup accomplished and runway cleared. Approximately 90 bags of mortar placed.
26 Jun	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.

Date	Times	Event Description
26 Jun	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 bolt holes.
26 Jun	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.
26 Jun	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.
26 Jun	1340-1400	Shims removed. Site cleaned with compressed air to remove all particles before sealing around panels with joint sealant.
26 Jun	1710-1730	Studs torqued to 81 Nm (60 foot-pounds) with torque wrenches. All studs torqued adequately, but several stud ends protrude above panel surface.
26 Jun	1810-1820	High studs ground down flush with surface using a heavy-duty disc-type electric grinder.
26 Jun	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.
26 Jun	1820-1830	Final inspection and job site cleanup completed.

A8.14. Contact Point for Assistance. If you need assistance with installation of these type panels, contact Mr. Richard I. (Dick) Smith at HQ AFCESA/CESC.