U.S. Department of Transportation

Federal Aviation Administration

Advisory Circular

Subject: Airport Foreign Object Debris (FOD) Management	**Date:** DRAFT **Initiated by:** AAS-100	**AC No:** 150/5210-23 **Change:**

1. PURPOSE. This advisory circular (AC) provides guidance for developing and managing an airport foreign object debris (FOD) program.

2. SCOPE. This AC presents the minimum performance standards that comprise an airport's FOD program. The program described herein is composed of four main areas: prevention; detection; removal; and evaluation. Each of the four areas (corresponding to a dedicated chapter in this AC) contains strategies and practices that utilize the fundamental principles of risk management to reduce FOD at airports.

The guidance in this AC is particularly applicable to airport owners and operators, air carrier station managers, and general aviation operators. Individuals in these positions may then be able to communicate to apron crews, maintenance technicians, and aircraft servicing personnel the safety hazards posed by FOD.

3. CANCELLATION: AC 150/5380-5B, *Debris Hazards at Civil Airports*, dated 7/5/96, is canceled.

4. APPLICATION: The Federal Aviation Administration (FAA) recommends the guidance and specifications in this Advisory Circular for developing and managing an airport FOD management program. In general, use of this AC is not mandatory. However, use of this AC is mandatory for the acquisition of FOD removal equipment through the Airport Improvement Program (AIP) or the Passenger Facility Charge (PFC) Program. See Grant Assurance No. 34, *Policies, Standards, and Specifications*, and PFC Assurance No.9, *Standards and Specifications*.

5. COMMENTS OR SUGGESTIONS for improvements to this AC should be sent to:

Manager, Airport Engineering Division (AAS-100)
ATTN: FOD MANAGEMENT
Federal Aviation Administration
800 Independence Avenue SW
Washington DC 20591

Michael J. O'Donnell
Director of Airport Safety and Standards

This page intentionally left blank.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1. TERMINOLOGY AND REFERENCES

1.1. DEFINITIONS.

a. Air Operations Area (AOA). All airport areas where aircraft can operate, either under their own power or while in tow. The AOA includes runways, taxiways, and apron areas.

b. Airport Apron. A surface in the AOA where aircraft park and are serviced (refueled, loaded with cargo, and/or boarded by passengers).

c. Airport Ramp. See Airport Apron.

d. Foreign Object Debris (FOD). Any object, live or not, located in an inappropriate location in the airport environment that has the capacity to injure airport or airline personnel and damage aircraft. **NOTE:** *The FAA is cooperating with international aviation organizations in an effort to develop a standard, international definition of FOD. If, and when, such a definition is developed and adopted by the International Civil Aviation Organization (ICAO), that definition will take precedence over the one provided in this AC.*

e. Foreign Object Debris (FOD) Damage. Any damage attributed to a foreign object that can be expressed in physical or economic terms which may or may not downgrade the product's safety or performance characteristics. **NOTE:** *For the purposes of this AC, and to reduce confusion and ensure consistency in language and terminology, "FOD" will only refer to the phrase "foreign object debris."*

f. Hazard. A condition, object or activity with the potential for causing damage, loss, or injury.

g. Manufacturer. The manufacturer, distributor, lessor, or supplier of automated FOD detection equipment. This includes any provider of a FOD removal program that incorporates automated FOD detection equipment.

h. Quality Assurance Plan (QAP). A part of a quality assurance program that contains detailed requirements and standards in order to assure that minimum standards of performance are met through quantitative measurement.

i. Risk. The chance of loss or injury measured in terms of severity (or hazard) and probability (or frequency).

1.2. ACRONYMS AND TERMS.

ACM	Airport Certification Manual
FAA	Federal Aviation Administration
FOD	Foreign Object Debris
GSE	Ground Support Equipment
ICAO	International Civil Aviation Organization
QAP	Quality Assurance Plan

USAF United States Air Force

1.3. APPLICABLE DOCUMENTS.

The following documents form part of this specification and are applicable to the extent specified.

a. FAA Orders, Specifications, Drawings, and Advisory Circulars (ACs):

AC 150/5200-5 *Wildlife Attractants On or Near Airports*

AC 150/5200-18 *Airport Safety Self-Inspection*

AC 150/5200-30 *Airport Winter Safety and Operations*

AC 150/5300-13 *Airport Design*

b. Military Publications:

MIL-STD-980 *Foreign Object Damage (FOD) Prevention in Aerospace Products*

c. Industry Publications:

NAPFI *Foreign Object Debris (FOD) Prevention Guidelines*

G. Chaplin *Make it FOD Free: The Ultimate FOD Prevention Program Handbook*

d. Sources:

(1) FAA ACs may be obtained from: U.S. Department of Transportation, Subsequent Distribution Office, Ardmore East Business Center, 3341 Q 75th Ave., Landover, MD 20785. Telephone: (301) 322-4961, FAX: (301) 386-5394, website: www.faa.gov

(2) FAA Orders, Specifications, and Drawings may be obtained from: Federal Aviation Administration, ATO-W CM-NAS Documentation, Control Center, 800 Independence Avenue, SW, Washington, DC 20591. Telephone: (202) 548-5502, FAX: (202) 548-5501, website: www.faa.gov/cm/dcc

(3) Military standards and specifications may be obtained from: DAPS/DODSSP, Building 4, Section D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Telephone: (215) 697-2179, FAX: (215) 697-1460, website: dodssp.daps.dla.mil

(4) Industry publications may be obtained from:

(a) National Aerospace FOD Prevention, Inc., Telephone: (800) 363-1121, website: www.nafpi.com

(b) The FOD Control Corporation, 8987 East Tanque Verde Road, Building 309 - Mail Stop #360, Tucson, Arizona USA 85749-9399, www.makeitfodfree.com

CHAPTER 2. INTRODUCTION

2.1. GENERAL.

The presence of FOD on airport runways, taxiways, aprons and ramps poses a significant threat to the safety of air travel. FOD has the potential to damage aircraft during critical phases of flight, which can lead to catastrophic loss of life and airframe, and increased maintenance and operating costs. FOD hazards can be reduced, however, through the implementation of a FOD management program and the effective use of FOD detection and removal equipment.

2.2. FOD FUNDAMENTALS.

a. FOD Hazards. FOD can severely injure airport or airline personnel or damage equipment. Types of potential damage include: cutting aircraft tires; being ingested into engines; or becoming lodged in mechanisms affecting flight operations. Personnel injuries or even death can occur when jet blast propels FOD through the airport environment at high velocities.

b. Sources of FOD.

(1) FOD comes from many sources, which complicates efforts to maintain safe aircraft movement areas. FOD can be generated from personnel, airport infrastructure (pavements, lights, and signs), the environment (wildlife, snow, ice) and the equipment operating on the airfield (aircraft, airport operations vehicles, maintenance equipment, fueling trucks, other aircraft servicing equipment, and construction equipment).

(2) FOD can collect both on and below ground support equipment stored or staged on the airport apron, particularly in gate areas. Jet blast can then blow FOD onto personnel or an airplane. Jet blasts can also create runway FOD when an airplane transitions from a relatively large-width runway onto a smaller-width taxiway. Outboard engines blow any loose dirt and materials from the shoulder and infield areas onto the runway. Also, the outboard engines of four-engine airplanes can move debris from the runway edge and shoulder areas, where it tends to accumulate, back toward the center of the runway or taxiway.

(3) Helicopters that maneuver over freshly mowed or loose-dirt infield areas can also move FOD onto runways, taxiways, and ramps. In addition, the rotor wash from a helicopter can propel lightweight GSE or materials staged nearby.

(4) FOD is often more common during the early spring, when airports often begin construction activities. FOD may also be more prevalent in winter conditions, as aging pavement infrastructure may be influenced by weathering (freeze and thaw cycles) and begin to crack, spall, or break apart. Advisory Circular 150/5200-30, *Airport Winter Safety and Operations*, contains specific guidance on using and removing sand to minimize its chances of becoming FOD in winter weather conditions.

(5) Weather can also be the cause of FOD due to movement. For instance, wind can blow dry debris, such as sand or plastic bags, from relatively non-critical areas onto the flight area. Rain water and drainage can stream mud, pebbles and other small items along the path of least resistance. Awareness of weather-related sources of FOD movement helps civil engineers to design barriers and other structures properly.

c. FOD Taxonomy. The exact nature of FOD is also varied. FOD can be composed of any material and can be of any color and size. In a one year airport study (*Information Paper on French Study on Automatic FOD Detection Systems – Workshop EUROCONTROL*, 9-10 June 2008), over 60% of the FOD items were made of metal, followed by 18% of the items being made of rubber. Dark-colored items made up nearly 50% of the FOD collected. Common FOD dimensions can be 1 in. by 1 in. (3 cm by 3 cm) or smaller. Typical FOD includes the following:

- aircraft and engine fasteners (nuts, bolts, washers, safety wire, etc.);
- aircraft parts (fuel caps, landing gear fragments, oil sticks, metal sheets, trapdoors, and tire fragments);
- mechanics' tools;
- catering supplies;
- flight line items (nails, personnel badges, pens, pencils, luggage tags, soda cans, etc.);
- apron items (paper and plastic debris from catering and freight pallets, luggage parts, and debris from ramp equipment);
- runway and taxiway materials (concrete and asphalt chunks, rubber joint materials, and paint chips);
- construction debris (pieces of wood, stones, fasteners and miscellaneous metal objects);
- plastic and/or polyethylene materials;
- natural materials (plant fragments and wildlife); and
- contaminants from winter conditions (snow, ice).

2.3 AN AIRPORT FOD MANAGEMENT PROGRAM

a. Airport Regulatory Requirements.

(1) The need for an airport to manage FOD is based on the requirements outlined in 14 CFR Part 139, *Certification of Airports*. The presence of FOD in the airport environment is discussed in §139.305.(a).(4), *Paved Areas*, which states: "Except as provided in paragraph (b) of this section, mud, dirt, sand, loose aggregate, debris, foreign objects, rubber deposits, and other contaminants shall be removed promptly and as completely as practicable." In addition, daily inspections performed at certificated airports (which form the primary means of FOD detection and removal at some airports) are required under §139.327, *Self-Inspection Program*. Inspections are a key component in airport operations, and an effective self-inspection program enables an airport operator to identify and eliminate unsafe conditions.

(2) Other FAA guidance documents, such as AC 150/5200-18, *Airport Safety Self-Inspection*, contain detailed information on the Part 139 inspection process, stating that "The inspector should continuously check for, and remove any FOD in movement areas, aircraft parking areas and loading ramps." It should be noted that while Part 139 requirements are mandatory for a holder of a Part 139 Airport Operating Certificate, the regulation contains many safety practices the FAA recommends for use at all airports.

(3) International regulations also discuss the issue of FOD in airports. ICAO Annex 14, *Aerodrome Design and Operation*, Chapter 10.2.1 states, "The surface of pavements (runways, taxiways, aprons and adjacent areas) shall be kept clear of any loose stones or other objects that might cause damage to aircraft structures or engines, or impair the operation of aircraft systems."

b. Program Areas.

(1) A successful FOD management program is comprised of four main areas, each containing significant elements, as outlined below:

- Prevention
  - Awareness (existence of the FOD program and management support)
  - Training and education (implementation of the FOD program)
  - Maintenance

- Detection
  - Risk assessment (identifying potential problems, knowing where to look)
  - Operations (manual inspections and use of detection equipment)
  - Equipment

- Removal
  - Equipment

- Evaluation
  - Data collection and analysis
  - Continuous improvement (trending, feedback, incident investigation)

(2) Practical guidance for FOD managers. An airport FOD management program that addresses each of the program areas discussed in this AC would provide for a minimum level of safety at an airport with respect to risks posed by FOD. FOD managers are encouraged to build upon this guidance when implementing or improving their own programs.

This page intentionally left blank.

CHAPTER 3. FOD PREVENTION

3.1. AWARENESS.

a. Program Existence and Health.

(1) A first step in implementing a successful FOD management program is making sure that applicable personnel are aware of the program's existence. An airport's FOD management system should be visible in all aspects of the airport operation. Systems safety is a good business practice and should be promoted accordingly. Systems safety improvement will occur most efficiently if all airport personnel are actively encouraged to identify potential FOD hazards, act to remove observed FOD, and propose solutions to mitigate those hazards. Some examples of organizational communication are:

(a) FOD seminars;

(b) FOD letters, notices and bulletins;

(c) FOD lessons-learned;

(d) FOD Bulletin boards, safety reporting drop boxes, and electronic reporting through web sites or email; and

(e) A method to exchange safety-related information with other airport operators through regional offices or professional organizations.

(2) The FOD Manager (who is responsible for administration of the airports overall FOD management program) should communicate the health of the FOD program through any of the means listed above. The FOD Manager should also ensure that lessons learned from hazardous occurrence investigations and case history or experiences, both internally and from other organizations, are distributed widely. An open line of communication should always be available between the FOD Manager and the airport/airline staff.

b. FOD Policy and Management Support.

(1) An effective FOD program must also have the full support of management. Management's commitment to FOD prevention should be formally expressed in a statement of the organization's FOD policy. The statement will serve to formally establish the FOD management program. Posting this policy statement in conspicuous locations will help reinforce the organization's commitment to FOD prevention and help remind employees of their FOD management duties. Some key elements of an airport's FOD policy are:

(a) An outline of the methods and processes that the organization will use to achieve desired safety outcomes.

(b) The organization's policy concerning responsibility and accountability.

(c) Identification of a FOD Manager (often, this person is also the airport's safety manager). This person reports to the highest level of management to assure appropriate consideration of all reports, recommendations, and issues.

(d) At larger airports, operations may support the FOD Manager being a full-time permanent employee and, in some cases, having a support staff. Some airports may have an existing risk management office that could substantially meet FOD management requirements.

(e) The responsibilities of the FOD Manager are clearly defined along with identified lines of communication within the organization.

(f) The establishment of a FOD committee. Though not required in the past, this is now common practice among airports, regardless of the size and complexity of the airport's operation. The committee acts as a source of expertise for the FOD Manager and is chaired by the FOD Manager.

(g) Suggested duties and responsibilities of a FOD manager are provided in Appendix A.

c. Safety Culture. An effective FOD management program requires more than the implementation of rules and procedures to be followed. It requires the support of management to establish the attitude, decisions, and methods of operation at the policy-making level that demonstrate the organizations priority to safety. In effective safety cultures, there are clear reporting lines, clearly defined duties and well understood procedures. Personnel fully understand their responsibilities and know what to report, to whom and when. Though it is an intangible aspect of a safety program, proper personal attitudes and corporate commitment enable or facilitate the elimination of unsafe acts and conditions that are the precursors to accidents and incidents.

3.2. TRAINING AND EDUCATION.

a. Audience. Each individual with access to an airport operations area (AOA) should understand their role in the prevention of FOD. These personnel include: airport operations; construction; aircraft maintenance and permanent/seasonal servicing staff (e.g. catering, fuel, cabin cleaning, baggage and cargo handling, waste disposal, etc.). A formal orientation/indoctrination program familiarizing new employees with safety, security, communications, and vehicle operations should include FOD management training. This training can supplement the general FOD awareness incorporated into the airside driver training curriculum already in place at many airports.

b. Features. The FOD manager provides current information and continual training relating to FOD issues relevant to the specific operation of the airport. The provision of appropriate training to all staff, regardless of their level in the organization, is an indication of management's commitment to an effective FOD management program. FOD training and education should consist of the following features:

(1) A documented process to identify training requirements;

(2) A validation process that measures the effectiveness of training;

(3) Recurrent training (to help maintain awareness);

(4) Human (and organizational) factors.

c. Training Objectives. The primary objectives of the FOD training program will be to increase employee awareness of the causes and effect of foreign object damage and to promote active employee participation in eliminating causes of foreign object damage during performance of daily work routines. The FOD manager should emphasize FOD management through employee motivational programs as well as by conducting training courses to emphasize FOD prevention through efficient design, product

discipline, maintenance, and flight line activities. The following subject matter should be included, as applicable, in the FOD manager's FOD prevention program:

(1) Overview of the FOD management program in place at the airport;

(2) Safety of personnel and airline passengers;

(3) Causes and principal contributing factors of FOD;

(4) The consequences of ignoring FOD, and/or, the incentives of preventing FOD;

(5) General cleanliness and inspection standards of work areas (including the apron and AOA);

(6) Proper care, use, and stowage of material and component or equipment items used around aircraft while in maintenance or on airport surfaces;

(7) Control of debris in the performance of work assignments (e.g. loose items associated with luggage, ramp equipment, and construction materials);

(8) Control over personal items and equipment;

(9) Proper control/accountability and care of tools and hardware;

(10) Requirements and procedures for regular inspection and cleaning of aircraft and apron areas;

(11) How to report FOD incidents or potential incidents;

(12) Continual vigilance for potential sources of hazardous foreign objects;

(13) FOD Detection procedures, including the proper use of detection technologies (if applicable); and

(14) FOD Removal procedures.

d. Training Documentation. Training requirements and activities should be documented for each area of activity within the organization. To the extent possible, a training file should be developed for each employee, including management, to assist in identifying and tracking employee training requirements and verifying that the personnel have received the planned training. Any training program should be adapted to fit the needs and complexity of the airport in question. At certificated airports, this is already being done for training required by 14 CFR Part 139, *Certification of Airports*.

3.3. MAINTENANCE PROGRAMS.

a. Each activity on the airport should have a FOD prevention program tailored to that particular activity. Some suggestions are as follows:

(1) Aircraft Servicing. Airlines and airport tenants generate much of the FOD found in gate areas, service roads, baggage makeup areas, and areas near flight kitchens. Agreements between airlines and their support organizations should specify which of the parties are responsible for cleaning various areas.

(2) Aircraft Maintenance. Account for and dispose of nuts, bolts, washers, safety wire, etc. Account for hand tools used in repair jobs. Aids in the control of these items include checklists, shadow boards, and cut out tool tray liners.

(3) Air Cargo. In an air cargo area, there is a high potential for blowing debris such as cargo strapping and plastic. Establish procedures to contain such debris, possibly by installing fencing where appropriate. Of course, FOD trapped by such fences should be removed regularly.

(4) Construction.

(a) Both airside and landside construction activities, as well as scheduled maintenance, should be communicated to airports users as early as possible. Specific FOD prevention procedures should be established for each construction project. These procedures should be based on the proximity of construction activities to operational areas but in general should stress containment and regular cleanup of construction debris. Airport preconstruction planning should include a means for controlling and containing FOD generated by the construction. This is especially true in high-wind environments where debris is more likely to become airborne.

(b) The designated routes of construction vehicles on the AOA should be examined, so as to avoid or minimize crossings of critical areas of aircraft operations. If high-risk crossings cannot be avoided, subsequent provisions such as an increased frequency of FOD inspections could be implemented.

(c) Contractors must fully understand the requirements and penalties incorporated in their contracts regarding the control and removal of FOD.

CHAPTER 4. FOD DETECTION

4.1. GENERAL.

a. While proper FOD awareness is fundamental for any successful FOD program, the act of detecting FOD is perhaps the most critical FOD operation that can take place at an airport. This process involves not only the identification of potential FOD causes and locations, but also the timely detection of any FOD airport surfaces. Whether detection occurs manually, through regular inspections, or through the use of continuously operating advanced detection technologies, the outcome is equally important.

b. A highly sensitive question involved in the use of continuously operating FOD detection technologies arises once an object is detected. An assessment of the risk posed by the object must be made quickly, which leads to the decision on whether or not to close an active runway in order to remove the detected FOD. If the location or characteristics of the FOD present no immediate safety hazard the object should be removed as soon as the operational schedule permits. If the location or characteristics of the FOD present an immediate safety hazard, provisions in the FOD management program should clearly indicate that a hazard exists and allow for an airport supervisor to take action and cease operations and, in the case of aircraft or airport equipment source of the FOD, notify the equipment operator.

c. The guidance in this chapter concerning the performance of a risk assessment will help an airport to decide whether or not a piece of FOD poses a significant enough risk to warrant closing a runway.

4.2. FOD RISK ASSESSMENT.

a. FOD risk assessment is at the heart of the FOD Management program. FOD risk assessment is a systematic, explicit, and comprehensive approach for managing FOD risks throughout the airport.

b. A FOD risk assessment enables an airport to determine where unsafe FOD conditions exist. Planning for and mitigating such conditions creates multiple layers of safety within the airport environment. An incident or accident will most likely occur when gaps in the safety layers present themselves, such as staff being unaware of a potentially hazardous situation. The risk assessment process helps to focus staff attention and streamline efforts expended in managing FOD.

c. There are five phases in the FOD risk assessment process:

- Phase 1. Describe the system
- Phase 2. Identify the hazards
- Phase 3. Determine the risk
- Phase 4. Assess and analyze the risk
- Phase 5. Treat the risk (i.e., mitigate, monitor and track)

d. These phases are described below:

(1) Phase 1: Describe the system. When considering the environment of the airport system, consider all of the FOD prevention functions already outlined in the ACM. The existing FOD prevention functions should steer the focus of the risk management analysis and will assist in determining potential mitigation strategies.

(2) Phase 2: Identify Hazards.

(a) In this phase, FOD sources (e.g., operations, equipment, people, and procedures) are identified in a systematic, disciplined way. There are many ways to do this, but all require the identifier to have at least four skills:

(i) Operational expertise

(ii) Training in FOD risk management, and if possible, hazard analysis techniques (based on the dynamic assessment of collected data)

(iii) A simple, but well-defined, hazard analysis tool

(iv) Adequate documentation of the process

(b) A table containing a sample list of common FOD found in airports, including a suggested hazard and frequency of occurrence, is provided below in Table 4-1. **NOTE:** *The items in this list are not complete, and an airport may decide that a particular item is rated differently in terms of the "hazard" and "frequency" listings.*

Table 4-1. Sample Airport FOD

FOD Items	Expected Hazard	Frequency of Occurrence
1. Small pieces of concrete	High	Common
2. Lug nuts from service vehicles	High	Common
3. Roller bearings	High	Common
4. Chunk of rubber	Low	Common
5. Mechanics wrench	High	Common
6. Fuel caps	High	Common
7. Cotter keys or aircraft safety wire	Moderate	Common
8. Plastic bottle/bottle cap	Low	Common
9. Strapping materials and plastic	Moderate	Common
10. Expansion joint materials	Low	Common
11. Construction materials – fasteners, wood, dirt, and gravel	Moderate	Based on construction activity
12. Runway infrastructure parts – damaged runway lights or signage	High	Uncommon
13. Aircraft fasteners	Moderate	Common
14. Metal strips or pieces	High	Uncommon
15. Fiberglass parts from aircraft	Moderate	Common
16. Small pieces of asphalt	High	Common

(c) The hazard identification effort should mirror the management structure and complexity of the airport in question. The airport manager at a small airport could conduct it alone, while it may be conducted by a committee or group at a larger airport. Regardless, the person or the group will require sufficient operations expertise, safety experience, and training to adequately conduct the assessment.

(d) The hazard identification stage considers all the possible sources and contributing factors of FOD as related to aircraft movement.

(3) Phase 3. Determine the risk

(a) In this phase, each FOD hazard in its system context is identified to determine what risks exist, if any, that may be related to the hazard. In this phase, there is no determination of the severity or potential of the risk occurring. First, all potential hazards are identified and documented. Next, the hazards are subjected to an assessment of the possible severity and potential risk as described in Phase 4.

(b) For example, an airport may have identified a FOD hazard at a busy taxiway intersection, with the associated risk of the FOD being ingested into the engines of taxiing aircraft. That hazard and the identified risk would be documented before moving to Phase 4, a determination of the probability of that risk occurring, and the severity if such an event were to occur.

(4) Phase 4: Assess and Analyze the Risk. In this Phase, the airport operator estimates the level of risk such as by using the predictive risk matrix in Figure 4-1.

(a) Risk is the composite of the predicted severity and likelihood of the outcome or effect (harm) of the hazard in the worst credible system state. In order to assess the risk of an accident or incident occurring, severity and likelihood are first determined.

(b) Severity is determined by the worst credible potential outcome. Less severe effects may be considered in addition to this, but at a minimum, the most severe effects are considered. Determination of severity is independent of likelihood, and likelihood should not be considered when determining severity. Over time, quantitative data may support or alter the determinations of severity and probability, but the initial risk determinations will most likely be qualitative in nature, based on experience and judgment more than data.

(c) The risk levels used in the matrix can be defined as:

(i) **High risk** – Unacceptable level of risk: The proposal cannot be implemented or the activity continued unless hazards are further mitigated so that risk is reduced to medium or low level. Tracking and management involvement are required, and management must approve any proposed mitigating controls. Catastrophic hazards that are caused by:

- single-point events or failures
- common-cause events or failures
- undetectable latent events in combination with single point or common cause events are considered high risk, even if extremely remote

(ii) **Medium risk** – Acceptable level of risk: Minimum acceptable safety objective; the proposal may be implemented or the activity can continue, but tracking and management are required.

(iii) **Low risk** – Target level of risk: Acceptable without restriction or limitation; the identified hazards are not required to be actively managed, but are documented.

(d) Hazards are ranked according to the severity and the likelihood of their risk, which is illustrated by where they fall on the risk matrix. Hazards with high risk receive higher priority for treatment and mitigation.

NOTE: *At U.S. airports, many of the airport operators' actions are governed by standards issued by the FAA. The FAA would not expect an airport operator to conduct an independent risk analysis of an action or condition directed by a mandatory FAA standard or specification. Any discretionary action or decision by the airport operator in the application of the standards should still be analyzed.*

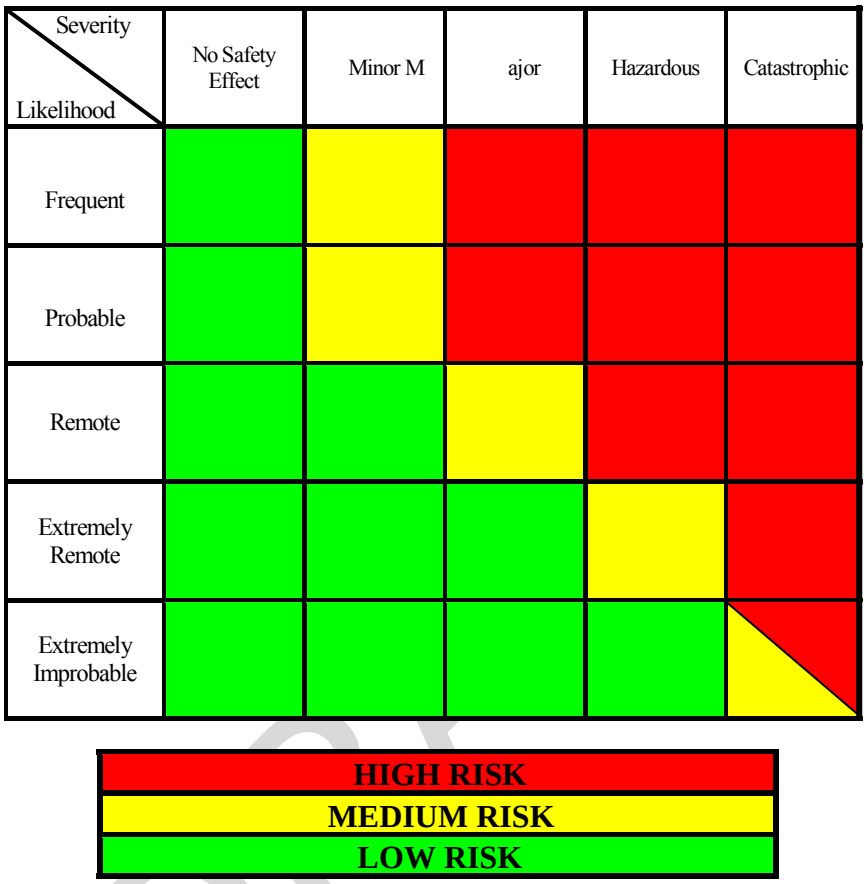

Figure 4-1. Predictive Risk Matrix

(5) Phase 5: Treat the risk. In this phase, the airport operator develops options to mitigate the risk and alternative strategies for managing a hazard's risk(s). These strategies can be used to reduce the hazard's effects on the system. It should be noted that the majority of risk management strategies address medium and high-risk hazards. Low-risk hazards may be accepted after considering risk.

(a) The risk management activity should identify feasible options to control or mitigate risk. Some options could include:

- Avoidance: selecting a different approach or not participating in, or allowing, the operation or procedure
- Assumption: accepting the likelihood, probability, and consequences associated with the risk
- Control: development of options and alternatives that minimize or eliminate the risk
- Transfer: shifting the risk to another area

(b) Prior to operational use, a mitigation strategy is validated and verified (as operational experience or data may support). Once validated, verified, and accepted, it then becomes an existing element of the system or operation.

(c) Next, the effect of the proposed mitigation measure on the overall risk is assessed. If necessary, the process is repeated until a measure or combination of measures is found that reduces the risk to an acceptable level.

(d) When risk is determined to be unacceptable, it is necessary to identify and evaluate risk mitigation measures by which the probability of occurrence and/or the severity of the hazard could be reduced. When risk mitigation strategies cross organizations, risk acceptance and approval from stakeholder organizations is necessary.

(e) Risk mitigation may require a management decision to approve, fund, schedule, and implement one or more risk mitigation strategies. The objective of this phase is to implement appropriate and cost-effective risk mitigation plans to mitigate hazards. Appropriate risk mitigation strategies are developed, documented, selected, and implemented. Hazard tracking is the core of this risk management phase. Each medium and high-risk hazard is tracked until its risk is mitigated to an acceptable level and the effectiveness of the controls mitigating the risk is verified. The hazard record is kept for the lifecycle of the system change.

(f) When assessing risk using a group or committee, remember that interactions between safety-group participants with varying experience and knowledge tend to lead to broader, more comprehensive, and more balanced consideration of safety issues than if an individual conducts the assessment. Thus, if possible, group analysis by appropriate subject matter experts, is recommended.

(g) Applying the Concept of FOD Risk Management: Appendix B provides an example of how FOD Risk Management could be applied to prevent the occurrence of FOD during airfield construction.

4.3. FOD DETECTION OPERATIONS

a. Inspection Areas. The results of a FOD risk assessment will determine the areas where attention is most needed for inspection on the airport environment. While detailed inspection guidance is provided in AC 150/5200-18 *Airport Safety Self-Inspection*, additional information can be helpful for airport personnel conducting FOD inspections. The following areas and operations are typically prone to having a FOD risk:

(1) Movement Areas (runways and taxiways)

(a) The portion of the runway used by aircraft to take off, where departing aircraft are most susceptible to FOD damage.

(b) Deteriorating or neglected pavements can exhibit spalling or cracks. For example, pieces of concrete can break loose from pavements or FOD can develop from fatigue corner cracks. FOD associated with building materials, debris falling from construction vehicles or blown from gate areas onto aircraft maneuvering areas. Broken pieces of pavement can collect at the edge of the gate area and be carried onto the airplane maneuvering area by the tires of vehicular ground support equipment (GSE). Service roads that cross taxiways should be monitored closely to prevent the vehicles using these roads from moving FOD onto the taxiways (especially in the case of construction operations).

(c) Shoulders. Areas adjacent to pavements should be stabilized to prevent FOD. (AC 150/5300-13, *Airport Design*, provides further guidance in the construction of stabilized shoulders.)

(d) Pavement Joints. Special attention should be paid to the cleaning of cracks and pavement joints as tests have shown that these are the main sources of foreign objects which are ingested.

(2) Airport apron (terminal gates). Areas where luggage is most frequently handled.

(3) Aircraft maintenance and servicing operations. Refueling, catering, cabin cleaning, and baggage and cargo handling can produce broken materials. Baggage pieces, including bag tags and wheels, can break off luggage and either fall onto the apron or collect in the door sill. Items collected in the door sill can damage the door or prevent it from fully sealing. They can also be knocked out of the sills and onto the apron at the next station. Other areas where FOD is likely to collect include the ground at both ends of the conveyor, and the area between the baggage cart and the conveyor belt.

(a) Areas of common or recent maintenance or servicing actions can have tools, nuts and bolts, safety wire, etc.

(b) Accounting for all tools.

(c) Aids in the control of these items include checklists, shadow boards, and cut out tool tray liners.

(4) Air cargo operations

(a) High potential for blowing debris such as plastic cargo wrappers.

(b) Fencing used to contain debris should be cleaned regularly.

(5) Construction Operations.

(a) The proximity of construction activities to operational areas presents a risk of debris.

(b) Regular and thorough cleaning of the construction site is expected, per local rules and pre-existing agreements (such as the construction safety plan).

(c) All vehicles should be driven on clean, paved surfaces when possible. If a vehicle must be driven on unpaved surfaces, the operator should check the vehicle tires for foreign objects immediately after returning to the pavement.

(6) Maintenance activities. These activities, which may be performed on the gate/apron, require a variety of small objects, such as rivets, safety wire, and bolts that become FOD when they are inadvertently left behind. An effective tool control program will reduce the number of missing hand tools.

b. Methods and Techniques.

(1) The FAA and ICAO require a daily, daylight inspection of aircraft operating areas. Operational areas must be inspected at least once each day, with additional inspections being made in construction areas and immediately after any aircraft or ground vehicle accident or incident or any spill of material which may cause slippery conditions. In addition to performing these inspections at the beginning of the day or shift, personnel on the airside should look for FOD during their normal shifts.

Inspections occurring at night, taking place after the runway is closed or before the runway is opened, also occur frequently.

(2) Continuous Detection Technologies.

(a) Recent technological developments have greatly expanded the capabilities of FOD detection through automation. Advanced technologies are now available for improved FOD detection, including capabilities for continuous detection on runways and other aircraft movement areas and mobile detection devices to supplement the capabilities of airport personnel.

(b) Inspection frequency. There are two basic types of FOD detection equipment: Fixed systems, supporting continuous surveillance; and Mobile systems, supplementing manual human/visual inspections.

(c) FOD Detection Notification. The airport operator and airlines have considerable flexibility in terms of how to automate FOD detection at the airport. The user interface may be located in the airport's operation or maintenance center, or it may be located in the ATC tower. Regardless of the configuration, an airport will determine the most efficient way to notify airport/airline personnel to remove the detected FOD, as well as the ATC staff to divert aircraft if a significant risk is presented.

(d) Wildlife. There is currently no uniform standard or procedures for the detection of wildlife in the AOA. However, preliminary results from research has indicated that dead wildlife can be a component of a FOD management program, and live wildlife can be part of a wildlife hazard management program. Of course, when wildlife are struck by aircraft, their remains can attract other wildlife, causing an overlap of both management programs.

(3) Manual Detection.

(a) When conducting an inspection on a runway, inspection techniques will be determined by runway availability and type of operation. Ongoing construction requires more frequent inspections. It may even be necessary to assign dedicated personnel to continually inspect for FOD during major construction activities. As part of the FOD management program, the FOD manager may find it appropriate to reach out to airlines and flight crews to leverage the airport's current FOD management efforts. For example, flight crews could be asked to report to air traffic control and station operations any FOD they observe on runways and taxiways. Airlines and aircraft handling agents may also be asked to designate individuals to inspect gate areas prior to aircraft movement to and from the gate.

(b) An inspection will involve passage along the length of the runway to observe and remove FOD. The most effective method involves two or more passages to reduce the width of the inspection zone. When there is time to do only one pass on the runway, inspection personnel, whenever practical, should drive in the direction of landing aircraft with high intensity flashing beacon and headlights on at all times. This practice will enable self-inspection personnel to see approaching aircraft and improve visibility of the vehicle to pilots. Inspection personnel should also drive the stub taxiways between the runway and parallel taxiway because these areas are commonly overlooked.

(c) Encouraging the participation of airport tenants in inspections will reinforce the concept that FOD prevention is a team effort and demonstrate the airport operator's commitment to a debris-free environment. As such, airline personnel, when feasible, should join the airport staff in daily airside inspections. This practice helps increase familiarity with local airfield conditions, and promotes effective communication between the airport and airlines. The placement of convenient and conspicuous FOD

containers (as described in Paragraph 5.2 of this AC) is a helpful reminder of the need to be vigilant in preventing the occurrence of FOD.

(i) An effective and clever operation currently in place at airports is the promotion of all-hands "FOD walks." These walks are typically conducted as part of an airport's FOD management campaign. Walks involve the coordination and invitation of airport and airline staff (e.g. ground handling agents, airlines, ARFF and apron personnel), external partners, and other community volunteers to participate in manually collecting airport FOD. These events can be promoted with offering food and water to participants, and various prizes (i.e. airport clothing) to those who collect the most FOD. Of note, during this type of event, identifying the location and origin of FOD (for data analysis and evaluation) is not always possible.

(d) For further guidance on the performance of airport inspections, please see AC 150/5200-18, *Airport Safety Self-Inspection*.

4.4. FOD DETECTION EQUIPMENT.

The standards and specifications found in AC 150/5220 24, *Airport Foreign Object Debris (FOD) Detection Equipment*, represent the FAA guidance for evaluating FOD detection systems.

CHAPTER 5. FOD REMOVAL

5.1. BACKGROUND.

a. Once FOD is detected, the next major operation of a FOD management program will occur: removing FOD from the airport environment. The most effective resource for FOD removal is the use of FOD removal equipment. Although specialized equipment is available and highly suited to some airport operations, FOD removal technologies are available for all airports.

b. A systems approach to FOD management addresses significant hazards and the possible risks these hazards may present to employees and the public. Individuals responsible for FOD removal operations should have direct responsibility for the safety of those operations and should be given the resources to implement the necessary controls.

c. The equipment described in this chapter may be used singularly or in combination. In either case, FOD managers are cautioned that personnel using particular FOD removal equipment may become complacent and completely rely on the equipment to remove all pieces of FOD in their area of operation. Personnel must be constantly aware of the performance of their equipment, and should regularly check to make sure visually detected FOD is in fact collected by their equipment during FOD removal operations.

5.2. EQUIPMENT CHARACTERISTICS.

This AC does not limit the equipment that airports may use for FOD removal. Currently available removal equipment can be categorized into two types: mechanical and non-mechanical. Additionally, the category of storage systems (FOD containers) is also of fundamental importance.

a. Mechanical Systems. These technologies use powered devices in mechanical systems that remove or retrieve FOD items and contain retrieved FOD for proper disposition. Equipment in this category vary in size, and are found in sizes from small push units to large area systems that are truck mounted. Types of mechanical removal systems include:

(1) Power Sweepers, including tow-behind bristle trailers. The sweeper removes debris from cracks and pavement joints, and is typically used in all areas of the AOA including areas where ground support equipment (GSE) is staged. **NOTE:** *For all brush systems, operators are cautioned that bristles can detach from brooms and produce a FOD source. Brushes made with metal bristles or spines are not recommended to be used for FOD removal purposes. Plastic or combination plastic/metal bristles may be appropriate, but the user should consult the equipment manufacturer for specific recommendations. Regardless of the equipment used, a thorough check of the pavement should be conducted at the conclusion of the sweeping procedure*.

(2) Vacuum systems. These systems perform FOD removal functions similar to the power sweepers described above, but use air flow as the primary means of object retrieval. The systems may also perform in conjunction with mechanical brooms or other recirculating air units.

(3) Jet air blowers. These systems remove FOD and other debris by directing a stream of high velocity air towards the pavement surface. When used in the airport environment, it is recommended that these systems incorporate a debris collection mechanism so that FOD will not simply be relocated to another area in the AOA.

b. Non-Mechanical Systems.

(1) Tow-behind friction mats. A rectangular assembly towed behind a vehicle that employs a series of bristle brushes and friction to sweep FOD into sets of capture scoops, which are covered by a retaining mesh to hold collected debris.

(2) Magnetic bars (attached to vehicles). These bars can be suspended beneath tugs and trucks to pick up metallic material. However, the bars should be cleaned regularly to prevent them from dropping the collected debris. Vehicles operation on the airside should be inspected periodically to ensure that they have no loose items that can fall off. Common magnetic materials include ceramic, rare earth, and alnico metals.

(3) Rumble strips (also "FOD Shakers"). Long devices, which are 10 to 15 ft (3 to 4.60 m) long, that are positioned on the pavement to dislodge FOD from vehicles that drive over them. While these devices may have been used in the past, they are no longer a widely accepted FOD removal system. Their effectiveness at removing debris from tires or vehicle undercarriages is negligible, and the equipment can generate its own FOD if not cleaned out regularly. The current best practice for removing FOD from tires is to stop a vehicle at a designated checkpoint, perform a visual inspection, and then use a hand tool to manually remove detected debris.

c. Storage Systems (FOD Containers).

(1) Designated FOD containers should be conspicuously placed at all gates for the collection of debris. The containers should be well marked, properly secured, and emptied frequently to prevent them from overflowing and becoming a source of FOD themselves. In addition, airport personnel can wear waist pouches to collect debris.

(2) "Closed-type" containers are preferable, given the opportunity for wind to dislodge the container contents. Consequently, "open-type" containers are not advised.

(3) Locations. Suggested locations include the following: near entry points to the airport operations area, in hangars, in aircraft tie-down and aircraft maintenance areas, and at each aircraft gate. Central or well-known storage locations increase the likelihood that collected debris will be deposited by personnel.

(4) Other means for containing FOD include: wind barriers and netting to restrict movement of airborne FOD; fencing to prevent animals from entering the airfield; and well-maintained paved surfaces. If damaged pavement cannot be repaired immediately, airport operators should make arrangements for aircraft to take an alternate route.

(5) Evaluating the debris collected in containers and pouches can reveal its sources and indicate where personnel and equipment should be deployed for more effective control. Chapter six of this AC will provide more information on this practice.

5.3. PERFORMANCE.

a. Operational Standards. Unless otherwise specified, the following standards apply only to "mechanical" FOD removal systems.

(1) Operational Speeds. The minimum speeds that FOD removal equipment should operate and collect 90% of FOD (based on calibration items) is 15 mph (25 km/h). Maximum speeds are limited by airport operations regulations. (Mechanical and non-mechanical systems)

(2) Collection path.

(a) The minimum path for a removal system used during airport operations is 60 in (150 cm) wide.

(b) Systems that are: used on the airport apron; pushed by hand; or designed to be mounted on existing airport operations vehicles, must have a minimum path 40 in (100 cm) wide.

(c) Magnets must be at least 36 in (90 cm) long and 4 in (10 cm) wide. (Mechanical and non-mechanical systems)

(3) Retention / Hopper Capacity.

(a) The minimum usable capacity of a power sweeper used during airport operations is 40 cu ft (1 cu m).

(b) For systems mounted on airport operations vehicles, the volume of the truck bed will represent the retention capacity.

b. Testing / Validation.

(1) All FOD removal equipment must be able to demonstrate the ability to collect 90 percent of the items listed in paragraph below, when they are placed in a 10 ft x 10 ft (3 m x 3 m) square on the pavement surface, on one pass of the equipment at a minimum speed of 15 mph (25 km/h). Where specific dimensions and weights are not provided, the purchaser will determine the object properties most characteristic of those found on their airport.

(2) Test / Validation Objects.

- A metal cylinder measuring 1.2 in (3.1 cm) high and 1.5 in (3.8 cm) in diameter,
- A sphere, measuring 1.7 in (4.3 cm) in diameter (i.e., a standard size golf ball),
- A "chunk" of asphalt or concrete,
- Any portion of a runway light fixture (in-pavement or edge light),
- A wrench (up to 8 in. (20 cm) in length),
- A socket (at least 2 in. (5 cm) in length),
- A piece of rubber from an aircraft tire,
- A distorted metal strip (up to 8 in. (20 cm) in length),
- Fuel cap (aircraft or automotive),
- Lug nut,
- Hydraulic line (from aircraft or GSE, up to 8 in. (20 cm) in length), and
- Aircraft fasteners and safety wire.

5.4. DESIGN STANDARDS.

a. General.

(1) Total Life. FOD removal systems must be designed to perform their intended function for their "total life" period, when maintained according to the manufacturer's instructions. The "total life" for which the equipment is designed, assuming it is used and maintained in accordance with the manufacturer's recommendations, must be a minimum of:

(a) 20 years, or 200,000 miles (322,000 km), for mechanical systems, excluding consumable parts (e.g. bristles, brooms, and other portions of the collection mechanism)

(b) 1 year, or 10,000 miles (16,000 km), for tow-behind friction mats and consumable parts.

(c) 30 years for all other non-mechanical systems.

(2) Environmental. FOD removal operations are not meant to occur when a given area is contaminated with snow or ice. In such winter conditions, the equipment listed in AC 150/5200-30 *Airport Winter Safety and Operations* is used to clear the AOA surfaces. Otherwise, FOD removal equipment, including all associated outdoor mounted equipment, must be designed to withstand the following climatic conditions and operate without damage or failure:

(a) Weather

(i) Ambient temperature range: 32 degrees F (0 degrees C) to 123 degrees F (52 degrees C) ambient outdoor air temperature (may be modified by the purchaser if the device is to be used in extreme climates)

(ii) Relative Humidity: 5% to 90% (may be modified by the purchaser if the device is to be used in extreme climates)

(iii) General Environment: Dust and airborne hydrocarbons resulting from jet fuel fumes.

(b) Components must be protected from mechanical, electrical, and corrosion damage causing impairment of operation due to rain, snow, ice, sand, grit, and deicing fluids.

(c) All electric motors, controls, and electrical wiring / equipment placed outdoors must be weatherproof in order to protect the equipment and connections from the elements.

(d) All non-moving structural components and materials must be individually and collectively designed and selected to serve the total life requirement under such conditions. Moving or working components, such as tires, motors, brakes, etc. are exempt from this provision.

b. Safety. The device must meet the requirements of SAE ARP1247, paragraph 3.8.

(1) Personnel Safety. The device must meet the requirements of SAE ARP1247, paragraph 3.9, except as provided below.

(a) If highway transportability, defined as the capability (of a self-propelled device) to be licensed for operation on public highways, is not specified by the purchaser, the provisions of SAE ARP1247, paragraph 3.9.1 do not apply.

(b) If the device is not self-propelled, the provisions of SAE ARP1247, paragraphs 3.9.2 through 3.9.4 do not apply.

(c) Noise and Vibration. The device must meet the requirements of FAA HF-STD-001, paragraph 13.5 (Noise) and MIL-STD-1472F, paragraph 5.8.4 (Vibration). The unit must be designed and constructed to prevent parts from working loose in service. It must be built to withstand the stresses, jars, vibrations, and other conditions incident to shipping, storage, installation, and service. Suitable and durable vibration isolators must be used between the engine and structural mounts and to include all other

structural mountings to protect the operator, instruments, components, hydraulics, and structure from vibration transmission.

(2) Equipment Safety. The device must meet the requirements of SAE ARP1247, paragraph 3.10.

(a) For any device not completely manually operated, a 5 lb (2 kg) BC-rated fire extinguisher must be mounted on the device at a location easily accessible to the operator.

(b) Warning devices.

(3) Emergency Operations. The device must meet the requirements of 49 CFR §38.23(b)(3)) and SAE ARP1247, paragraph 3.9.11. Where there is a conflict with the two documents, the DOT regulations take precedence.

(a) Power or Equipment Failure. The device must meet the requirements of 49 CFR §38.23(b)(4)).

(4) Storage / Security. All requirements needed to properly store and secure the device must be supplied by the manufacturer.

c. Engines and Related Equipment.

(1) General. The vehicle must have a commercially-produced engine that is certified to comply with the Environmental Protection Agency (EPA) and state laws for off-highway emission requirements at the time of manufacture. The engine and transmission must operate efficiently and without detrimental effect to any drive train components when lubricated with standard, commercially available lubricants in keeping with the recommendations of the engine and transmission manufacturers.

(2) Acceleration. The fully loaded vehicle will accelerate from 0 to 50 miles per hour (mph) on a level paved road within 30 seconds.

(3) Altitude. Where justified, the vehicle will be designed for operation at 2,000 feet above sea level.

(4) Indicators. Engines used to drive systems, other than the vehicle propulsion system, must be equipped with a tachometer (green-lined within the correct operating RPM range and red-lined above this range) or automatically governed to prevent over-revving.

(5) Engine cooling system. Liquid coolant systems must be rated for the maximum engine loads under the environmental conditions specified by the airport, or at the conditions of maximum intermittent output approved by the engine manufacturer, whichever criterion results in the largest heat transfer capacity. A label will be installed near the engine coolant reservoir reading “Engine Coolant Fill.”

(6) Fuel system.

(a) Gasoline powered engines must meet all performance requirements without requiring premium grades of fuel. Diesel powered engines must be certified for aviation turbine fuel. LPG engines must be certified for (Natural Gas Producers Association) HD-5 motor fuel.

(b) Alternative fuels, such as bio-diesel, clean diesel, gaseous fuels (natural gas and liquid petroleum gas), alcohols (methanol and ethanol), Jet A, and reformulated gasoline may also be used. Equipment modifications to allow the use of such fuels must conform to manufacturer specifications.

(c) Fuel filters. Primary and secondary fuel filters will be provided. Fuel filter elements will be easily replaceable by a mechanic without loss of engine prime.

(d) Fuel tank. The fuel tank will have a fill opening readily accessible to personnel standing on the ground and designed to prevent fuel splash while refueling. Each tank will be located and mounted so as to provide maximum protection from damage, exhaust heat, and ground fires. If more than one tank is furnished, means will be provided to assure equalized fuel level in both tanks. An overturn fuel valve will be provided for each tank to prevent spillage in the event of a rollover. Each fuel tank must be prominently labeled with the type of fuel used in the engine.

(7) Exhaust system. The exhaust system will be constructed of high grade rust resistant materials and protected from damage resulting from FOD impact. Exhaust system outlet(s) will be directed upward or to the rear, away from personnel accessing equipment compartments and the engine air intake, and will not be directed toward the ground. Engine exhaust systems must be provided with flame and spark arrestors.

d. Chassis and Vehicle Components

(1) Transmission. A fully automatic transmission will be provided.

(2) Driveline. If the driveline is equipped with a differential locking control, a warning/caution label will be placed in view of the driver indicating the proper differential locking/un-locking procedures. The operator's manual will also include a similar warning/caution. All moving parts requiring routine lubrication must have a means of providing for such lubrication. There must be no pressure lubrication fittings where their normal use would damage grease seals or other parts.

(3) Axle capacity. Each axle will have a rated capacity, as established by the axle manufacturer.

(4) Tires and wheels. Tires and wheels will be certified by the manufacturer for not less than 25 miles of continuous operation at 60 mph at the normal operational inflation pressure. A spare tire and wheel assembly will be provided; however, the spare tire and wheel assembly are not required to be mounted on the vehicle. Tires will be new. Retreads, recaps, or re-grooved tires are not permitted.

(5) Towing connections. The vehicle will be equipped with towing connections allowing for the vehicle to be towed fore and aft.

(6) Brake system.

(a) The vehicle will be equipped with a braking system in accordance with Federal Motor Vehicle Safety Standard (FMVSS) standards. Vehicles with a Gross Vehicle Weight Ratio (GVWR) above 26,000 lbs will be equipped with air brakes. All components of the braking system will be installed in such a manner as to provide protection from objects liable to strike and cause damage to the brake system components. No part of the braking system will extend below the bottom of wheel rims, to ensure, in case of a flat tire, that the weight of the vehicle will be supported by the rim and the flat tire and not be imposed on any component of the braking system.

(b) Braking systems for vehicles with a maximum speed of less than 20 mph (32 km/h) must meet the requirements of Title 49 CFR Part 393, §393.41 and 393.52. The maximum stopping distance in feet must be equal to the design speed in mph (in meters must be equal to the design speed in km/h).

(7) Steering. The vehicle will be equipped with power steering. The fully loaded vehicle will have a wall to wall turning diameter of less than three times the overall length of the vehicle in both directions.

e. Cab. The vehicle will have a fully enclosed door cab of materials which are corrosion resistant, such as aluminum, stainless steel, or glass reinforced polyester construction. Steps and handrails will be provided for all doors. The lowermost step(s) will be no more than 20 inches above level ground when the vehicle is fully loaded. A tilt steering column will be provided.

(1) Windshield and windows. The windshield and windows will be of tinted safety glass. Each door window will be capable of being opened far enough to facilitate emergency occupant escape in the event of a vehicle accident.

(2) Instruments and controls. All instruments and controls will be illuminated and designed to prevent or produce windshield glare. Gauges will be provided for oil pressure, coolant temperature, and automatic transmission temperature. All device instruments and controls must be located within convenient reach of the seated driver.

(3) HVAC System. If an HVAC system is specified by the purchaser, enclosed lift systems must meet the requirements of SAE J1503 and FMVSS No. 103. In sections where the two documents may conflict, FMVSS No. 103 takes precedence.

(4) Seats. The driver seat will be adjustable fore and aft. Each seat will be provided with a Type 2 seat belt assembly (i.e., 3-point retractable restraint) in accordance with Code of Federal Regulations (CFR) 49 CFR Part 571, §571.209.

(5) Windshield wipers and washer. The vehicle will be equipped with electrically powered windshield wiper(s). The wiper arm(s) and blade(s) will be of sufficient length to clear the windshield area described by Society of Automotive Engineers (SAE) J198, Windshield Wiper Systems - Trucks, Buses, and Multipurpose Vehicles. Individual wiper controls will include a minimum of two speed settings and an intermittent setting. The wiper blades will automatically return to a park position, out of the line of vision. The vehicle will be equipped with a powered windshield washer system, including an electric fluid pump, a minimum one gallon fluid container, washer nozzles mounted to the wiper arms (wet arms), and a momentary switch.

(6) Warning signs. Signs that state "Occupants must be seated and wearing a seat belt when apparatus is in motion" will be provided in locations that are visible from each seated position.

f. Electrical / Lighting

(1) General.

(a) Lighting must in all cases meet the requirements of AC 150/5210-5, *Painting, Marking, and Lighting of Vehicles Used on an Airport*, using the standards for airfield service vehicles.

(b) Unless otherwise specified, electrical systems incorporating a storage battery must have a nominal rating of 12 or 24V DC.

(c) If highway transportability is specified, or otherwise specified by the purchaser, the vehicle lighting must comply with the appropriate provisions of the Uniform Vehicle Code and Federal Motor Vehicle Safety Standards (i.e. FMVSS Title 23, Chapter 2, Standard No. 108 "Lamps, Reflective Devices, and Associated Equipment"). The following lighting equipment must also be provided:

(i) Two sealed-beam headlamps with high and low beams and a beam indicator.

(ii) Two red combination tail and stop lamps, visible from the rear of the vehicle.

(iii) Directional turn signals.

(iv) Dual backup lights controlled by the transmission shift lever.

(d) When possible, headlights must be located on the vehicle so that they are 22 in (559 mm) below the operator's eye level.

(2) Battery Powered Devices.

(a) Batteries must be designed to have a minimum life of 3 years when maintained according to the manufacturer's instructions. For design purposes, a frequency of use of 1000 cycles per year must be assumed.

(b) A self-contained battery charger with automatic voltage control must be provided. The charging process will require the operator to connect a readily-accessible plug to a standard 110 or 220-volt receptacle, as specified by the purchaser.

(c) The battery system must incorporate a battery condition gauge. If a low voltage condition could result in higher amperage flow and motor burnout, then the status-monitoring device must provide a time warning to the operator.

(3) Electromagnetic Interference. The equipment must meet the current issues of radio suppression specification MIL-STD-461, Class 3D, Requirements for the Control of Electromagnetic Interference Emissions and Susceptibility. It must be capable of operating through the entire amplitude modulated aircraft radio frequency range of 75 MHz – 136 MHz.

g. Hydraulic and Pneumatic. The following requirements shall apply to hydraulic systems other than the chassis brake system.

(1) Raising and lowering of the system hopper must be accomplished by one person and through two or more hydraulic cylinders, powered by an electric or engine driven pump.

(2) Hydraulic fluid must be as recommended by the manufacturers of the hydraulic system components.

(3) The materials used for each hydraulic line must be consistent with its application. Fixed lines must be made of high quality steel or stainless steel. Flexible lines must be used only where necessary.

h. IDENTIFICATION AND MARKING.

(1) The device must meet the requirements of SAE ARP1247, paragraph 3.13.9 and AC 150/5220-5, using the standards for airfield service vehicles. The shifting diagram placard specified in SAE ARP1247, paragraph 3.13.9.6 may be provided in a medium other than metal if designated to last for

the total life of the equipment. In the event that identification and marking guidance differs between SAE ARP1247 and AC 150/5210-5, AC 150/5210-5 takes precedence.

(2) Painting and Marking. The device must meet the requirements of SAE ARP1247, paragraph 3.13.11.

(a) The system must be primed in accordance with accepted industry standards for heavy-duty industrial equipment intended for outdoor use.

(b) The system must be furnished as specified by the purchaser, in accordance with AC 150/5210-5, using the standards for airfield service vehicles.

i. Optional Equipment.

(1) The following options are not allowed unless specific justification is provided:

(a) Turbocharged engine;

(b) Auxiliary hand hose, and hand hose hydraulic assist;

(c) Gutter-broom attachments**.**

(2) Vehicle undercarriage coatings are not allowed.

5.5. ADDITIONAL STANDARDS.

Additional FOD removal system standards are located in Appendix C.

This page intentionally left blank.

CHAPTER 6. FOD EVALUATION

6.1. DATA COLLECTION AND ANALYSIS

a. A critical part of any FOD management system is the information available for problem assessment and management program design. Although anecdotal information on FOD collected at airports is available, no comprehensive assessment of FOD types and sources is possible unless a comprehensive data collection and analysis scheme is in place.

b. Documentation. The FOD manager will ultimately determine the documentation guidelines in a FOD management program. Certain small items, such as plastic wrappers or baggage tags, may simply warrant efficient collection and disposal. A consistent trend of small items, such as those coming from a particular entity or operation, or particularly large or hazardous FOD, may require detailed documentation for effective analysis and prevention efforts. It is recommended that airport personnel collect the following information, to the extent practicable, whenever FOD is collected:

(1) How the FOD object was detected

(2) Date and time of FOD detection and retrieval

(3) Description of FOD retrieved (category, size, color)

(4) Location of FOD object (coordinates and reference to the AOA location)

(5) Possible source

(6) Name of personnel detecting / investigating FOD item

(7) An image of the FOD object retrieved (if available)

(8) Name of person, date, and time, of incident investigation

(9) Airport operations data during the FOD detection event

(10) Weather data during the FOD detection event

(11) Flight schedules during the FOD detection event

(12) Chain of custody information.

c. Reporting.

(1) Depending on the volume or significance of collected FOD, the FOD manager may decide that it is necessary to designate and train certain personnel to collect, tag, store, and report on the collected FOD for future data analysis efforts. An additional communication procedure may also need to be established, so that the person who first collects the FOD will notify the person responsible for reporting the FOD. In any case, a well-defined reporting procedure is an important aspect of any FOD management program.

(2) The FOD management program should include a visible non-punitive FOD reporting system supported by management. The reporting system should permit feedback from personnel regarding FOD

hazards and other safety-related concerns. The FOD management system should use this information to identify and address operational or administrative deficiencies. The safety reporting system may also identify and correct non-conformance to safety policy.

d. Investigation. It is recommended that major FOD incidents (as classified by the airport) are investigated by the FOD manager or other appropriate airport personnel, to the extent sufficient time allows. An investigation should try to determine the source of FOD and damage caused. When the investigation is completed and necessary corrective action has been implemented in accordance with the FOD management plan, final disposition of the incident should be entered into a FOD incident report.

e. Database. It is important that the organization maintain a record of the measures taken to fulfill the objectives of the FOD management system. These records may be required in the event of a formal investigation of an accident or serious incident, and can also be used to identify any trends, repeats, unusual conditions, etc., in order for corrective action to be initiated. Records can also support the assessment of system operational history and assure operational capabilities. The disposition of reported information will be based on the airport's Concept of Operations (CONOPS) and FOD management program specifications and support §139.327 certification. All records should be maintained in sufficient detail for a period of at least 2 years to ensure traceability of all significant safety-related decisions. The FAA is currently developing the framework for a national FOD database. Airport's collecting high-quality FOD data (showing at least the type, location, and source), are encouraged to submit their data to FAA once the national database is in operation.

6.2. CONTINUOUS PROGRAM IMPROVEMENT.

a. Safety performance monitoring validates the FOD management program, confirming the organization's safety objectives. Through regular review and evaluation, management can pursue continuous improvements in FOD management and may revise safety objectives, policies, procedures, and training programs to ensure that the FOD management program remains effective and relevant to the organization's operation.

b. The FOD Manager, in assessing the effectiveness of the FOD management program, should work with the persons that have direct responsibility for analyzing hazards, identifying control measures derived from that analysis, and ensuring those measures are effective. Effective FOD management is a combination of technology application and a well developed concept of operations (CONOPS).

c. Program Audits. Similar to financial audits, these audits provide a means for systematically assessing how well the organization is meeting its FOD management objectives. The audit provides a review of existing conditions and results in recommendations for enhanced debris control. Management may choose to have an external agency audit the system (e.g., by a consultant or another airport operator), or choose to perform the audit using airport/airline staff. In addition to supporting the airport operator's existing responsibilities for self-inspection and correction of discrepancies under 14 CFR Part 139, an effective airport FOD management program audit should:

(1) Systematically review the effectiveness of existing FOD-management procedures used by airport and airline personnel, including all available feedback from daily self-inspections, assessments, reports, and other safety audits:

(2) Develop identified performance indicators and targets;

(3) Solicit input through a non-punitive safety reporting system;

(4) Communicate findings to staff and implement agreed-upon corrective procedures, mitigation strategies, and enhanced training programs; and

(5) Promote safety in the overall operation of the airport by improving coordination between airport staff, airline personnel, and airport tenants.

d. FOD Committee. Airports with a FOD committee of airport tenant representatives tend to control FOD more successfully than those without such a committee because the representatives can address local conditions and specific problems. At airports served by multiple airlines, the airlines should have these representatives as well as an airport user's committee to coordinate FOD control efforts among themselves.

This page intentionally left blank.

APPENDIX A: SUGGESTED DUTIES AND RESPONSIBILITIES OF THE FOD MANAGER

A.1. GENERAL. The airport operator should designate a FOD Program Manager(s) that will develop and implement plans and programs to prevent, detect, and remove FOD on an airport. The FOD Manager(s) should be appointed by an Airport executive, or executive of the commercial business operating at the airport, and should have sufficient authority and organizational freedom to identify and implement FOD preventive measures whenever and wherever required.

A.2. THE FOD MANAGER should:

a. Review and assess the airport's FOD management program and make necessary revisions.

b. Conduct schedules audits of work areas to assess the effectiveness of the FOD management program.

c. Assure implementation of corrective actions for FOD prevention.

d. Assure that FOD incidents are thoroughly investigated and that incident reports are accomplished as specified in paragraph 6.1 of this AC.

e. Assure that causes of FOD incidents are thoroughly analyzed to define essential corrective measures.

f. Notify affected contractor organizations and personnel of unique FOD prevention requirements.

g. Develop techniques and assign responsibilities for publication of special FOD prevention instructions.

h. Review results of the FOD incident investigations and evaluate the adequacy of corrective actions.

i. Evaluate the amount and kind of foreign objects found and how they were found (e.g. during daily inspections, by pilots, airport operations staff, etc.).

j. Review and approve FOD prevention training curricula, designate training personnel, and assure that contractor personnel receive required training.

k. Assure that written procedures provide for adequate records attesting to the current status and adequacy of the FOD management program.

l. Manage any additional program activities, as required.

This page intentionally left blank.

APPENDIX B: APPLICATION OF FOD RISK MANAGEMENT DURING AIRFIELD CONSTRUCTION

NOTE: *Because of the many variables within an airfield construction operation this case will focus on only one hazard and risk example.*

XYZ Airport has two runways and is planning to build a localizer platform near the approach end of the secondary runway. Construction vehicles must cross the primary runway to gain access to the construction site. Because there are numerous operations during the day, a decision is made to do work at night during lighter traffic. The airport's FOD Manager understands a need to develop a plan for night construction to avoid interruption of day operations. It is clear that there are many challenges in developing such a plan.

To begin formulating the plan, the FOD manager consults with the designated FOD Safety Committee and follows the guidance outlined in the FAA Advisory Circular 150/5370-2, *Operational Safety on Airports During Construction*. One area of concern found during this process was the transportation of small items to the construction site in a way that would avoid losing any items on the airfield that would then become FOD hazards. In evaluating this process, the committee decides to follow the concept of systems safety and apply SRM to evaluate their decisions.

B.1 PHASE 1. DESCRIBE THE SYSTEM:

- Runway environment during construction at night, including a high volume of construction vehicle traffic between the ramp and the construction site.
- Existing driver training program and the use of escorts for construction vehicles.
- Air Traffic Control Tower, but no radio communications with construction vehicles, which are not radio-equipped.
- Signs, markings and lighting for the taxiways, runways, and construction area.
- Tool control program utilized by construction workers.

B.2 PHASE 2. IDENTIFY THE HAZARDS:

- Construction vehicles crossing primary runway.

B.3 PHASE 3. DETERMINE THE RISK:

- Construction vehicles dropping FOD on runway.

B.4 PHASE 4. ASSESS AND ANALYZE THE RISK:

- Using the Predictive Risk Matrix, it is the opinion of the committee there is a *probable* chance a construction vehicle will cross the primary runway and drop small construction items. There are night air carrier operations at the airport, so there is a *remote* chance that an aircraft could come into contact with the dropped FOD. The likelihood that FOD dropped on the runway and caused an aircraft accident is therefore *probable*, but the committee understands that the severity of such an incident could be *major*.

- The committee agrees that the proposed means of getting construction vehicles to the construction site is unacceptable and must be mitigated.

B.5 PHASE 5. TREAT THE RISK:

- The committee decides to *control* the risk by using an existing airport perimeter road to gain access to the construction site. All construction vehicles will then be escorted on the perimeter road. Use of the perimeter road may delay construction vehicles due to driving distance but it's in the best interest of safety.

- If no perimeter taxiway was available, temporary rumble strips could be laid down near the apron where trucks enter the AOA, and at the construction site near the taxiway pavement. Also, additional removal operations could be performed before, during, or after the daily construction operations.

- The committee documents this decision process for future follow-up with the Airport FOD Manager.

APPENDIX C: FOD REMOVAL EQUIPMENT: ADDITIONAL STANDARDS

C.1 CONSTRUCTION STANDARDS.

a. General Requirements.

(1) All equipment and material must be new, undamaged, and of the best grade; decisions concerning quality, fitness of materials, or workmanship are determined by the purchaser.

(2) Where items exceed one in number, the manufacturer must provide products from the same component manufacturer with identical construction, model numbers, and appearance.

(3) Insofar as possible, products must be the standard and proven design of the manufacturer.

(4) The manufacturer must install electrical connections for power, controls, and devices in accordance with NEMA and NEC recommendations and requirements. Transmitting equipment must be installed and adjusted in accordance with manufacturer's published instructions and the requirements specified herein.

b. Workmanship. The device must meet the requirements of SAE ARP1247, paragraph 3.13.7.

c. Materials. The device must meet the requirements of SAE ARP1247, paragraph 3.13.2.

(1) Moisture and Fungus Resistance. The device must meet the requirements of SAE ARP1247, paragraph 3.13.4.

(2) Corrosion of Metal Parts. The device must meet the requirements of SAE ARP1247, paragraph 3.13.5.

d. Parts.

(1) Standard and Commercial Parts. The device must meet the requirements of SAE ARP1247, paragraph 3.13.3.

(2) Interchangeability and Replaceability. The device must meet the requirements of SAE ARP1247, paragraph 3.13.6.

(1) Spare / Replacement of Parts. The manufacturer must develop and provide to the purchaser a parts list, including associated replacement/repair costs.

(2) Substitutions. The purchaser must approve any material or equipment designated as an “or equal” product, but these items must be clearly distinguished and noted in the technical manuals as substitutions.

e. Codes, Standards, Regulations, and References. The manufacturer must recognize and comply with all codes and standards applicable to the design and construction of this type of equipment which are generally accepted and used as good practice in the industry.

C.2 DELIVERY AND ACCEPTANCE STANDARDS.

a. For self-propelled, mechanical FOD removal equipment, the manufacturer must provide trained personnel at the time of delivery to place the device into operation.

b. Transportability. If highway transportability is specified by the purchaser, the device must meet the requirements of SAE ARP1247, paragraph 3.7.

c. Quality Assurance. The manufacturer must test all of the equipment installed under this specification and demonstrate its proper operation to the purchaser. The manufacturer must furnish all required labor, testing, instruments and devices required for the conduct of such tests.

(1) The manufacturer must install all electrical, instrumentation, and mechanical works to the satisfaction of the purchaser, with inspecting authorities having jurisdiction.

(2) The manufacturer must notify the purchaser in writing of any instances in the specifications that are in conflict with applicable codes. The manufacturer must perform all work in accordance with applicable laws, rules, or regulations.

(3) Deviations from the specifications required for conformance with the applicable codes and/or laws must be corrected immediately, but not until such deviations have been brought to the attention of the purchaser.

(4) For applicable codes and/or laws that govern the minimum design requirements; where this AC calls for materials, vents, ductwork, sizes, design details, etc., in excess of the code requirements, the AC takes precedence.

d. Inspection. Inspections must meet the provisions of SAE ARP1247, paragraph 4.3.

e. Testing. After the equipment has been installed and the various units have been inspected, adjusted, and placed in correct operating condition, the equipment must be field tested in accordance with the purchasers testing procedures and requirements. The field tests must demonstrate that the equipment functions are in compliance with the specifications over the entire range of operation. The manufacturer must report any unusual conditions and correct deficiencies of any of the units.

(1) Preliminary Qualification Tests. Preliminary qualification tests may be specified by the purchaser.

(2) Formal Qualification Tests. Formal qualification tests may be specified by the purchaser.

(3) Specification Conformance Tests. The manufacturer must perform any tests referred to in SAE ARP1247, paragraph 4.6, if specified by the purchaser. The purchaser may elect to accept documentation of previously run tests.

(4) Reliability Test and Analysis. A reliability test and analysis may be specified by the purchaser.

f. Data and Analyses. If requested by the purchaser, the requirements of SAE ARP1247, paragraph 4.4, must be met by the manufacturer.

g. Manuals and Publications. The following operation and maintenance manuals must accompany the delivered equipment. The quantity of items is specified by the purchaser. No special format is required.

(1) Operator's handbook.

(2) Illustrated parts breakdown and list.

(3) Preventive maintenance schedule.

C.3 POST-DELIVERY STANDARDS.

a. Training. For self-propelled, mechanical FOD removal equipment, the manufacturer must provide trained personnel at the time of delivery to adequately train airport/airline staff in the operation and maintenance of the equipment.

(1) Training must include written operating instructions that depict the step by step operational use of the device. Written instructions must include, or be supplemented by, materials which can be used to train subsequent new operators.

(2) Training topics must include trouble shooting and problem solving, in the form of theory and hands-on training, for personnel designated by the purchaser.

(3) A minimum of 4 hours of training for every airport/airline personnel and technician on the purchaser's maintenance staff must be provided by the manufacturer. Training selected personnel as part of a "Train the Trainer" program will also satisfy this requirement.

(4) Training time per day must not exceed 8-hour shifts, unless otherwise specified by the purchaser.

(5) Upon the completion of training, the manufacturer must issue each participant a certificate of competency.

b. Maintenance / Reliability. The equipment and its accessories must be designed and constructed with reliability of operation as a primary consideration. The minimum reliability design requirement is that the equipment be designed to operate between periodic preventive maintenance activities of 4 months. The above interval does not apply in cases where the component manufacturer recommends more frequent maintenance intervals.

(1) Preventive. The manufacturer must develop and provide to the purchaser written documentation on recommended preventive maintenance actions.

(a) For the purpose of this specification, normal servicing of fuel, oil, tire pressure, battery, and water are not considered preventive maintenance.

(2) Cleaning. The manufacturer must develop and provide to the purchaser written documentation on recommended cleaning procedures, including solvent types and tools.

(3) Inspection. The manufacturer must develop and provide to the purchaser written documentation on regularly scheduled maintenance inspection procedures. A focus on sensitive equipment and schedule timelines must be included in the documentation.

(4) Spare / Replacement of Parts. The manufacturer must develop and provide to the purchaser a parts list, including associated replacement/repair costs.

(5) Tools and Test Equipment. The device must meet the requirements of SAE ARP1247, paragraph 3.12.4.

C.4 PROCUREMENT GUIDANCE.

a. Buy America. Equipment described in this chapter purchased with federal funds (AIP or PFC) are subject to the Buy America Act codified in 49 USC 50101. Further information, including waiver qualifications, can be found in the legislative text located at: http://uscode.house.gov/