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Civil Engineering

PAVEMENT EVALUATION PROGRAM

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This instruction implements AFPD 32-10, Installations and Facilities. It outlines responsibilities, requirements, and procedures for requesting, conducting, and reporting results of pavement structural evaluations; friction characteristics evaluations; Pavement Condition Index (PCI) surveys; power check pad anchor tests; and roughness surveys. It also outlines the procedures for determining the need for runway rubber removal and provides guidance and criteria for airfield pavement Engineering Assessments (EA) and asset management. Use this guidance in the United States (U.S.) and U.S. territories in conjunction with applicable Federal, state, and local laws and regulations. Although evaluation procedures follow the same methods anywhere in the world, for installations outside the United States and its territories, compliance requirements within the Overseas Environmental Baseline Guidance Document (OEBGD) or the final governing standard (FGS) for the host country take precedence over this document. Ensure that all records created as a result of processes prescribed in this publication are maintained in accordance with Air Force Manual (AFMAN) 33-363, *Management of Records*, and disposed of in accordance with the Air Force Records Disposition Schedule (RDS) located in the Air Force Records Information Management System (AFRIMS). Send comments and suggested improvements on Air Force (AF) Form 847, *Recommendation for Change of Publication*, through major commands (MAJCOM) to the Air Force Civil Engineer Center (AFCEC), 139 Barnes Drive, Suite 1, Tyndall AFB, FL 324035319. The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Air Force.

SUMMARY OF CHANGES

This document has been substantially revised and must be completely reviewed. Major changes include updates to information on equipment and procedures used by AFCEC to plan and conduct airfield pavement structural and runway friction characteristics evaluations, including procedures for determining when to remove rubber; additional procedures for managing the condition survey program; additional information on procedures and equipment for performing anchor tests; and procedures and criteria for EAs and asset management.

WAIVER

Waiver Authority Statement. Requests for waivers must be submitted through the chain of command to the appropriate Tier waiver approval authority or alternately for non-departmental level publications. Request for waivers must be processed through command channels to the appropriate level of command as determined by AFI 33-360.

Chapter 1

OVERVIEW

1.1. Purpose of the Program. The Air Force Pavement Evaluation Program obtains, compiles, and reports pavement strength, condition, and performance data, including data on structural, friction, roughness, and anchor capability on all airfields with present or potential Air Force missions. Pavement evaluation data give civil engineers the information they need to actively manage base and airfield pavement systems, as well as providing operators the information they need to manage and control the airfield. They use the results of pavement evaluation studies to:

1.1.1. Determine the size, type, gear configuration, number of passes, and weight of aircraft that can safely operate from an airfield without damaging the pavement or the aircraft.

1.1.2. Develop or adjust operations usage patterns for a particular aircraft pavement system (for example, parking, apron use patterns, and taxiway routing).

1.1.3. Project or identify major maintenance or repair requirements for an airfield pavement system to support present or proposed aircraft missions. Structural evaluations provide engineering data used in pavement EAs and asset management and are a good reference aid for designing projects.

1.1.4. Develop and maintain airfield layout and physical property data to the section level to assist airbase mission and contingency planning functions and provide information for validation of real property records.

1.1.5. Develop and confirm design criteria.

1.1.6. Develop and justify major pavement projects and maintenance and repair (M&R) plans.

1.1.7. Enhance flight safety by implementing recommendations from friction and roughness characteristics reports, when applicable.

1.1.8. Verify that power check pad anchors can safely support aircraft engine maintenance.

1.2. Program Elements. The Air Force Pavement Evaluation Program consists of several elements:

1.2.1. Airfield pavement structural evaluations.

1.2.2. Runway surface effects evaluations (friction characteristics and runway roughness).

1.2.3. PCI surveys for airfields and road networks.

1.2.4. Power check pad (trim pad) anchor tests.

1.2.5. Pavement EAs.

1.2.6. Asset management.

1.3. Types of Evaluations:

1.3.1. **Airfield Pavement Structural Evaluation:** Determines a pavement's load-carrying capability for various aircraft by testing the physical properties of the pavement system in its current condition.

1.3.2. **Runway Friction Characteristics Evaluation:** Determines the hydroplaning potential of a runway surface under standardized wet conditions.

1.3.3. **PCI Survey:** Identifies and documents pavement distresses caused by aircraft loadings, vehicle traffic, and environmental conditions. Base and command personnel use these data to:

1.3.3.1. Determine the operational condition of pavements;

1.3.3.2. Develop and prioritize sustainment, repair and restoration/modernization projects;

1.3.3.3. Determine whether an airfield structural pavement evaluation is needed;

1.3.3.4. Perform EAs;

1.3.3.5. And manage assets.

1.3.4. **Power Check Pad Anchor Test:** Uses specialized equipment and procedures to determine the capability of anchors to support aircraft engine tests.

1.3.5. **Engineering Assessments:** EAs are analyses currently provided as part of PCI surveys that combine data from the PCI survey, structural evaluation and friction evaluation and are conducted to prioritize pavement O&M projects.

1.4. Asset Management. An Activity Management Plan (AMP) is prepared to determine the funding required to maintain essential infrastructure. AMPs include information on Real Property inventory, Levels of Service (LOS), Key Performance Indicators (KPI), and the planned investments (projects/requirements) identified to achieve the required LOS (see Chapter 9).

Chapter 2

ROLES AND RESPONSIBILITIES

2.1. AFCEC:

2.1.1. Manages the airfield pavement structural evaluation, runway friction characteristics evaluation, condition survey, and power check pad anchor testing programs.

2.1.1.1. Coordinates with MAJCOMs for priorities for pavement structural evaluations, runway friction characteristics evaluations, and power check pad anchor tests.

2.1.1.2. Develops an annual schedule and performs evaluations based on resource availability, contingency requirements, and other factors.

2.1.2. Manages/monitors the airfield PCI survey program and assists MAJCOMs to ensure that the surveys are accomplished at the required frequency. Provides on-call contract support to accomplish PCI surveys funded by MAJCOM/base.

2.1.3. Maintains a central file on base and airfield PCI surveys, airfield structural pavement evaluations, runway friction characteristics evaluations, and power check pad anchor tests.

2.1.4. Consults on pavement evaluations, including runway roughness, and performs special pavement and soil studies as required.

2.1.5. Develops criteria and guidance for pavements EAs and asset management.

2.1.6. Obtains/maintains Air Force-wide approval for PAVER to reside on the network.

2.1.7. Provides fund cite for shipping soil and core samples (reference paragraph 2.3.2.5).

2.2. MAJCOM/DRU Civil Engineer:

2.2.1. Ensures that all MAJCOM bases conduct airfield and roads PCI surveys on a 5-year recurring cycle for Main operating bases and auxiliary fields. Geographically Separated Units in remote areas may be exempted from this requirement at the MAJCOM Pavement Engineer's discretion.

2.2.2. Ensures that bases prepare and distribute airfield PCI survey reports. If required, requests contract support and provides funding to AFCEC for PCI surveys.

2.2.3. Formally requests airfield pavement structural evaluations, runway friction characteristics evaluations, and anchor tests from AFCEC when needed, justified, properly supported, and prioritized.

2.2.4. Manages the MAJCOM pavement EA program and the asset management program.

2.3. Base Civil Engineer (BCE): *Note:* The following requirements by the base follow the waiver tiering system established in AFI 33-360. Waiver Tiers (T-0, T-1, T-2, T-3) identify the appropriate approval authority for all waivers.

2.3.1. Accumulates and maintains background information for condition surveys, pavement evaluations, and friction characteristics evaluations (T-2).

2.3.2. Provides the support required for pavement evaluations (T-2). Detailed support requirements are outlined in the AFCEC base support requirements letter. The BCE's responsibilities include the following:

2.3.2.1. Provides local transportation, clearances for base and airfield access, runway closure times, billeting, vehicle maintenance, airfield equipment, and other required support for the evaluation teams.

2.3.2.2. Provides the labor, material, and equipment to excavate and backfill test sites, if required, and repair core holes.

2.3.2.3. Arranges approval for the teams to photograph pavement areas.

2.3.2.4. Provides a project officer and representative to support AFCEC evaluations and surveys.

2.3.2.5. Provides or arranges for shipping of pavement and soil samples when necessary in support of AFCEC APE Team (reference paragraph 2.1.7).

2.3.2.6. Provides the construction history since the last evaluation, as-built and design drawings, and planned construction projects.

2.3.2.7. Removes rubber buildup prior to runway friction evaluation, if required.

2.3.2.8. Disconnects and moves aircraft arresting cables to the side, as required.

2.3.2.9. Provides equipment and other requirements, such as water for friction testing and crane or forklift for power check pad anchor testing.

2.3.3. Provides technical assistance for runway rubber removal determinations; manages the rubber removal contract or conducts rubber removal with in-house resources (T-2).

2.3.4. Manages the base asset management program (T-2).

2.3.5. In conjunction with the airfield manager, performs visual airfield inspections at least annually to identify M&R requirements including runway rubber removal (T-2). Coordinates with contracting officer to establish appropriate M&R contracts.

2.3.6. In order to ensure that base pavement engineers have adequate knowledge on Air Force pavements, design and repair techniques, base pavements experts should receive and maintain adequate professional continuing education. This will ensure that the personnel will stay current on practices and techniques, along with having the basic knowledge necessary to perform adequate EAs. The Civil Engineer School's WENG 555 *Airfield Pavement Construction Inspection*, WENG 550 *Airfield Pavement Rehabilitative Design and Maintenance*, or equivalent courses can provide this training.

2.4. Airfield Manager:

2.4.1. Provides the annual number of operations for each type of aircraft using the runway (T-3).

2.4.2. Coordinates with BCE on required runway rubber removal frequency (T-2).

2.4.3. In conjunction with the BCE, performs visual airfield inspections at least annually, to identify M&R requirements, excess rubber buildup, etc (T-2).

Chapter 3

LINEAR SEGMENTATION OF PAVEMENTS

3.1. Department of Defense (DOD) Linear Segmentation Guidance. Recent efforts by the DOD to better manage infrastructure assets resulted in the publication of new guidance on Real Property Inventory Requirements and linear segmentation of the assets. This guidance can be found at **http://www.acq.osd.mil/ie/bei/library.shtml#rpir**. It establishes a framework for a transformed real property accountability business process, and establishes data standards required to manage real property assets throughout their life cycle. This AFI provides guidelines for linear segmentation of both airfield and roadway pavements to supplement DOD guidance and provides a common framework that enables pavement evaluation data to be shared with real property, asset management, and geospatial information systems. This integration allows these systems to use the data generated by recurring pavement evaluations as an authoritative source of pavements inventory and condition data for the systems of record. The Linear Segmentation Playbook available at **https://cs.eis.af.mil/a7cportal/CEPlaybooks/OPS/LI/default.aspx** provides a supplement to this AFI.

3.1.1. To achieve OSD linear segmentation objectives, data elements outlined in the *OSD Real Property Information Data Model Version 5.0* used in real property systems, are assigned to linear segmentation data elements used in pavements management. The key field of importance is the Real Property Unique ID (RPUID) which is linked to each section, although other fields are linked as well, including the Real Property Network, Real Property Site Unique Identifier (RPSUID), Facility Number, Facility Analysis Category (FAC), and Category Code (CATCODE). Following is a description of these data elements.

3.1.1.1. **Real Property Network.** The Real Property Network groups assets based on the common service or commodity provided, such as an airfield pavement system or road, street, and parking area system. This concept aligns well with the network concept used in the pavement community. The primary criteria for a network is that is can have only one Real Property Site Unique Identifier (RPSUID). In addition, a network may be established for other reasons. For example, even though they have the same RPSUID as the main base, the roads and parking in base housing may be a separate network, especially if they have been privatized. Real property records, privatization agreements, or survey data will be important in determining where exact break points are when transitioning from one network to another. Following are some examples of networks that will be established:

- Airfield network for main base
- Paved road, drive and parking network for main base
- Unpaved road, drive and parking network for main base
- Airfield network for auxiliary fields or landing zones
- Paved road, drive and parking network for auxiliary fields or GSUs
- Unpaved road, drive and parking network for auxiliary fields/ranges
- Paved road, drive and parking network for housing

3.1.1.2. **RPSUID.** The RPSUID is a unique number that is assigned to each site by OSD. In most cases this will equate to an installation.

3.1.1.3. **RPUID.** The RPUID is a non-intelligent code assigned by OSD used to permanently and uniquely identify a real property asset. Note that there is a one-to-one relationship between the RPUID and the facility number.

3.1.1.4. **Facility Number.** AFI 32-9005, *Real Property Accountability and Reporting*, paragraph A9.8 requires that all facilities located on or under control of the installation, including privately owned, have a unique facility number assigned by the Real Property Officer.

3.1.1.5. **FAC.** The FAC is an OSD level designator that represents the current use by the assigned user of a specific portion of the real property asset. For example FAC 1111 identifies a runway.

3.1.1.6. **CATCODE.** The CATCODE is a Military Service designator that represents the current use by the assigned user of a specific portion of a real property asset. Each FAC has one or more CATCODES assigned to it. For example CATCODE 111111 is the Air Force CATCODE for runways. Note that CATCODES are not the same among the services. A pavements facility can have only one CATCODE.

3.2. Pavement Management Segmentation. For many years, engineers have segmented pavement systems into basic units, designating pavements with common characteristics as networks, branches, and sections. Figure 3.2 shows the accepted schema for naming segments on an airfield and Figure 3.3 shows the schema for roads and parking areas. Unified Facilities Criteria (UFC) 3-260-01, *Airfield and Heliport Planning and Design*; UFC 3-260-02, *Pavement Design for Airfields*; and UFC 3-260-03, *Airfield Pavement Evaluation;* also provide information on segmentation and procedures for identifying branches and sections of airfield pavements for both PCI and structural pavement evaluations.

3.2.1. **Network.** A network is typically characterized as all pavements with a similar function, such as all airfield pavements or all roads and parking areas on a base. This construct aligns well with the Real Property definition of a network as described above. Networks are further subdivided into branches that are a logical subset of the network.

3.2.2. **Branch.** A branch is a subset of the network such as a runway, a named taxiway or an apron for an airfield, or a named road or parking area. Branches are subdivided into sections that are a subset of the branch with specific physical or usage characteristics.

3.2.3. **Section.** A section is a subset of a branch and is assigned based on characteristics such as pavement type, use, structure, construction history, traffic area, rank, or condition. Some of these characteristics, such as traffic area, are just applicable to airfields, while others, such as pavement type apply to both airfields and roads.

3.2.3.1. **Pavement Type.** There are several pavement types: flexible, rigid, rigid or flexible overlay on rigid, flexible overlay on flexible, composite, and reinforced rigid, as well as unsurfaced. A specific section contains only one pavement type.

3.2.3.2. **Pavement Use.** Airfield pavements consist of runways, taxiways, aprons, overruns and shoulders. The pavements not associated with the airfield on a base consist of roads, parking areas, and driveways. A section typically has a single pavement use.

3.2.3.3. **Pavement Structure.** The thickness and strength of the pavement and soil layers usually vary considerably throughout an airfield or road and parking system;

however, each discrete pavement section must have relatively uniform cross-sectional properties to represent the section.

3.2.3.4. **Construction History.** In most cases, pavements are constructed using different materials and techniques on various portions of the airfield or base at different times. All pavements included in a specific section have a consistent construction history.

3.2.3.5. **Pavement Rank.** Pavement sections are assigned a rank; Primary, Secondary, Tertiary, or Unused to help define the importance of the structure in the asset management system as described in paragraph 9.3.1. When a portion of a branch contains pavements with more than one rank, establish sections within the branch according to the rank.

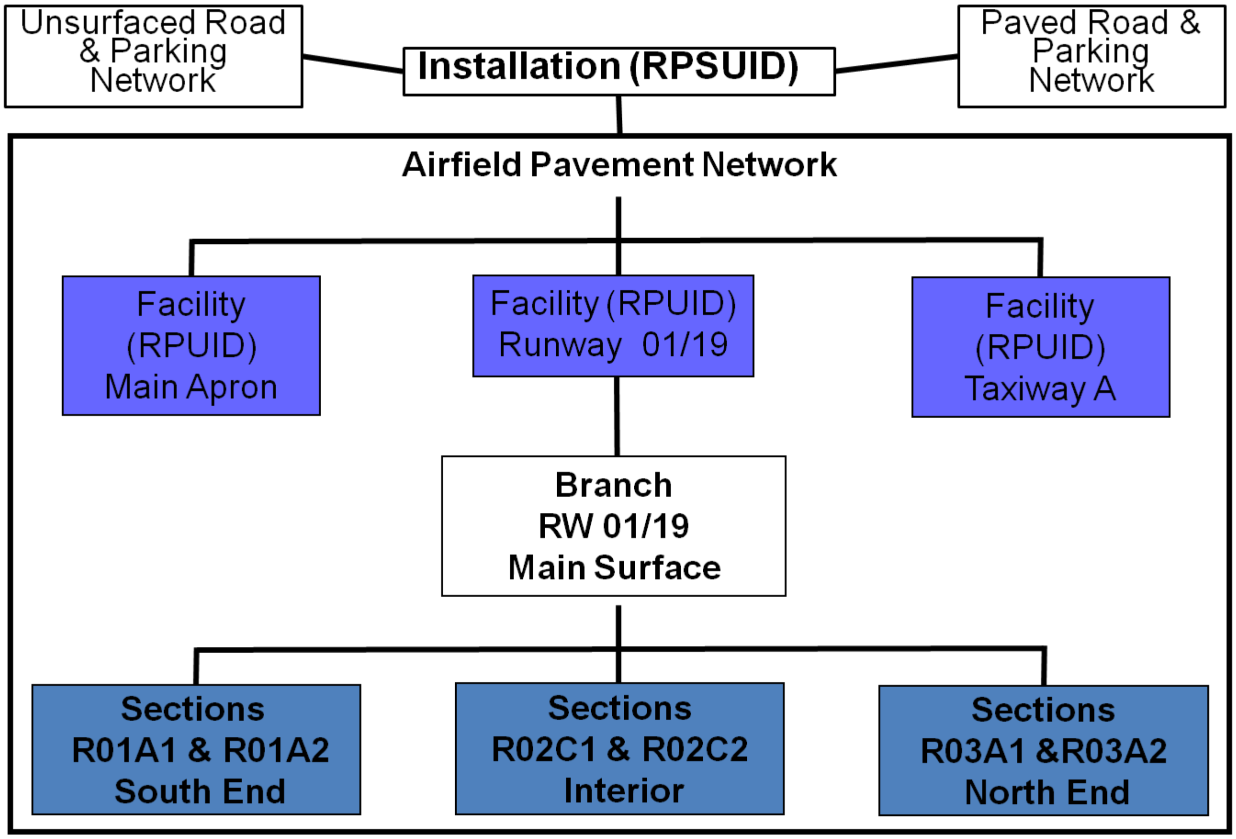
3.2.3.6. **Traffic Areas.** Airfield pavements are divided into traffic areas based on the lateral distribution of aircraft traffic and effective gross aircraft load. These areas are designated types A, B, C, and D. A section typically has a single traffic area designation e.g. A01B has a B traffic area. Further details regarding traffic area segmentation rules are provided in paragraph 3.6.

3.2.3.7. **Pavement Condition.** Each pavement section has consistent characteristics as addressed in paragraphs 3.2.3.1 through 3.2.3.6. Sometimes the condition of the pavement in an area varies considerably. In this situation, the discrete pavement area can be subdivided into separate pavement sections based on the surface condition of the pavement. See paragraph 3.6.4 for details on creating sections based on condition.

3.3. Correlation of Real Property and Engineering Pavement Linear Segmentation Data. The general hierarchy for integrating pavements real property and engineering data is network, facility, branch, and section. Ideally, there should be a one-to-many relationship between each of these entities as you proceed down the hierarchy (See Figure 3.1 below). However, initial efforts to correlate segmentation data elements (branches and sections) used in pavements management with real property pavement facilities highlighted several issues that may need to be addressed when implementing linear segmentation guidance at a specific location. The primary impact of these issues is that there will likely be instances where the hierarchy shown in Figure 3.1 cannot be maintained without compromising the ability to manage the asset from an engineering perspective. A primary example is having to divide a single branch into multiple branches preventing analysis of that branch as a single entity (for example, will not be able to calculate the weighted area condition for a named taxiway within PAVER). In instances where the pavements have the same category code, the Real Property Officer may be able to consolidate the multiple facilities into one, resolving the issue. If asset depreciation or other issues prevent this and the facility cannot be modified, the hierarchy may be disregarded to maintain the integrity of the branch.

3.3.1. **Pavement Facilities and Category Codes:** In pavement terms, a facility is an area of pavement with a specific function such as a runway, apron, taxiway, overrun, shoulder, roadway(s), or parking area(s). In real property terms the definition of a linear facility is more restrictive. Currently the primary constraint for creating a linear facility is that category codes cannot be mixed. For example, overruns (category code 111115) cannot be combined in a facility with the main load bearing surface of the runway (category code 111111). The facility is not only tied to the category code, but may also be tied to other characteristics such as when it was originally constructed.

Figure 3.1. Segmentation Hierarchy.



3.3.2. **Creation/Designation of Pavement Facilities Varies from Base to Base;** Real Property guidance requires a real property record be prepared for each real property asset. In practice, bases have implemented theses rules in many different ways. Pavement assets are assigned facility numbers separately or in the aggregate, according to command or base determination. Each base will have a pavement facility map that shows the geospatial extents of each pavement facility in its real property records. If the base does not have one, it must create it. The Linear Segmentation playbook, https://cs.eis.af.mil/a7cportal/CEPlaybooks/OPS/LI/default.aspx provides additional information on creating pavement facility maps. The intent of the playbook is to provide standard guidance for creating pavement facilities to reduce the variability from base to base outlined below whenever updates/changes are required. In general, the following situations exist in the field;

3.3.2.1. **Runways.** Typically each runway at a base has its own facility number and the overruns for the runway have a separate facility number. There are instances where runway shoulders have a separate facility as well, but most bases have included all shoulders for runways, aprons, and taxiways in one facility.

3.3.2.2. **Taxiways.** In terms of real property records, some bases have included all taxiways in one facility, some bases have created a facility for each named taxiway (a taxiway with an alpha designation), and other bases have included multiple named taxiways in multiple facilities. Additionally, while it poses significant issues from a pavement asset data management perspective, some bases have created a facility for concrete taxiways and one for asphalt taxiways. As with runways, some bases have combined all shoulders into one facility number while other bases have taxiway shoulders in a separate facility.

3.3.2.3. **Aprons.** As with taxiways, there is variability from base to base in the designation of apron facilities. Some bases have all aprons with a specific category code (even if they are not contiguous) included in a single facility for that category code, other bases have each contiguous apron documented as a separate facility, and others have a combination of the two. Finally, as with taxiways, some bases have created a facility number for all concrete aprons and one for all asphalt aprons.

3.3.2.4. **Roads, Streets and Access Roads.** The term road is typically intended to mean highways, roads, and streets. While ideally, each named road would be managed as a separate facility for real property inventory and programming purposes, as will airfields, there is variability with the way bases have implemented the rules for designating road and parking facilities. Some bases have assigned all surfaced roads (CATCODE 851147) in one facility, others have created a separate facility for all concrete roads and one for all asphalt roads, but most bases have some other variation in which there are multiple road facilities for paved roads and multiple road facilities for unpaved roads. In addition, any access road not associated with a parking area that provides access to a building (for example, the road that goes to the front entrance of the Wing Headquarters building should be considered part of the road facility. Unsurfaced roads (CATCODE 852101) are handled in a manner similar to paved roads. The installation may have all unsurfaced roads in a separate facility or may have documented multiple facilities to capitalize unsurfaced roads.

3.3.2.5. **Driveways.** The term driveway has been used to refer to access roads for buildings or parking areas as well as pavements serving a residence. The current AF real property definition of a driveway (CATCODE 851145) is a private road leading from a street or other thoroughfare to a building, house, or garage. It is normally a hard surfaced road constructed of concrete or asphalt. UFC 3-250-01FA, *Design of Roads Streets, Walks and Parking Areas* and UFC 3-250-18FA, *Geometric Design for Roads Streets and Walks* clearly intends for the term driveway to be associated with a residence in the housing area. While bases have assigned this category code to other pavements, current guidance dictates it be reserved for driveways in housing. As with roads, bases may have assigned all surfaced driveways to one facility, created a separate facility for all concrete driveways and one for any asphalt driveways, or some other variation.

3.3.2.6. **Parking Areas.** Parking areas include both the parking area itself and the access roads that serve it. Some bases have assigned all parking areas for a given category code in a single facility. There are currently six different category codes for surfaced and unsurfaced parking areas which would equate to six facilities. Most bases have multiple pavement facilities for each CATCODE and in practice, there is a great deal of variation in how bases determine which parking areas to include in a specific facility. The main rule of thumb is that parking areas with different category codes cannot be included in the same facility.

3.4. Assigning Branches and to Facilities. Because of the variation described above, the pavement facility map plays a crucial role in correlating engineering pavement segments (branches and sections) to pavement facilities. To start the correlation process, obtain the pavement facility map depicting the location of each pavement facility on the base from the base GeoBase office. As mentioned previously, if the base does not have this map, it must be created. Without this map, it will be extremely difficult, if not impossible, to correlate engineering segments to real property pavement facilities. The map should clearly show the geospatial extent of each pavement facility listed in the real property record. It will include all paved and unpaved airfield, road, driveway, and parking surfaces.

3.4.1. During initial efforts to align branches and sections from the pavement management system with facilities in the real property system, branches and sections used in past pavement evaluations may need to be modified to align with the facility/branch hierarchy and to ensure the boundaries of the branches and sections align properly with the facilities.

3.4.2. When problems or discrepancies are identified, such as inability to maintain facility branch hierarchy, incorrect facility boundaries, or erroneous category codes, discuss the issue with the base pavement engineer, real property officer and the GeoBase office and make needed changes to real property facility numbers and the pavement facility map outlined in the Pavement Linear Segmentation Playbook.

3.4.3. The real property data elements identified in section 3.1 are included as user defined fields in PAVER 6.5.2 using a database template. In PAVER 7.0, the real property data elements are integral to the PAVER data schema so pavements management data and real property facility data can be correlated. The real property data elements are assigned at the section level to provide maximum flexibility and the ability to adjust to future changes. PAVER and the Pavement Computer Aided Structural Engineering (PCASE) program share inventory, meaning that PCASE uses the same branch and section structure as PAVER and data for a given base can be stored in a common database for use by both programs.

3.4.4. Earlier versions of PAVER and PAVER-PCASE 7.0 have a GIS capability which allows the user to import a shape file and create associations between the branches and sections in the inventory and the polygons on the map that define the geospatial extent of the branches and sections. Creating these relationships using PAVER-PCASE ensures adherence to all business rules.

3.4.5. Once a relationship is created between facilities, branches, and sections, the area and condition data in PAVER, as well as the structural capacity data generated by PCASE, can be shared with real property, asset management, and geospatial information systems. The primary key used to exchange data between PAVER-PCASE and these other systems is the RPUID.

3.5. Branch Level Airfield Pavement Segmentation Rules. Ideally, a branch may be assigned to only one facility and a section may be assigned to only one branch. A branch will be given both a branch name and a branch unique ID in PAVER-PCASE. As noted previously, there are instances where the manner in which facilities are designated creates issues for pavement management. In general, if a branch has multiple facility numbers assigned, the RPO, base pavement engineer, and GeoBase office should work together to resolve the issue. If it cannot be resolved, maintain the integrity of the branch. Following are some general guidelines for assigning branches to facilities.

3.5.1. **Runways.** The load bearing surface of each runway is typically a branch. Assign that branch to the facility for that runway. The overruns for a runway will constitute one branch. Assign the overrun branch to the overrun facility for that runway. The shoulders for each runway are typically a branch (RWSHOULDER). Assign that branch to the appropriate shoulder facility whether all shoulders are one facility or there is a separate facility for runway shoulders.

3.5.2. **Taxiways.** For linear segmentation and evaluation purposes, a taxiway will be defined as one with an alphanumeric designation (e.g. Taxiway A, Taxiway A1). The distinction is discussed further in paragraph 3.6.7. In pavement management, the load bearing surface of each named (with an alphanumeric designation) taxiway is typically a branch. If the taxiway has a shredout (e.g. Taxiway A1) include it in the branch with the same alpha designation; in this this example, Taxiway A. Assign these branches to the appropriate facility number per the pavement facility map. The shoulders for taxiways are also given a branch designation (TWSHOULDER). Assign that branch to the appropriate shoulder facility, whether all shoulders are one facility or there is a separate facility for taxiway shoulders.

3.5.3. **Aprons.** Aprons are more of a challenge than runways and taxiways. There are ten different category codes for various types of aprons. In general, aprons can be divided into two types; those used to park aircraft, such as a main parking apron or dispersed parking pads, and those used for short-term parking, such as an arm/disarm pad or for support equipment. There is one category code for aircraft parking aprons and nine for other aprons used by aircraft and support equipment. Main parking aprons or dispersed parking pads (CATCODE 113321) will have an AP prefix in the branch name (e.g. APMAIN) and all other aprons/pads will have an OA prefix in the branch name (e.g. OAHOTCARGO).

3.5.3.1. Divide each contiguous main apron into separate branches based on operational use. For example, a portion of the apron is used for the primary mission aircraft and a portion is used for transient aircraft or an Air National Guard or Reserve mission. These branches will be assigned to the appropriate facility as required.

3.5.3.2. Dispersed parking aprons are typically grouped into a single branch. For instance, all parking pads on the loop taxiway would be in the branch APLOOP. If each of the individual pads has been assigned a facility number, creating a separate branch for each of these facilities significantly complicates analysis. In these instances, disregard the hierarchy and create the branch as described above.

3.5.3.3. For other aprons, use the category code as the guide for creating branches. For example, all arm/disarm pads (CATCODE 116661) on an airfield, even though they are not contiguous, will be included in a branch. Create a separate branch for compass calibration pads, power check pads, dangerous cargo pads, etc.

3.5.3.4. The shoulders for all aprons will be assigned to a branch. Shoulder branches will be assigned to the appropriate facility. Assign that branch to the appropriate shoulder facility whether all shoulders are one facility or there is a separate facility for apron shoulders.

3.6. Airfield Pavement Segmentation Rules. In addition to the branch level rules outlined above, other general rules apply to creating and modifying sections. The Linear Segmentation

Playbook; **https://cs.eis.af.mil/a7cportal/CEPlaybooks/OPS/LI/default.aspx** gives some specific examples to supplement the information provided below.

3.6.1. Airfield Section Naming Conventions. Figure 3.2 below provides an overview of the rules and codes for designating sections. Each airfield section for a specific network has a unique number assigned. For instance, section R01A1 identifies the keel section of the first thousand feet on a given runway. That section number is not used anywhere else on that airfield.

3.6.2. As new sections are created and old ones deleted, over time the section numbering on a base can become complicated. In the past, teams would completely re-number the sectioning on a base to follow a pattern and make it easier to locate sections. While renumbering the whole airfield or road network does make locating sections easier, it presents other issues with continuity. Do not completely re-number pavement sections just to "clean up" the drawing as part of an evaluation. If a new section is created, give it the next consecutive number available or shredout the section if it is structurally the same as the parent section (for example, A10B would be shred out into A10B1 and A10B2). The benefit of each section having the same number over time outweighs the inconvenience. This is especially true when trying to correlate pavement management data with real property and asset management systems.

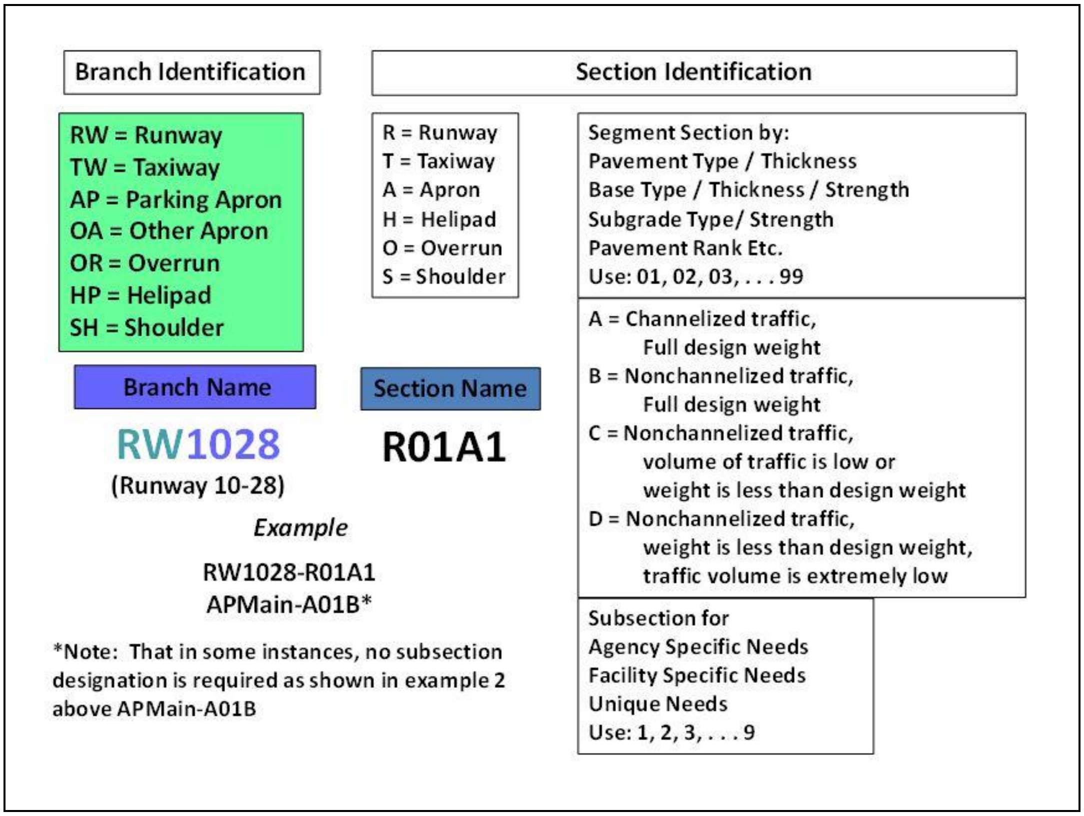
3.6.3. Do not re-use section numbers if the entire section is demolished. Delete the section number in the physical property data (PPD) sheet, but retain it in the construction history with a note that it was demolished. Due to inconsistent application of these rules in the past, there may be gaps in section numbering, but no clear indication of why these numbers are no longer used. If the omitted section numbers are verified as not being used in past evaluation reports, the numbers may be used. Once a number is assigned, do not use it again.

3.6.4. Each pavement section must have relatively uniform cross-sectional properties. Sections can be created with shredouts if they are structurally the same but have a different rank or significantly different PCI. The primary purpose for this business rule is to allow pavement evaluation teams and other users to quickly identify pavements with similar structures on a map and to increase the efficiency of testing. Sections with shredouts will be consolidated when performing coring, dynamic cone penetrometer, and heavyweight deflectometer (HWD) testing.

3.6.4.1. Do not shred out a section that has different physical characteristics. If a portion of a section is reconstructed and is now structurally different, the new portion should get a new section number. For example, a portion of an asphalt ladder taxiway section, T14C, is reconstructed with concrete as part of a runway military construction (MILCON) project. The new section should be given the next consecutive unassigned section number rather than dividing the section into T14C1 and T14C2.

3.6.4.2. A pavement that is milled and overlaid with the same thickness of asphalt that was in the original section would be considered structurally similar and could be given a shredout unless heavyweight deflectometer testing indicates otherwise.

Figure 3.2. Airfield Segmentation Schema.



3.6.5. **Runways.** The keel section of the runway sees a much higher volume of traffic than the outer portions and therefore will usually have a different PCI deterioration rate. To address this issue, designate the keel section of the runway as a section separate from the outer portions. The keel section will be given a shred out (e.g. R01A1) and the outer (noncontiguous) portions of the runway will be given a shred out (e.g. R01A2). The R01A designation indicates that both sections have similar construction and the shredout indicates the sections have another characteristic that warrants they be separated, such as rank or in this case, PCI.

3.6.6. **Overruns.** Overruns and the outside portion of some runways are designed using a D traffic area. For evaluation purposes, overruns are typically evaluated with a C traffic area if evaluated for load bearing capacity with the exception of section 3.6.6.1 below. The primary reason for this is that evaluating an overrun with a D traffic area results in high allowable gross loads (AGLs) and a pavement classification number (PCN) that may be misleading to those using the report. Typically, an overrun will have a tertiary rank unless there is an aircraft arresting system present.

3.6.6.1. Overruns can be constructed with a Type A traffic area to increase the takeoff length for mission aircraft. In these instances, the pavement should be marked with a displaced threshold (per ETL 04-2) and classified (CATCODE) as a runway rather than an overrun. The section will have an R designation, be given an A traffic area, and it will be indentified as a primary pavement. Overruns on unsurfaced landing zones are always evaluated as A traffic.

3.6.6.2. If it is marked as a runway with a displaced threshold but is included in an overrun facility, identify the issue to the base to update the current use (CATCODE). If the CATCODE is correct, label it as an overrun with an A traffic area and give it a primary rank.

3.6.7. **Taxiways, Access Taxiways, and Taxilanes.** While the term taxiway is often used for all three of these entities, they are each defined slightly differently and are treated differently. See UFC 3-260-01, *Airfield and Heliport Planning and Design*, and UFC 3-260-02, *Pavement Design for Airfields* for specific definitions.

3.6.7.1. For linear segmentation and evaluation purposes a taxiway is defined as having an alphanumeric designation (e.g. Taxiway A, Taxiway A1 or East Loop Taxiway). If a named taxiway passes through an apron, it is considered a separate branch/section than the apron pavement. As shown in Figure 3.2, a taxiway will have a T designation. A primary taxiway will have an A traffic area, while ladder taxiways or taxiways that only have a low volume of traffic will typically have a C traffic area.

3.6.7.2. A taxilane on an apron will not typically have an alpha designation. It may or may not have the same representative thickness as the apron but is considered part of the apron in either case. If the taxilane has a different structure than the surrounding apron pavement, it must be subdivided into a separate section of the apron branch and will have an A designation and the same traffic area as the surrounding apron; typically B type traffic for a main apron or C for a hangar access apron.

3.6.7.3. Access taxiways do not have an alphanumeric designation and as the name implies, provide access to a main or hangar access apron, pad, or washrack, etc. Historically, access taxiways have been given either A or T designations and may have A, B, or C traffic areas. In an effort to standardize, many past designations will need to be updated. Do not create a separate section for an access taxiway if it is the same construction as the apron or pad that it is accessing. If the construction is different, make it a separate section and give it a T designation. Note that even though it has a T designation, it will be considered part of the apron facility and branch and will have the appropriate apron CATCODE. It will have the same traffic area as the apron or pad to which it provides access. This will typically be either B or C traffic as outlined in UFC 3-260-02, Figures 3-1 thru 3-3.

3.6.8. **Shoulders.** Shoulders are typically designed to support vehicle traffic and are not given a traffic area in design. AFCEC does not evaluate the structural capability of shoulders as part of an evaluation unless the MAJCOM specifically requests it. Shoulder pavement is given a D traffic type in the inventory should it need to be evaluated in the future.

3.6.9. **Random Slab Replacement and Minor Asphalt Repairs.** Do not subdivide sections that have randomly replaced slabs, have asphalt patches or small areas where the asphalt has been replaced. Generally, a section should only be subdivided when it is a large section and the replaced pavement is contiguous and comprises 25 percent or more of the existing section. Determining what constitutes a large section and when to break out a section involves engineering judgment. The intent is not to break out sections unless it has a significant impact to the outcome of the evaluation or the ability of the base to manage their pavement.

3.6.10. **Pavement Rank.** Sections may be created to differentiate between the relative importance of the pavement to the mission. Consider a situation where the main apron was built at one time with similar construction throughout and is assigned a facility number. Assume the facility has one branch (APMAIN). Currently a portion of the apron supports the assigned flying mission, but half the apron is only used occasionally for air shows or overflow transient aircraft. The portion of the apron that supports the active mission is primary and the remaining apron is tertiary. Divide the apron into two sections (A01B1 primary and A01B2 tertiary for example). That they both have the designation A01B indicates they are structurally similar and the shredout is used to differentiate other differences, such as rank in this case.

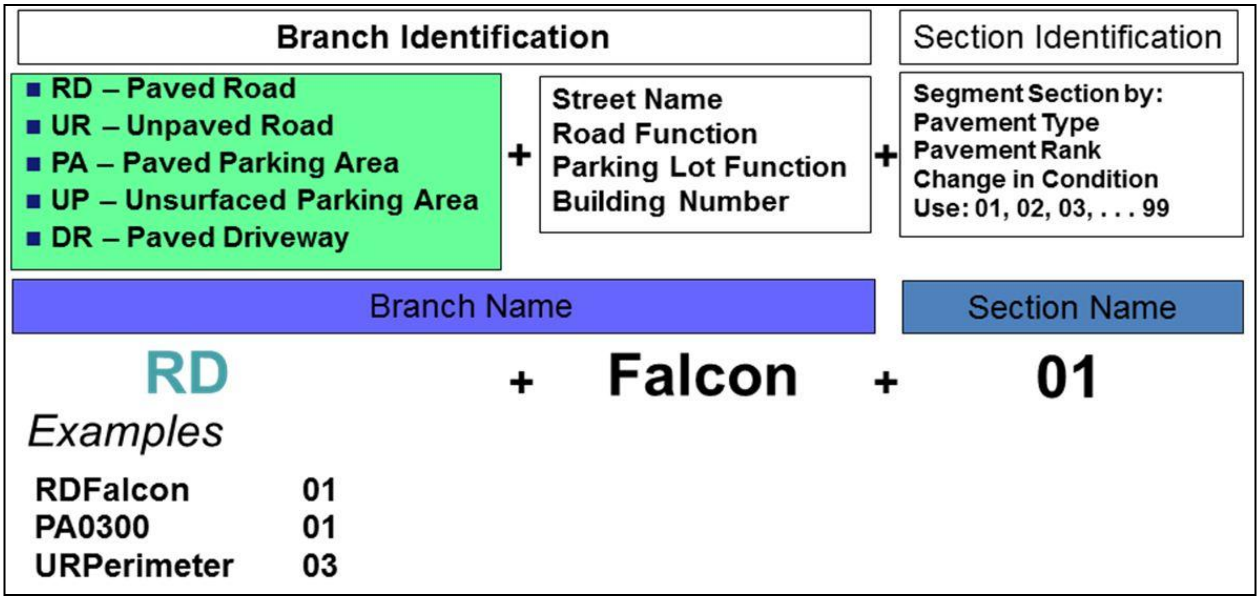
3.6.11. **Pavement Condition.** In general, only shred out additional sections on an apron or taxiway due to condition if the area involved is 25% or more of the total section area and the weighted area average PCI of the sample units within each area differs by at least 15 points. Note that these criteria are somewhat arbitrary and are intended as a rule of thumb. The objective is to only create new sections that significantly impact the results of the evaluation. Don’t subdivide small sections.

3.7. Segmentation of Roads, Driveways, and Vehicle Parking Areas. As outlined in paragraph 3.4., the starting point for aligning branches and sections from the pavement management system with real property facilities is obtaining a pavement facility map that clearly shows the geospatial extent of each pavement facility listed in the real property record (including paved and unpaved roads, drives, and parking areas). If that map does not exist, it must be created before assigning branches and sections to facilities. The base Real Property Officer will work with the base Pavement Engineer and the GeoBase office to ensure that each pavement facility on a base is identified on the map.

3.7.1. The segmentation taxonomy for roadways and parking areas, as for airfields, is network, branch, and section, as shown in Figure 3.3. The same processes described above for creating a pavement facility map and assigning branches and sections to airfield facilities applies. In addition, the same hierarchy shown in Figure 3.1 for network, facility, branch, and section applies to roads and parking areas. As discussed in paragraph 3.3, there will be instances where the hierarchy shown in Figure 3.1 cannot be maintained without compromising the ability to manage the asset from an engineering perspective. An example for roads is a perimeter road that has three facility numbers for different portions of the road. Following the hierarchy would require dividing a single branch (RDPERIM) into multiple branches, preventing analysis of that branch as a single entity. If the RPO cannot combine the facilities, disregard the hierarchy and maintain the integrity of the branch. Following are some specific rules for segmenting roads and vehicle parking areas.

3.7.2. Several networks are typically created for an installation. One will be created for all paved roads, driveways, and parking areas, and one for all unsurfaced roads, driveways, and parking areas. In most instances, a separate network is created for housing areas, especially if there is indication they may be privatized. Separate networks are also created for the roads and parking associated with geographically separate sites.

Figure 3.3. Segmentation of Roads and Parking Lots.



3.7.3. **Branches.** Historically, each named road on a base and each parking area or group of parking areas associated with a specific building or function have been given a branch designation. Following are specific rules for creating these branches.

3.7.3.1. **Road Branches.** Each named road on a base is designated as a separate branch. As with airfields, each of these branches is assigned a rank based on the criteria outlined in paragraph 9.3.2. If a portion of a named road is primary and another portion is secondary, create separate sections for each.

3.7.3.1.1. The process of assigning branches and sections is simple, if all paved roads on a base are assigned to one facility. However, it becomes more complex when all concrete roads are one facility and all asphalt roads are combined in one facility or there are multiple road facilities based on other criteria. Ideally, branches should be created to ensure that no branch is assigned to more than one facility. However in the event of a conflict as described in paragraph 3.3., the hierarchy may be disregarded to ensure the integrity of the branch. For example, a portion of Main Street is constructed of concrete and a portion is asphalt. Each of these areas is a portion of the branch for Main Street. If there is a separate facility for concrete roads and one for asphalt roads, maintain the Main Street branch, but break out sections to align with the respective asphalt and concrete road facilities. If a base has two sites or networks and a branch crosses into different sites or networks, the branch must be divided to ensure a branch is not assigned to more than one network.

3.7.3.2. **Assigning Road Branches.** A surfaced road will use the prefix RD and unsurfaced road will use the prefix UR. The road name will be used as the remainder of the branch name (e.g. RDMAIN or URPERIMETER). There will be instances where the road does not have a name, especially unsurfaced roads. In these cases, give unnamed roads temporary names (URUNAMED1, 2, 3 etc). Before completing the report have the base review all unnamed roads and provide names if they are available. If names are not available, use the temporary name you assigned.

3.7.3.3. **Parking Area Branches.** Assign each parking area or group of parking areas associated with a specific building or function a branch ID and name. Note that a parking area branch includes the access road or access driveway servicing that parking area. Each of these branches will be assigned to the appropriate facility. This will be straight forward when all parking areas on a base are combined into one facility for each respective category code or each parking area has its own facility number. The pavement facility map for roads and parking will provide the primary guide for assigning branches to facilities.

3.7.3.4. **Assigning Parking Area Branches.** Typically, the parking area will use the building number it is associated with or the function of the parking area as the branch name (e.g. PA1138 or PAEXCHANGE). If the parking area does not have a name; especially unsurfaced parking areas, give the unnamed parking area a temporary name (PAUNNAMED1, 2, 3 etc). Before completing the report have the base review all unnamed parking areas and provide names if they are available. If they are not available, use the temporary name.

3.7.4. **.** A section is a portion of a branch that differs in pavement characteristics from other sections such that further segmentation is required to uniquely identify that section. This may include pavement type, construction history, traffic volume, or other physical characteristics, such as the number of lanes. Note that sections for roads and parking are treated differently than those for airfields in that the section number is unique for each branch but is not unique for the base as a whole. For example, the branch for Main Street, RDMAIN has 24 sections numbered 01 thru 24. The branch for Flightline Road, RDFLIGHT is made up of 16 sections numbered 01 thru 16. The only way to distinguish a section uniquely is by the concatenation (branch ID plus section ID) of the branch and the section.

3.7.4.1. **Road .** If the only difference in a road is the pavement material type—concrete for part of the road and asphalt for the remainder of the road—that road branch has two sections. If there is a long road section with consistent physical characteristics, create a section break approximately every half mile. Since base roads do not typically have mile markers, try to create these breaks where the road intersects with another road, a parking area, or some other distinguishable feature. The intent of this guidance is not to create a section break at each intersection, but rather to create enough sections to ensure adequate sampling for projecting maintenance and repair requirements.

3.7.4.2. **at Inter.** Pavement section breaks are not created at each intersection unless there is a change in characteristics or some other factor that drives the creation of the section break at that intersection. When required at an intersection, the section break will be shown as a single line perpendicular to the centerline. The pavement in the intersection will be assigned to the road with the higher rank. When roads are of equal rank, the pavement in the intersection will be assigned to one of the roads, ensuring there is no double counting of pavement area.

3.7.4.3. **Parking Area .** Similar to roads and airfields, parking area branches will be subdivided into sections based on their physical characteristics or construction history. The access road serving a parking area is part of the branch for that parking area and is assigned the appropriate parking area category code for that facility. If the access road has the same construction as the parking area it serves, it can be included with the parking area section. If the access road is constructed differently or is long, it will be assigned a separate section number for the parking area branch. If the parking area is shared between buildings, it may have two separate facility numbers. If that is the case, create separate sections so they can be assigned to the appropriate facility.

3.7.4.4. **Driveways.** As mentioned in 3.3.2.5, the term driveway refers specifically to pavements in housing that serves a residence(s). All driveways on a base may be included in a single facility or each specific housing area may be designated as a separate facility. All driveways on a given street should be included in a single branch and that branch assigned to the appropriate driveway facility. Each individual driveway may be assigned a section if it has sufficient area, or groups of driveways with similar characteristics may be combined in a section to get an adequate sample unit. Note that if the housing area is privatized, inventory the roads, driveways, and parking, but do not inspect them. If the housing area is not privatized, inspect the pavements unless otherwise stipulated in the Statement of Work.

3.8. Pavement Segmentation Mapping. Mapping plays a key role in achieving the OSD linear segmentation objectives. In order to ensure the entire pavement inventory is mapped consistently and accurately, pavement evaluation teams and contractors will use the following process when doing a structural pavement evaluation or pavement condition index survey. Additional details can be found in the Linear Segmentation Playbook that can be accessed at **https://cs.eis.af.mil/a7cportal/CEPlaybooks/OPS/LI/default.aspx**

3.8.1. Obtain the latest Pavement Facility Map and Common Installation Picture (CIP) as well as the latest imagery from the base prior to beginning the evaluation. Ensure you have the metadata associated with both the CIP and imagery and determine the source and accuracy of the vector data in the CIP. In addition obtain a copy of the Airfield Pavement Plan (E-7 Tab), and Airfield Pavement Details (E-8 Tab) if available. Identify any significant issues with the mapping, such as misaligned pavements, duplicate polygons, or other issues that affect the accuracy of the map. The metadata plays a key role in that the pavement vector data in the CIP may have been generated from earlier imagery or an actual survey. If this is the case, the vector data may not align with the current imagery. Ensure that any changes made to the CIP are based on more accurate data. Work with the base GeoBase office to resolve any issues prior to the start of the evaluation.

3.8.2. Current guidance in this AFI will drive changes to past pavement segmentation. Make any required changes to the branches and sections based on the current imagery, pavement facility map, and construction history data provided by the base prior to the evaluation. During the evaluation, make modifications to the branches and sections as well as any changes required to the CIP based on field observations. Document the changes made to the CIP for coordination with the base as a separate document when submitting the report.

3.8.3. Provide a copy of the updated map (in shape file format), along with the change documentation, to the base GeoBase office at the outbrief for their review as part of the draft report review process. Address all base comments regarding mapping and provide the base with a response on resolution of comments.

3.8.4. Provide a copy of the updated map (in shape file format and/or geodatabase format) with the final report. Note that in addition to the shape file, contractors are required to provide all source files in ESRI or AutoCAD format, as appropriate.

Chapter 4

AIRFIELD STRUCTURAL PAVEMENT EVALUATION

4.1. Basic Concepts. In theory, the pavement evaluation procedure is the reverse of the design procedure. The design procedure uses a known design aircraft loading and foundation strength to determine the physical characteristics of the required pavement structure. The evaluation procedure uses known physical characteristics to determine allowable gross loads (AGL) at various pass levels for specific aircraft groups. This section outlines some basic principles and factors that affect pavements and explains how to systematically obtain physical property data.

4.1.1. **Size of Load.**

4.1.1.1. To compute loads on the pavement structure, the Air Force uses: aircraft gross weights; gear configurations; tire spacing (for multiple wheel assemblies); tire pressure or contact area; and weight distribution/center of gravity.

4.1.1.2. To simplify the mechanics of the evaluation, AFCEC assigns Air Force and selected DOD and commercial aircraft to 14 aircraft groups (see Figure 4-1). It then selects a controlling aircraft for those aircraft groups containing more than one aircraft. The controlling aircraft is the aircraft in a particular group that causes the maximum state of stress in a pavement system.

4.1.2. **Frequency of Load.** Load repetitions (aircraft passes) greatly affect pavement life. Pavement life can be expressed in terms of different aircraft weight and pass level combinations. Definitions of passes are contained in UFC 3-260-03. The Air Force evaluates each section for the 14 aircraft groups at the four pass intensity levels shown in Figure 4.1. Figure 4.2 shows the gear type for each aircraft and the Federal Aviation Administration (FAA) designation. Stress points used to calculate allowable loads are also indicated by the red "+" symbols under each gear configuration.

4.1.3. **Distribution of Loads.** Distribution of loads also affects pavement life. Traffic tends to be more concentrated (channelized) on taxiways and runway ends and more evenly distributed (nonchannelized) on the interior portions of runways and on aprons.

4.2. Determination of Pavement Capability.

4.2.1. **AGL.** For each section, AFCEC determines separate AGLs for the four pass intensity levels shown in Figure 4.1. Only four pass levels are used to simplify reporting. The AGLs associated with levels I through IV are based on the physical property data or layered elastic data for each section. For frost-susceptible areas, AFCEC publishes a second table of AGLs if applicable (see UFC 3-260-03). These AGLs are determined for each section for the four pass intensity levels but are based on reduced subgrade strength or reduced modulus values during the frost-thaw period. For sections with a PCI less than or equal to 40, the AGL is reduced by 25 percent. Values in the AGL tables are capped at 2 million pounds (907,185 kilograms).

Figure 4.1. USAF Aircraft Group Index and Pass Intensity Levels.

Aircraft Group Index

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Included Aircraft	C-12 C-21 C-23 C-38A C-41A HH-60 RC-26 RQ-4-Bk 10 T-1* T-6 T-37 UH-1H	A-10 AT-38 F-15* F-16 F-22 F-35 F-117 RQ-4-Bk 20+ T-38	CV-580* MH-53 MV-22 CV-22	C-130* C-27J C-295 CN-235	C-20* C-37	B-717* C-9 DC-9 T-43	A-320 A-321 B-727 B-737 C-22 C-40 MD-81 MD-82 MD 83 MD 87 MD 90 P-3*	A-300 A-310 B-2A B-707 B-720 B-757 C-32A* DC-8 E-3 E-8C KC-135 VC-137	A-330 B-1 B-767 DC-10-10 L-1011 MD-10 B-767 -400ER*	C-17* IL-76	C-5*	A-340 B-777 DC-10-30 DC-10-40 KC-10 MD-11*	A-380 AN-124 B-747 B-747-8 E-4 VC-25 B-747 -400*	B-52*

Note: * Denotes Controlling Landing Gear Configuration in Group

•Pass Intensity Levels (in Passes)

Level	1	2	3	4	5	6	7	8	9	10	11	12	13	14
I	300,000			50,000										15,000
II	50,000			15,000										3,000
III	15,000			3,000										500
IV	3,000			500										100

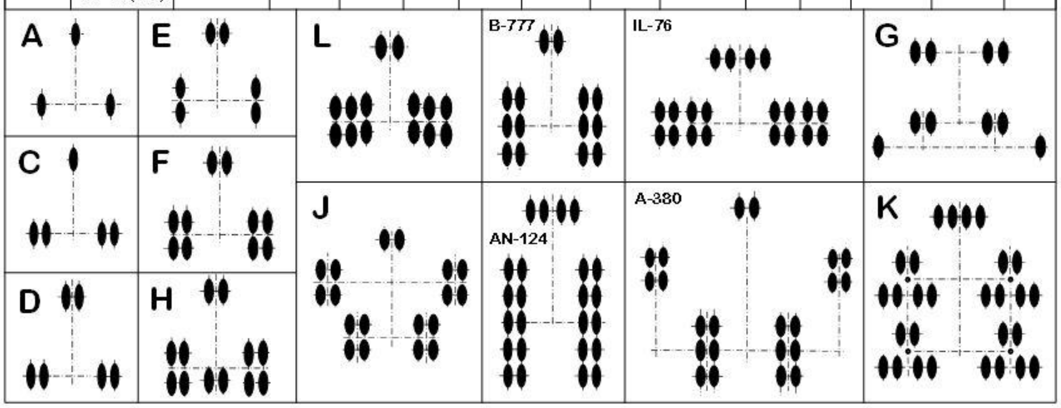
Gross Weight Ranges for Aircraft Groups (in KIPs)

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Lowest Gross Weight	4	8	23	22	39	49	55	110	177	178	374	240	342	230
Highest Gross Weight	27	84	61	175	91	121	210	376	507	585	840	775	1,301	488

Figure 4.2. Gear Types.

Aircraft Group Index: Gear Types

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Included Aircraft	A C-23 C-41A HH-60 T-1* T-6 T-37 C C-12 RQ-4-Bk 10 D C-21 C-38A RC-26 UH-1H (skid)	A A-10 AT-38 F-15* F-16 F-22 F-35 F-117 RQ-4-Bk 20+ T-38	D CV-580* MH-53 MV-22 CV-22	E C-130* C-27J C-295 CN-235	D C-20* C-37	D B-717* C-9 DC-9 T-43	D A-320 A-321 B-727 B-737 C-22 C-40 MD-81 MD-82 MD 83 MD 87 MD 90 P-3*	F A-300 A-310 B-2A B-707 B-720 B-757 C-32A* DC-8 E-3 E-8C KC-135 VC-137	F A-330 B-1 B-767 DC-10-10 L-1011 MD-10 B-767 -400ER*	L C-17* IL-76	K C-5*	H A-340 DC-10-30 DC-10-40 KC-10 MD-11* B-777	J B-747 B-747-8 E-4 VC-25 B-747 -400* A-380 AN-124	G B-52*



4.2.2. **Pavement Classification Number (PCN).** AFCEC determines and reports the airfield PCN, as defined by the International Civil Aviation Organization (ICAO), for each section. The PCN expresses the capability of a pavement to support aircraft traffic and varies with aircraft weight, gear configuration, and the number of passes. However, since ICAO only requires reporting the PCN of the runway, the runway PCN is reported on the documentation page and executive summary of the report. The runway PCN is based on the weakest section in the first 1,000 feet (305 meters) of each end of the runway (full width) or in the central keel (75 feet [23 meters]) for the remainder of the runway. Overruns and the remaining non-keel pavements of the runway interior are excluded. The Air Force standard for reporting PCNs is 50,000 passes of a C-17. This is because the C-17 is the primary heavy cargo aircraft for the Air Force and is expected to continue to be the primary heavy cargo aircraft well into the future. Using a standard aircraft and number of passes enables the Air Force to compare pavement capability across the entire Air Force. The Army and Navy select a critical aircraft and project passes or equivalent passes for the pavement life, normally 20 years.

4.2.3. **Evaluation Technique.** AFCEC follows these fundamental steps in all pavement evaluations:

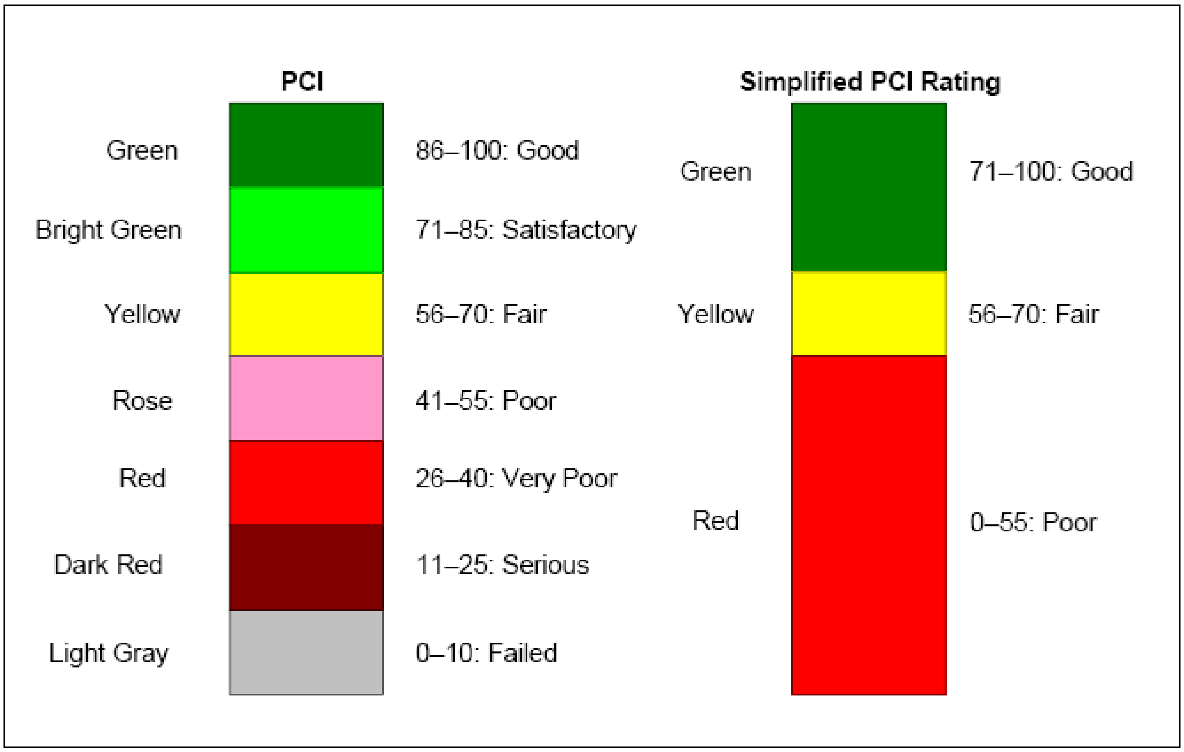
4.2.3.1. Thoroughly study all existing information regarding design, construction, maintenance, and traffic history of the pavements. AFCEC also reviews:

4.2.3.1.1. Previous pavement evaluation or condition survey reports;

4.2.3.1.2. Results of physical property tests of pavements; and, 4.2.3.1.3. Weather records for the vicinity.

4.2.3.2. Determine or validate the pavement condition by a cursory visual inspection. Both the standard PCI rating outlined in American Society for Testing and Materials (ASTM) D5340, *Standard Test Method for Airport Pavement Condition Index Surveys*, and a simplified pavement condition rating, shown in Figure 4.3, are used.

Figure 4.3. ASTM D5340 PCI Rating and Simplified PCI Rating.



4.2.3.3. Determine the scope and validity of available data and determine what additional information and tests are needed.

4.2.3.4. Obtain field data and samples. Samples are tested in the field or sent to AFCEC for laboratory testing and data analysis.

4.2.3.5. Select the representative strength and thickness values for the individual sections that comprise the pavement structure.

4.2.3.6. Determine AGLs and PCNs for each pavement section using representative physical property data and field test results.

4.2.3.7. Develop recommendations for major M&R based on results of the evaluation.

4.3. Methods and Procedures.

4.3.1. Before AFCEC schedules an evaluation, preferably within 2 years, a PCI survey should be performed in accordance with ASTM standards. The survey may be performed with in-house resources, by local contract, or through an AFCEC contract.

4.3.2. Each year, AFCEC sends an annual call letter to the MAJCOMs, asking for the structural evaluation requirements for the following fiscal year.

4.3.3. The MAJCOMs respond with a priority listing of bases requiring evaluation in the following fiscal year, along with proper justification, including the PCI rating for each section.

4.3.4. Based on this information, AFCEC develops a schedule for structural evaluations.

4.3.5. In the fourth quarter of each fiscal year, AFCEC informs the MAJCOMs about which bases it has selected for evaluation the following fiscal year.

4.3.6. In prioritizing bases for evaluation, MAJCOMs consider:

4.3.6.1. Time since the last evaluation. Structural evaluations normally occur every 7 to 10 years.

4.3.6.2. Operational requirements or mission changes that significantly change pavement loading.

4.3.6.3. Safety issues caused by structural deterioration since the last evaluation.

4.3.6.4. Plans for major reconstruction or rehabilitation projects.

4.3.6.5. New construction for which there is no sufficient design, as-built, or physical property data to determine the pavement's load-bearing capability.

4.3.7. Approximately 3 months before deployment, AFCEC sends a letter to the scheduled base (with a copy to the responsible MAJCOM) detailing the support needed for the evaluation.

4.3.8. AFCEC reviews construction and traffic history, soils and drainage data, master plans, and other data, when available, to plan the test program and to develop the evaluation report.

4.4. Field Tests. During the field testing phase of an AFCEC pavement evaluation, required pavement and soil layer physical property data are obtained. This phase usually takes 8 to 12 calendar days, depending on the size of the base.

4.4.1. Base airfield operations personnel should plan on closing a runway for 1 to 2 days for an evaluation; however, the pavement evaluation team can respond quickly to emergencies if the runway is needed.

4.4.2. AFCEC decides which data are required and which specific types of tests to conduct based on pavement type, construction history, problem areas, mission, and various other factors.

4.4.3. The pavement evaluation team obtains data and samples and conducts assessments, including:

4.4.3.1. Type of pavement.

4.4.3.2. In situ pavement and soil layer thicknesses, including total thickness above the natural subgrade for flexible pavements.

4.4.3.3. Cores used to determine the thickness of surface materials and the flexural strength of the concrete using split-tensile tests.

4.4.3.4. Heavy weight deflectometer (HWD) deflection measurements used to determine pavement capability using modulus of elasticity and layered elastic theory (non-destructive evaluation).

4.4.3.5. Strength and thickness of underlying layers (California Bearing Ratio (CBR) or k (modulus of soil reaction) value) using the dynamic cone penetrometer (DCP) or the automated DCP (semi-destructive).

4.4.3.6. Effective modulus of subgrade reaction for rigid pavements or CBR for flexible pavements measured in excavated pits (destructive evaluation, not commonly used due to impact on operations).

4.4.3.7. Modulus of elasticity for each pavement and soil layer (non-destructive).

4.4.3.8. In situ moisture content and density of subgrade soils and base course materials (destructive evaluation).

4.4.3.9. Cursory visual assessment of pavement condition.

4.4.3.10. Soil samples for sections for which no previous data exist, as required. Sieve analysis and Atterberg limits tests are performed to classify the soil using the Unified Soil Classification System.

4.4.3.11. Quality of subgrade, subbase, and granular base courses (tested in situ).

Note: Laboratory tests on samples of materials and construction control data supplement the field tests. The team determines the pavement and soil layer physical properties by visual observations, laboratory tests on pavement samples, or from construction data.

4.5. Laboratory Tests. ASTM standards are used for laboratory and field testing. As with field testing, the data and types of tests required in the laboratory vary with the situation.

4.6. Evaluation Procedure. The evaluation thoroughly analyzes all physical property and laboratory data and selects representative thickness and strength data and the appropriate evaluation method and computer codes to determine the AGL and PCN for each section.

4.7. Structural Reports.

4.7.1. **Preliminary Findings.** The pavement evaluation team normally provides an outbrief to base officials after completing the field investigations. The outbrief summarizes the results of the cursory visual inspection, testing accomplished, test results, preliminary data analysis, preliminary recommendations, and immediate actions required, if any. A draft copy of the appendices for the final report is left with the base after the outbrief.

4.7.2. **Final Pavement Evaluation Report.** AFCEC prepares, publishes, and distributes a final pavement evaluation report after all laboratory and field testing has been completed, results analyzed, and AGL and PCN values determined. The report includes:

4.7.2.1. **Executive Summary:** A synopsis of the evaluation, the results, and recommendations.

4.7.2.2. **Introduction:** A statement of the purpose, objectives, and scope of the evaluation, including a description of the evaluated pavements. The introduction includes potential uses of the report and a description of the appendices.

4.7.2.3. **Background:** A general description of the airfield, aircraft traffic, construction history, climatic and geological conditions, and drainage. Previous evaluations and studies are briefly discussed.

4.7.2.4. **Test Procedures:** An overview of the pavement testing equipment and procedures employed in the field and in the laboratory, along with a discussion of material properties. Includes a description of the condition of the airfield pavements based on the cursory visual inspection, including appropriate photographs.

4.7.2.5. **Analysis:** Outlines procedures used to evaluate data and calculate AGLs and PCNs.

4.7.2.6. **Conclusions and Recommendations:** The engineer's conclusions and recommendations based on data analysis. Topics typically include:

4.7.2.6.1. The capability of various airfield pavement sections to support current and projected aircraft traffic;

4.7.2.6.2. Observations on the overall condition of the airfield pavements; and,

4.7.2.6.3. Recommendations for major M&R and construction.

4.7.3. **Appendices:** Information, data, and test results that document the evaluation. Table 4.1 lists the standard appendices, which are supplemented by additional appendices when necessary.

Table 4.1. Structural Report Appendices.

Appendix	Description
A	Airfield Drawings: Graphically depicts the different pavement sections, designations, core and test locations, and surface condition of the airfield.
B	Field Test Data: Includes the field coring log and cursory pavement condition rating.
C	Physical Property Data: Contains the tabulated physical properties and elastic layer data of each pavement section evaluated. Section number and area, material types, layer thickness, strength, and engineering properties are included. Layered Elastic Model Data: Describes the properties of the model structure used to determine allowable loads and remaining life of the pavement system. Construction History: Provides a brief summary of the construction and maintenance activities on each section.
D	Allowable Gross Loads (AGLs): Lists the allowable loads at four pass intensity levels for each aircraft group for every section.
E	Pavement Classification Number (PCN) Table: Lists PCNs, a standardized method of reporting pavement strength, for each section.
F	Aircraft Classification Number (ACN) Charts: Provides ACN charts for the 14 standard aircraft groups plus some additional aircraft.
G	Related Data: Includes aircraft group indices, gross weight ranges for each aircraft group, and pass intensity levels.

4.7.3.1. **Summary of Pavement Data:** Documents all data used in the evaluation for each pavement section. A typical summary includes:

4.7.3.1.1. Section number;

4.7.3.1.2. Pavement identification, e.g., runway, taxiway, apron;

4.7.3.1.3. Area of the section;

4.7.3.1.4. General condition (simplified PCI) of the pavement;

4.7.3.1.5. Type and thickness of overlay pavement, pavement base, subbase, and subgrade;

4.7.3.1.6. Representative flexural strength, CBR, and k value;

4.7.3.1.7. Soil layer classifications;

4.7.3.1.8. Layered elastic model data;

4.7.3.1.9. Construction history;

4.7.3.1.10. Real Property Report.

4.7.3.2. **Summary of AGLs:** Contains tables listing AGLs for each pavement section for the four pass intensity levels and the 14 aircraft groups (Figure 4.1). Paragraphs 4.7.3.2.1. and 4.7.3.2.2. provide descriptions of the number and types of tables that are normally published:

4.7.3.2.1. One table contains AGLs that are computed and reported within a range from the lowest weight of the lightest aircraft to the highest weight of the heaviest aircraft in each aircraft group (see Figure 4.1). AGLs are calculated for each section at four pass intensity levels. Values are shaded green when the computed AGL is greater than the maximum weight of any aircraft in the group (also seen as a "+" in older reports). Values are shaded yellow when the computed AGL is between the minimum and maximum weight of any aircraft in the group and aircraft should be limited to this weight to preserve pavement life to the specified pass intensity level. The value is shaded red with white text (also seen as an "A" in older reports) when the computed AGL is less than the minimum weight of any aircraft in the group.

4.7.3.2.2. For locations considered susceptible to frost action based on climate and soil classification, an additional table is published. This table is presented in the same format as described in paragraph 4.7.3.2.1, but is derived based on reduced subgrade strength or reduced modulus values to account for weakened conditions during the frost melt period.

4.7.3.3. **PCNs.**

4.7.3.3.1. PCNs are presented for each section based on the ICAO procedure as outlined in UFC 3-260-03. Along with the PCN number, the pavement type, subgrade strength category, tire pressure category, and evaluation method are reported. A code system, implemented to allow an abbreviated presentation of the necessary information, is used as follows:

4.7.3.3.1.1. The pavement type is abbreviated "R" for rigid (portland cement concrete [PCC]) or "F" for flexible (asphalt concrete [AC]) pavements.

4.7.3.3.1.2. The four subgrade categories—A, B, C, and D—indicate high, medium, low, and ultralow subgrade strengths, respectively.

4.7.3.3.1.3. The four tire pressure categories—W, X, Y, and Z—indicate high, medium, low, and very low tire pressures, respectively.

4.7.3.3.1.4. The evaluation methods are “T” for a technical evaluation or “U” for an evaluation based on the type of aircraft that commonly use the airfield.

4.7.3.3.2. The PCN code 31/R/C/W/T, for example, indicates a PCN numerical value of 31, a rigid pavement, a low-strength subgrade, that high-pressure tires are allowed, and that a technical evaluation was performed to determine the PCN. AFCEC determines and reports the airfield PCN for 50,000 passes of the C-17.

4.8. Distribution of Reports. AFCEC distributes the final report to the BCE; airfield manager; appropriate MAJCOMs; Air National Guard; Air Force Reserves; Headquarters Air Mobility Command, Directorate of Operations (HQ AMC/A3); Air Force Institute of Technology (AFIT); U.S. Army Corps of Engineers Engineer Research and Development Center (USACE/ERDC); USACE Transportation Systems Center (USACE/TSMCX); Naval Facilities Engineering Command (NAVFAC); National Geospatial-Intelligence Agency (NGA); Air Force Research Laboratory (AFRL); Air Force Flight Standards Agency (AFFSA); and Defense Technical Information Center (DTIC). Contact AFCEC for a detailed distribution list.

4.9. Updating Physical Property Data.

4.9.1. To ensure that physical property data remain current, construction agencies must provide the as-built or design data on all airfield pavement projects to the BCE. The BCE, in turn, provides a copy of the following information to AFCEC on pavements that have been constructed or reconstructed since the last pavement evaluation:

4.9.1.1. Type of surface and texture (PCC, AC, surface treatment and burlap drag, wire combed, grooved, porous, rough, medium, and smooth, etc.).

4.9.1.2. Thickness of the pavement and each layer in the pavement structure.

4.9.1.3. Subgrade and base course moisture contents and densities.

4.9.1.4. PCC flexural strength test results.

4.9.1.5. CBR/k/modulus values from design/construction records.

4.9.2. The BCE maintains construction records, including as-built drawings on all pavement projects that are under BCE control.

4.9.3. If the airfield pavement undergoes major changes, such as reconstruction or rehabilitation, AFCEC may use as-built and construction control data to reevaluate the pavement. If an airfield pavement system undergoes significant structural changes but the construction data are either inadequate or unavailable, the BCE can request a new pavement evaluation.

Chapter 5

RUNWAY FRICTION CHARACTERISTICS EVALUATIONS

5.1. Runway Friction Characteristics Evaluation. An AFCEC runway friction characteristics evaluation assesses a runway's tractive qualities and hydroplaning potential. Since these properties are subject to change with time and traffic, an evaluation will determine what, if any, maintenance may be required.

5.1.1. **Frequency.** MAJCOMs should request a runway friction characteristics evaluation when:

5.1.1.1. Recent evaluation reports recommend frequent testing.

5.1.1.2. Surface treatment significantly alters the runway surface characteristics (for example, grooving, texturing, overlay, or reconstruction). When runways are grooved, textured, etc., as a result of an AFCEC recommendation to improve safety, the base should verify the results by independent testing.

5.1.1.3. A mission change significantly alters the runway's rate of wear and rubber accumulation.

5.1.1.4. An aircraft skidding accident or incident occurs.

5.1.2. **Evaluation Schedule.** AFCEC develops an annual friction characteristics evaluation program based on MAJCOM requirements. The annual data call process is described in section 4.3.

5.1.3. **Support Requirements.** AFCEC will provide the base detailed support requirements approximately 6 weeks prior to the evaluation.

5.1.4. **Evaluation Procedures.** The evaluation report describes the procedures for evaluating runway friction characteristics, including equipment descriptions, testing methods, and some theory on their use. Testing includes friction tests, slope measurements, and texture measurements. Procedures and equipment generally correspond to those outlined in FAA Advisory Circular (AC) 150/5320-12C, *Measurement, Construction, and Maintenance of SkidResistant Airport Pavement Surfaces*.

5.1.5. **Evaluation Report.** After conducting the field evaluation, AFCEC analyzes the results and publishes a formal report. This report includes:

5.1.5.1. A description of the equipment and test procedures;

5.1.5.2. A summary of the pertinent data and results;

5.1.5.3. The criteria for analysis;

5.1.5.4. Interpretation of the results based on these criteria and the judgment of the engineer;

5.1.5.5. A narrative that presents the engineer's conclusions and recommendations for improving the runway's friction characteristics; and,

5.1.5.6. Appendices that document the data collected during testing. These appendices are described in Table 5.1.

Table 5.1. Friction Characteristics Evaluation Report Appendices.

Appendix	Description
A	Slope Measurements: Displays the slopes measured on the runway. The transverse and longitudinal slopes are measured every 500 feet (152 meters).
B	Texture Measurements: Presents the texture depth for various locations and the rainfall intensities required to flood these areas.
C	Friction Measurements: Contains average friction values and friction plots for the entire length of the runway and describes the guidelines for determining acceptable friction characteristics.
D	Estimation of Rubber Deposits: Presents a method to determine rubber removal requirements based on visual inspections.

5.2. Distribution of Runway Friction Characteristics Evaluation Reports. Hard copies of the report are provided to the base pavement engineer, airfield manager, appropriate MAJCOM pavement engineer, and are kept on file at AFCEC. Electronic copies are made available through the AFCEC Pavements Reports Web site, and notifications are sent to AFIT, NGB, NAVFAC, ERDC, DTIC, AFFSA, TSMCX, NGA, and HQ AMC/A3.

5.3. Runway Roughness Evaluation. A runway roughness evaluation examines the elevation profile of the runway surface and evaluates aircraft response to this profile. AFCEC no longer conducts these evaluations but maintains contact with the National Aeronautics and Space Administration (NASA), the FAA, and other organizations conducting research in this field and with contractors that perform the evaluations. Bases requiring a runway roughness evaluation can contact AFCEC for assistance.

5.4. Runway Rubber Removal Determination. Most bases schedule runway rubber removal based on the amount of time between cleanings or a visual inspection rather than measuring the friction reduction effects of the rubber accumulation using CFME. The following subparagraphs, adopted in part from FAA AC 150/5320-12C and other FAA standards, provide guidance for using a CFME unit to determine when to schedule rubber removal on Air Force runways. Some bases have CFME that is used to determine when to remove snow and ice. This guidance provides the information necessary for those bases to use the CFME to determine rubber removal frequency or to contract to determine rubber removal frequency. AFCEC does not routinely schedule friction tests strictly to determine when to remove rubber.

5.4.1. **Background.** Skid resistance of runway pavement deteriorates due to a number of factors, primarily: 1) mechanical wear and polishing action from aircraft tires rolling or braking on the pavement and from snow removal equipment, and 2) the accumulation of contaminants, chiefly rubber, on the pavement surface. The effects of these two factors are directly dependent on the volume and type of aircraft traffic. In addition, rubber deposits obscure airfield markings, which can become a safety issue. The most persistent contaminant problem is deposits of rubber from tires of landing jet aircraft. Rubber deposits occur at the touchdown areas on runways and can be quite extensive. Heavy rubber deposits can completely cover the pavement surface texture, causing loss of aircraft braking capability and directional control, particularly when runways are wet.

5.4.2. **Minimum Friction Survey Frequency.** Table 5.2 is provided as guidance for scheduling runway friction testing for rubber removal. This table is based on an average mix of turbojet aircraft operating on any particular runway. When, of the total aircraft mix, a runway end has 20 percent or more wide body aircraft (e.g., B-52, C-5, C-17, C-130, KC-10, KC-135, etc.), select the next higher level of aircraft operations in Table 5.2 to determine the minimum testing frequency. As data is accumulated on the rate of change of runway friction under various traffic conditions, the scheduling of friction surveys may be adjusted to ensure that evaluators will detect and predict marginal friction conditions in time to take corrective actions.

Table 5.2. Friction Testing Frequency (From FAA AC 150/5320-12C).

Number of Daily Minimum Aircraft Landings Per Runway End*	Minimum Friction Testing Frequency
Less than 15	1 year
16 to 30	6 months
31 to 90	3 months
91 to 150	1 month
151 to 210	2 weeks
Greater than 210	1 week
*Each runway end should be evaluated separately, e.g., Runway 18 and Runway 36.	

5.4.3. **General Requirements.**

5.4.3.1. **FAA Performance Standards for CFME.** Appendix 3 of FAA AC 150/5320-12C contains the performance specifications for CFME. These standards should be followed in procuring CFME and replacement tires for the equipment.

5.4.3.2. **FAA Qualified Product List.** The equipment listed in Appendix 4 of FAA AC 150/5320-12C has been tested and meets the FAA standards for CFME for use in conducting maintenance friction tests.

5.4.3.3. **Training of Personnel.** As stated in FAA AC 150/5320-12C, "The success of friction measurement in delivering reliable friction data depends heavily on the personnel who are responsible for operating the equipment. Adequate professional training on the operation and maintenance of the CFME and the procedures for conducting friction measurement should be provided, either as part of the procurement package or as a separate contract with the manufacturer. Also, recurrent training is necessary for review and update to ensure that the operator maintains a high level of proficiency."[1] Experience has shown that without recurrent training, personnel will not be aware of new developments on equipment calibration, maintenance, and operating techniques. A suggested training outline is provided in Appendix 5 of FAA AC 150/5320-12C. Training should include both the operation and maintenance of the CFME and the procedures for conducting friction surveys. These procedures are provided in section 5.4.4 of this AFI.

5.4.3.4. **Equipment Calibration.** All CFME should be checked for calibration within tolerances provided by the manufacturer before conducting friction surveys. The CFME

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[1] FAA, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, Advisory Circular 150/5320-12C (March 1997), 20.

self-wetting system should be calibrated periodically to ensure that the water flow rate is correct and that the amount of water produced for the required water depth is consistent and applied evenly in front of the friction measuring wheel(s) for all test speeds.

5.4.4. **Conducting Friction Evaluations with CFME.**

5.4.4.1. **Preliminary Steps.** Friction measurement operations should be preceded by a thorough visual inspection of the pavement to identify inadequacies such as drainage problems, including ponding and groove deterioration, and structural deficiencies. Careful and complete notes should be taken, not only of the CFME data but also of the visual inspection. Personnel operating equipment should be fully trained and current in all procedures. The CFME should be checked for accurate calibration and the vehicle checked for adequate braking ability. Remove aircraft arresting cables to prevent damage to equipment.

5.4.4.2. **Location of Friction Surveys on the Runway.** When conducting friction surveys on the runway(s) at 40 miles per hour (mph) (65 kilometers per hour [km/h]), the operator should begin recording data at the threshold when adequate overruns with in-ground lighting are present. If the length of the overrun is such that the operator cannot accelerate to speed before crossing the threshold, then data should be collected as soon as the vehicle reaches 40 mph (65 km/h). The friction survey should be terminated approximately 500 feet (152 meters) from the opposite end of the runway if the length of the overrun is not adequate for the operator to use the overrun for deceleration; otherwise, the survey should be terminated at the threshold. When conducting friction surveys on the runway(s) at 60 mph (97 km/h), the operator should begin recording data at the threshold when adequate overruns with in-ground lighting are present. If the length of the overrun is such that the operator cannot accelerate to speed before crossing the threshold, then data should be collected as soon as the vehicle reaches 60 mph (97 km/h). The friction survey should be terminated approximately 1,000 feet (305 meters) from the opposite end of the runway if the length of the overrun is not adequate for the operator to use the overrun for deceleration; otherwise, the survey should be terminated at the threshold. Where travel beyond the end of the runway or overrun could result in equipment damage or personal injury, additional runway length should be allowed for stopping. The lateral location on the runway for performing the tests should be 10 and 20 feet (3 and 6 meters) from the centerline. Unless surface conditions are noticeably different on either side of the runway centerline, a test on one side of the centerline in the same direction the aircraft lands should be sufficient; however, when both ends of the runway are to be evaluated, vehicle runs can be made to record data on the return trip (both ways).

5.4.4.3. **Vehicle Speed for Conducting Surveys.** FAA-approved CFME can be used at either 40 or 60 mph (65 or 97 km/h). The lower speed determines the overall macrotexture/contaminant/drainage condition of the pavement surface. The higher speed provides an indication of the condition of the surface’s microtexture. A complete survey should include tests at both speeds.

5.4.4.4. **Use of CFME Self-Wetting System.** Since wet pavement always yields the lowest friction measurements, the CFME should be equipped with a self-wetting system to simulate worst case conditions. Self-wetting systems simulate rain to produce wet pavement surface conditions and provide the operator with a continuous record of friction values along the length of the runway. The attached nozzle(s) are designed to provide a uniform water depth of 0.04 inch (1 mm) in front of the friction measuring tire(s). This wetted surface produces friction values that are the most meaningful in determining whether or not corrective action is required.

5.4.4.5. **Friction Level Classification.** Mu numbers (friction values) measured by CFME can be used as guidelines for evaluating the surface friction deterioration of runway pavements and for identifying the appropriate corrective actions necessary for safe aircraft operations. Table 3-2 of FAA AC 150/5320-12C depicts the friction values for three classification levels for FAAqualified CFME operated at 40- and 60-mph (65- and 97-km/h) test speeds. This table was developed from qualification and correlation tests conducted at NASA's Wallops Flight Facility.

5.4.4.6. **Evaluation and Maintenance Guidelines.** The evaluation and maintenance guidelines in the following subparagraphs are recommended based on the friction levels classified in Table 3-2 of FAA AC 150/5320-12C. These guidelines take into account that poor friction conditions for short distances on the runway do not pose a safety problem to aircraft, but long stretches of slippery pavement are of serious concern and require prompt remedial action.

5.4.4.6.1. **Friction Deterioration Below the Maintenance Planning Friction Level (500 feet [152 meters]).** When the average Mu value on the wet runway pavement surface at both 40 and 60 mph (65 and 97 km/h) is less than the Maintenance Planning Friction Level but above the Minimum Friction Level in Table 3-2 of FAA AC 150/5320-12C for a distance of 500 feet (152 meters), and the adjacent 500-foot (152-meter) segments are at or above the Maintenance Planning Friction Level, no corrective action is required. These readings indicate that the pavement friction is deteriorating but the situation is still within an acceptable overall condition.

5.4.4.6.2. **Friction Deterioration Below the Maintenance Planning Friction Level (1000 feet [305 meters]).** When the average Mu value on the wet runway pavement surface at both 40 and 60 mph (65 and 97 km/h) is less than the Maintenance Planning Friction Level in Table 3-2 of FAA AC 150/5320-12C for a distance of 1,000 feet (305 meters) or more, an extensive evaluation should be conducted to determine the causes and extent of the friction deterioration. If the surface has rubber buildup, the airfield manager should submit a work request to have rubber removed from the affected areas of the runway.

5.4.4.6.3. **Friction Deterioration Below the Minimum Friction Level.** When the average Mu value on the wet pavement surface at both 40 and 60 mph (65 and 97 km/h) is below the Minimum Friction Level in Table 3-2 of FAA AC 150/5320-12C for a distance of 500 feet (152 meters), and the adjacent 500-foot (152-meter) segments are below the Maintenance Planning Friction Level, action should be taken immediately to correct the affected areas of the runway. Before undertaking corrective measures, inspect the overall condition of the entire runway pavement surface to determine if other deficiencies exist that may require additional corrective action.

Chapter 6

TESTING OF POWER CHECK PAD ANCHORING SYSTEMS

6.1. Background. Most Air Force fighter aircraft use aircraft anchoring systems during power checks and routine maintenance procedures. When requested by the MAJCOMs, AFCEC tests anchors to determine their capability to safely support the loads imposed by these aircraft. AFCEC tests only existing power check pad anchors: AFCEC does not test Hush House anchors or new power check pad anchors. If new power check pad anchors are constructed as specified in applicable UFCs or Engineering Technical Letters (ETLs), testing is not required; however, if there are quality concerns, proof loading to ensure that new anchors meet operational requirements should be included in the project documents. Emergency requests for testing of new anchors must be approved by the AFCEC commander and will require funding by the MAJCOM/base. Equipment and inspection and testing procedures are detailed in Appendix G of UFC 3-260-03. The base provides a forklift or crane for the tests.

6.2. Testing Schedule. AFCEC develops an annual anchor testing program based on MAJCOM requirements. The annual data call process is described in section 4.3.

6.3. Anchor Testing Report. After completion of field testing and data analysis, AFCEC publishes an anchor testing report. The report documents the equipment and procedures used to test the anchors and includes proof load data. The report also contains a proof load affidavit. Examples of the recorded data and the affidavit are provided in UFC 3-260-03, Appendix G.

6.4. Report Distribution. AFCEC distributes the anchor test report to the appropriate base and MAJCOMs and maintains files at AFCEC.

Chapter 7

PAVEMENT CONDITION SURVEY PROGRAM

7.1. Program Management. AFCEC manages the Air Force pavement condition survey program. Responsibilities include maintaining files of all previous condition survey reports for each base, maintaining on-call contracts for conducting condition surveys, scheduling/monitoring contract work when funds are provided by a MAJCOM/base, performing quality assurance, and updating the PAVER pavement management system and applicable reference documents.

7.2. Reference Documents. Condition surveys and reports are accomplished in accordance with the most current version of the following documents:

7.2.1. ASTM D5340 and UFC 3-260-16FA, *Airfield Condition Survey Procedures*.

7.2.2. ASTM D6433, *Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys*.

7.2.3. ASTM E1926, *Standard Practice for Computing International Roughness Index of Roads from Longitudinal Profile Measurements*.

7.3. Contract Procedure. AFCEC provides an on-call service for accomplishing condition surveys by contract. The MAJCOM/base requiring a condition survey provides AFCEC with the name of the base, the pavements to be surveyed (airfield, roads, or parking lots), and the current base point of contact. If the pavements have not been surveyed previously, or if significant changes have occurred since the last evaluation, the MAJCOM/base (customer) also provides the area of the pavements to be surveyed. The customer also identifies any special requests, such as development of DD Form 1391, "*FY___ Military Construction Project Data*" for pavement projects or use of automated procedures for road surveys. AFCEC develops the statement of work and government cost estimate for review by the customer. After receiving funding from the base or MAJCOM, the AFCEC program manager (PM) works with the contracting officer to award a task order under a pre-negotiated contract. The PM works with both the customer and the contractor to ensure that the contractor has the latest structural pavement evaluation data and other required information. AFCEC reviews the preliminary report for technical and contractual adequacy and works with the contractor, MAJCOM, and base to reconcile issues, ensure that applicable comments are incorporated, and ensure that the effort is completed within schedule.

7.4. Report Content. The statement of work outlines the content required in the report and includes the products in the following subparagraphs, at a minimum. (Surveys conducted by other means, i.e., in-house, Individual Mobilization Augmentees (IMAs), or Guard or Reserve PCI teams, should contain the same products.)

7.4.1. **Field Survey Inbrief.** Provide an entry briefing to the BCE project officer and other base officials, as arranged by the project officer. This inbrief should explain the survey procedures and describe the base support needed to complete the evaluation.

7.4.2. **Field Survey Outbrief.** Provide an exit briefing to the BCE project officer and other base officials, as arranged by the project officer. This outbrief should summarize the survey results and provide a general impression of pavement maintenance requirements.

7.4.3. **Reports.** The contractor produces a report for the airfield and/or road network. The current PCI report template can be found on the AFCEC Airfield Pavement Evaluation Team site on the Air Force Portal.

Chapter 8

PAVEMENT ENGINEERING ASSESSMENT STANDARDS

8.1. EA for Airfields. An EA is used to help prioritize or rank proposed M&R pavement projects. The EA uses ratings of Adequate, Degraded, and Unsatisfactory to prioritize or rank the projects. The EA can also be used to determine a numerical rating for a network, branch, or section to assist MAJCOMs and HQ USAF in comparing and assessing airfields. **Note that criteria in this chapter are to be used only for project prioritization and are not associated with criteria in other chapters of this document.**

8.1.1. **EA Criteria.** Apply the criteria in section 8.1.5 to determine or validate a section/branch rating of Adequate, Degraded, or Unsatisfactory.

8.1.2. **Project Priorities.** Apply the criteria in section 8.1.6 to set priorities for projects on sections/branches within each impact rating category.

8.1.3. **Numerical Rating System.** The criteria in section 8.1.8 can be used to establish a numerical rating for pavement systems or entire airfields to allow comparison throughout a MAJCOM and to assess the potential impact of projects.

8.1.4. **Rating Factors.** The factors used to determine EAs or ratings are the PCI, Friction Index (runway pavements only), Structural Index, and Foreign Object Damage (FOD) Index (optional).

8.1.4.1. **PCI.** The PCI is a numerical rating (on a scale of 0 to 100) determined by a visual pavement survey based on procedures in ASTM D5340, ASTM D6433, and UFC 3-260-16FA. Refer to the most current version of the ASTM publications. MAJCOMs are responsible for conducting condition surveys to determine the PCI of a pavement. Surveys should be accomplished every 5 years. Currently, the surveys are accomplished with in-house resources or by contract, individual mobilization augmentees (IMAs), or Guard and Reserve units. AFI 32-1032 requires a PCI for projects submitted to MAJCOMs for approval.

8.1.4.1.1. This AFI establishes a standard color code for the seven condition codes described in ASTM D5340 and also for a corresponding simplified PCI rating system used when performing EAs. The simplified rating categories of Good, Fair, and Poor are depicted in Figure 8.1. The PCI ratings can be displayed on color-coded airfield layout maps.

8.1.4.1.2. Table 8.1 provides a more detailed description of the PCI rating categories and their associated distress levels and probable maintenance requirements. Figure 8.1 and Table 8.2 display the EA ratings and associated PCI values.

Figure 8.1. PCI and Simplified PCI Rating Scales.

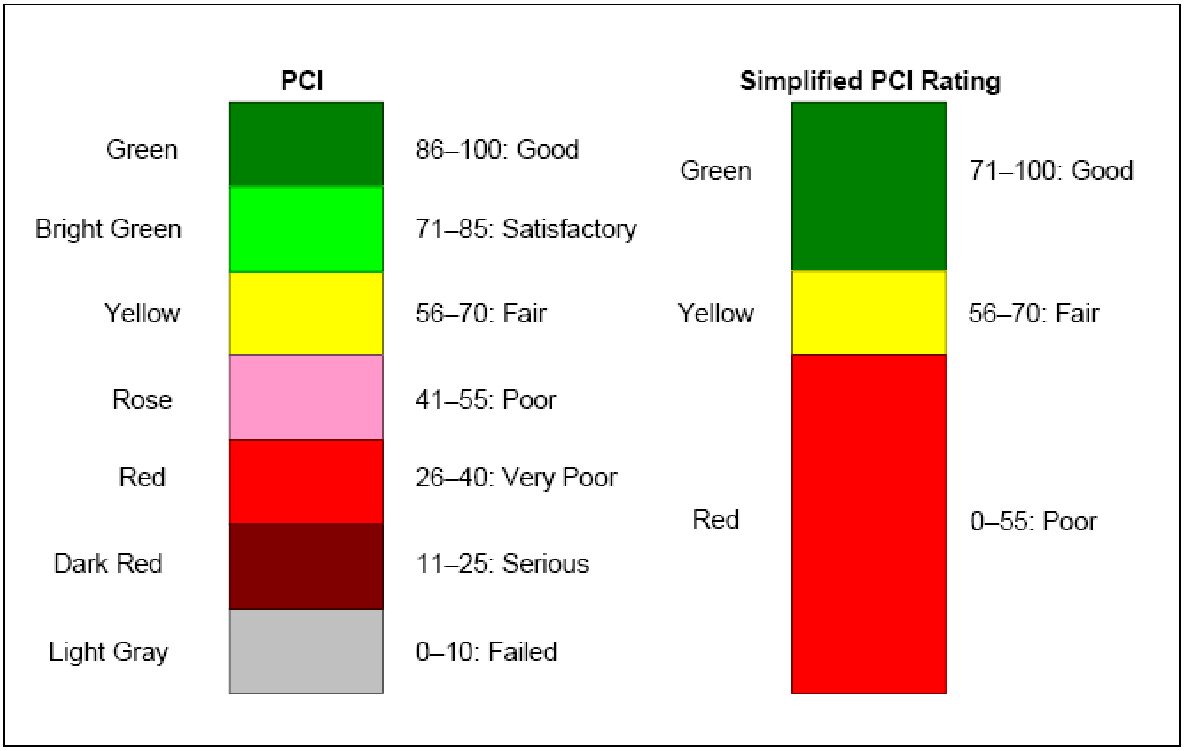


Table 8.1. Definition of PCI Ratings.

Rating	Definition
86–100	GOOD: Pavement has minor or no distresses and should require only routine maintenance.
71–85	SATISFACTORY: Pavement has scattered low-severity distresses that should require only routine maintenance.
56–70	FAIR: Pavement has a significant amount of generally low- and medium-severity distresses. Near-term M&R needs may range from routine to major.
41–55	POOR: Pavement has low-, medium-, and high-severity distresses that probably cause some operational problems. Near-term M&R needs may range from routine up to a requirement for reconstruction.
26–40	VERY POOR: Pavement has predominantly medium- and high-severity distresses that cause considerable maintenance and operational problems. Near-term M&R needs will be intensive in nature.
11–25	SERIOUS: Pavement has mainly high-severity distresses that may cause operational restrictions; immediate major repairs are needed.
0–10	FAILED: Pavement deterioration has progressed to the point that safe aircraft operations may no longer be possible; complete reconstruction is required.

Table 8.2. EA PCI Criteria.

EA Rating	PCI
Adequate	71–100
Degraded	56–70
Unsatisfactory	0–55

8.1.4.2. **Friction Index.** AFCEC conducts tests to determine the friction characteristics of runways and compiles the results in a runway friction characteristics report for a given base. The friction values measured by approved friction testing equipment (see FAA AC 150/5320-12C) are used to determine friction indices. This guidance assumes that all U.S. Air Force friction tests are conducted with either a GripTester or a Mu-Meter (three-wheeled trailer devices used for pavement surface friction testing). To determine friction indices, the runway should first be divided into 500-foot-long (152-meter-long) segments. The Friction Index for each segment is equal to the average friction value measured by GripTester or Mu-Meter tests conducted at 40 mph (65 km/h). The average for a segment can be taken as the average of the results from test runs conducted on each side of the runway centerline. Do not include friction values measured along the runway edges, which would be outside the expected aircraft wheel path area. The Friction Index for a section is equal to the Friction Index of the segment comprising the section. If the section is composed of more than one segment, assign the lowest of the segment friction indices to the section. Based on the Friction Index assigned to the section, a corresponding friction rating can be assigned using Table 8.3, which correlates friction indices from different friction measuring equipment to friction ratings. **The friction ratings in Table 8.3 are to be used to rank and compare projects and do not correspond to the guidance in FAA AC 150/5320-12C.** As with PCI ratings, friction ratings can be displayed on a color-coded airfield layout map, using green for the corresponding rating of Good, yellow for Fair, and red for Poor. Because rubber deposits can lower the measured friction values, the truest measure of a pavement's friction characteristics will be obtained if testing is accomplished shortly after completion of rubber removal. Therefore, to the maximum extent possible, friction testing should be scheduled as soon as possible following completion of a rubber removal project.

Table 8.3. Friction Index and Friction Rating Scales.

Friction Rating	Friction Index 40 mph (65 km/h) Nominal Test Speed, Unless Noted [10]									
	RCR[1]	Grip Tester[2]	JBI[3]	Mu-Meter	Surface Friction Tester[4]	Runway Friction Tester[5]	Bv-11 Skiddo-Meter[4]	Decel Meters[6]	Locked Wheel Devices[7]	IMAG[8]	ICAO Index[9]
Good	>17	>0.49	>0.58	>0.50	>0.54	>0.51	>0.59	>0.53	>0.51	>0.53	5
Fair	12–17	0.34–0.49	0.40–0.58	0.35–0.50	0.38–0.54	0.35–0.51	0.42–0.59	0.37–0.53	0.37–0.51	0.40–0.53	3–4
Poor	≤11	≤0.33	≤0.39	≤0.34	≤0.37	≤0.34	≤0.41	≤0.36	≤0.36	≤0.40	1–2

Notes:

1. RCR (runway condition rating): Decelerometer reading x 32 obtained at 25 mph (40 km/h)
2. Measurements obtained with smooth ASTM tire inflated to 20 psi (140 kilopascals [kPa])

3. JBI: James Brake Index obtained at 25 mph (40 km/h)
4. Measurements obtained with grooved aero tire inflated to 100 psi (690 kPa)
5. Measurements obtained with smooth ASTM 4- by 8-inch (102- by 203-millimeter) tire inflated to 30 psi (210 kPa)
6. Decelerometers include Tapley, Bowmonk, and electronic recording decelerometer at 25 mph (40 km/h)
7. ASTM E274, *Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire*, skid trailer and ASTM E503, *Standard Test Methods for Measurement of Skid Resistance on Paved Surfaces Using a Passenger Vehicle Diagonal Braking Technique*, diagonal-brake vehicle equipped with ASTM E524, *Standard Specification for Standard Smooth Tire for Pavement Skid-Resistance Tests*, smooth test tires inflated to 24 psi (170 kPa)
8. IMAG: Trailer device (manufactured in France) operated at 15 percent slip; grooved PIARC tire inflated to 100 psi (690 kPa)
9. ICAO: International Civil Aviation Organization index of friction characteristics
10. A wet runway produces a drop in friction with an increase in speed. If the runway has good texture, allowing the water to escape beneath the tire, then friction values will be less affected by speed. Conversely, a poorly textured surface will produce a larger drop in friction with an increase in speed. Friction characteristics can be further reduced by poor drainage due to inadequate slopes or depressions in the runway surface.

8.1.4.3. **Structural Index.** The Structural Index is a ratio of Aircraft Classification Number to Pavement Classification Number (ACN/PCN) for a section. The ACN represents the impact a particular aircraft will have on the pavement. The PCN represents the capability of the pavement to support an aircraft. AFCEC conducts structural evaluations for Air Force bases and for each evaluation publishes an airfield pavement evaluation report containing the PCN for each pavement section. The airfield pavement evaluation report also contains ACN data on certain aircraft (i.e., critical aircraft from each of the standard aircraft group indices as defined in Chapter 4). Additional ACN data are available from AFCEC's *Aircraft Characteristics for Airfield Pavement Design and Evaluation* report; USACE ETL 1110-3-394, *Aircraft Characteristics for Airfield-Heliport Design and Evaluation*; FAA AC 150/5335-5, *Standardized Method of Reporting Airport Pavement Strength PCN*; and the Pavement-Transportation Computer Assisted Structural Engineering (PCASE) computer program. Data from the latest AFCEC airfield pavement evaluation report can be used to determine the Structural Index and corresponding structural rating for each pavement section. (**Note:** Do not compute a Structural Index for overruns.) Different aircraft may be used to determine the ACN for different sections based on a base's mission and traffic patterns. An ACN/PCN ratio less than 1.10 is classified as Good, a ratio between 1.10 and 1.40 is classified as Fair, and a ratio greater than 1.4 is classified as Poor. The structural ratings of each section can be displayed on a color-coded airfield layout map, using green for the corresponding rating of Good, yellow for Fair, and red for Poor. **These ratios and ratings are to be used for comparison and prioritization only; they are not to be used to determine and report capability to support aircraft.**

Note: Some airfield pavement evaluation reports contain two sets of PCN values, one for normal conditions and one for the frost-melt or thaw-weakened period. In such instances, the Structural Index determination should be based on the reported PCN values for normal conditions.

8.1.4.4. **FOD Index.** This factor is optional because FOD is not a primary concern for some MAJCOMs. At certain locations, however, FOD potential is one of the primary factors for determining the serviceability of a pavement area. A FOD Index can be determined using the PCI survey data. The FOD Index is determined from the PCI calculated by considering only the distresses/severity levels capable of producing FOD as presented in Tables 8.4 and 8.5. In calculating the PCI for determining the FOD Index, note that a multiplier, or modification factor, of 0.6 is applied to the deduct value for alligator cracking, and a multiplier, or modification factor, of 4.0 is applied to the deduct value for joint seal damage. The FOD Index equals ($100-PCI_{FOD}$) and can be calculated using PAVER.

Table 8.4. Distress List for ACC Pavements.

Distress Type	Severity Levels (L = Low, M = Medium, H = High)
Alligator Cracking (modification factor: 0.6)	L, M, H
Block Cracking	L, M, H
Jet Blast Erosion	n/a
Joint Reflection Cracking	L, M, H
Longitudinal and Transverse Cracking	L, M, H
Oil Spillage	n/a
Patching	M, H
Raveling and Weathering	L, M, H
Shoving	M, H
Slippage Cracking	n/a

Table 8.5. Distress List for PCC Pavements.

Distress Type	Severity Levels (L = Low, M = Medium, H = High)
Blow Up	L, M, H
Corner Break	L, M, H
Durability Cracking	M, H
Linear Cracking	L, M, H
Joint Seal Damage (modification factor: 4.0)	L, M, H
Small Patching	L, M, H
Large Patching	L, M, H
Popouts	n/a
Pumping	n/a
Scaling	L, M, H

Shattered Slab	L, M, H
Joint Spalling	L, M, H
Corner Spalling	L, M, H

8.1.4.5. **FOD Potential Rating Scale.** A FOD Potential Rating scale ranging from 0 to 100 can be used to indicate the potential for FOD problems. Figure 8.2 shows a numerical FOD Potential Rating scale and corresponding descriptive categories. The FOD Potential Rating depends on the type of aircraft using the pavement, the type of pavement surface (asphalt or concrete), and the FOD Index. The FOD Index and the FOD Potential Rating should be determined from the most current pavement condition survey. Relationships between FOD indices and FOD potential ratings have been developed for F-16, KC-135, and C-17 aircraft; Figures 8.3 and 8.4 show these relationships for asphalt and concrete pavements, respectively. These three aircraft were selected as a representative cross section in regards to engine height above the pavement surface and engine susceptibility to FOD (e.g., engine type, size, air flow, thrust). Table 8.6 shows the FOD Index ranges corresponding to the FOD Potential Ratings of Good, Fair, and Poor, as determined from Figures 8.3 and 8.4. Table 8.7 provides recommendations on which standard aircraft curve (i.e., F-16, KC-135, or C-17) to use when determining the FOD Potential Ratings for other aircraft. Different aircraft curves may be used to determine the FOD Potential Ratings for different sections based on a base's mission and traffic patterns. The FOD Potential Ratings can be displayed on a color-coded airfield layout map, using green for the corresponding rating of Good, yellow for Fair, and red for Poor.

Figure 8.2. FOD Potential Rating Scale.

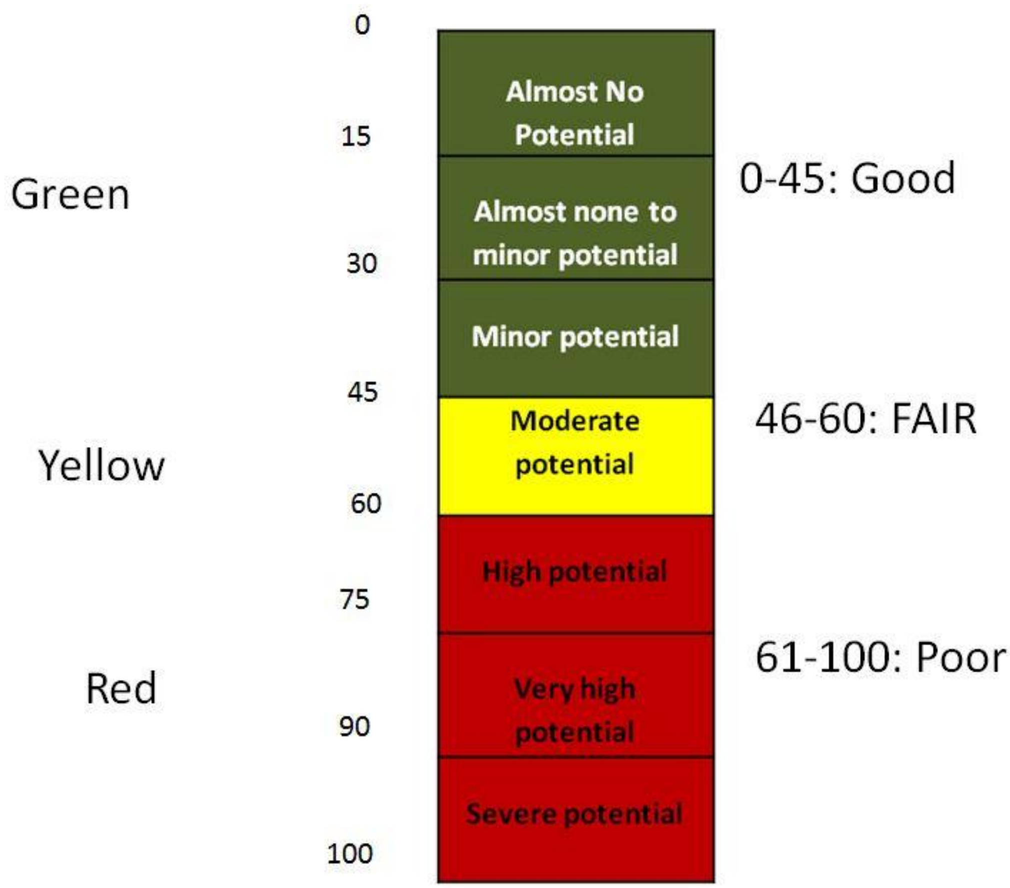


Figure 8.3. Relationships Between FOD Index and FOD Potential Rating for Asphalt Pavements.

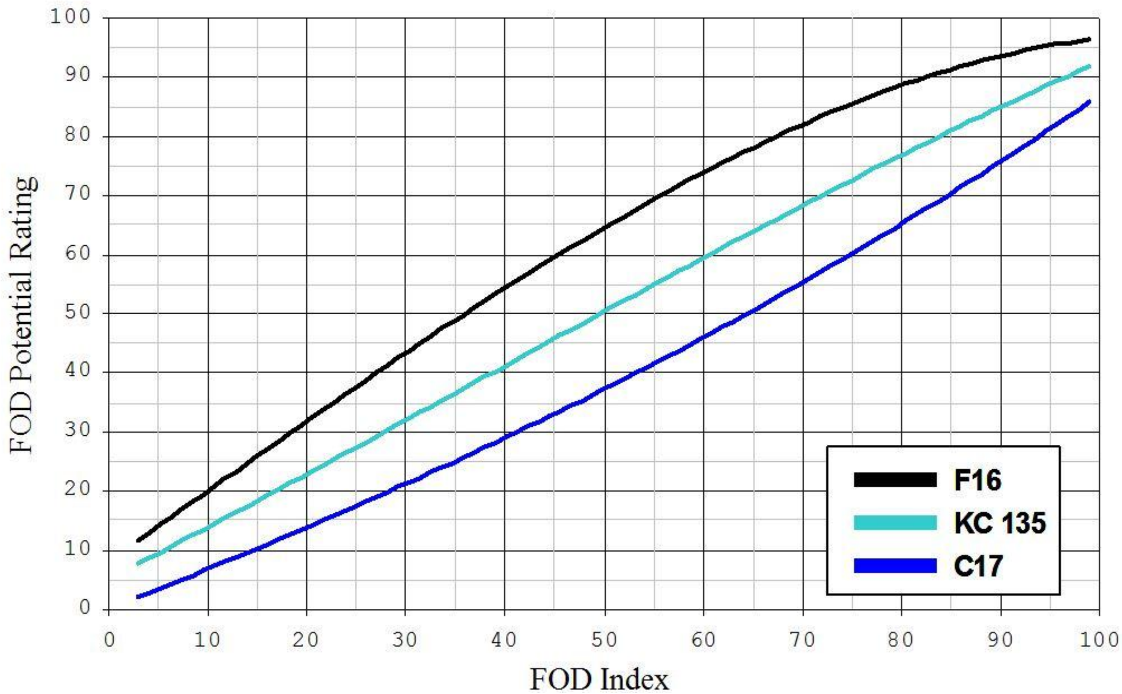


Figure 8.4. Relationships Between FOD Index and FOD Potential Rating for Concrete Payments.

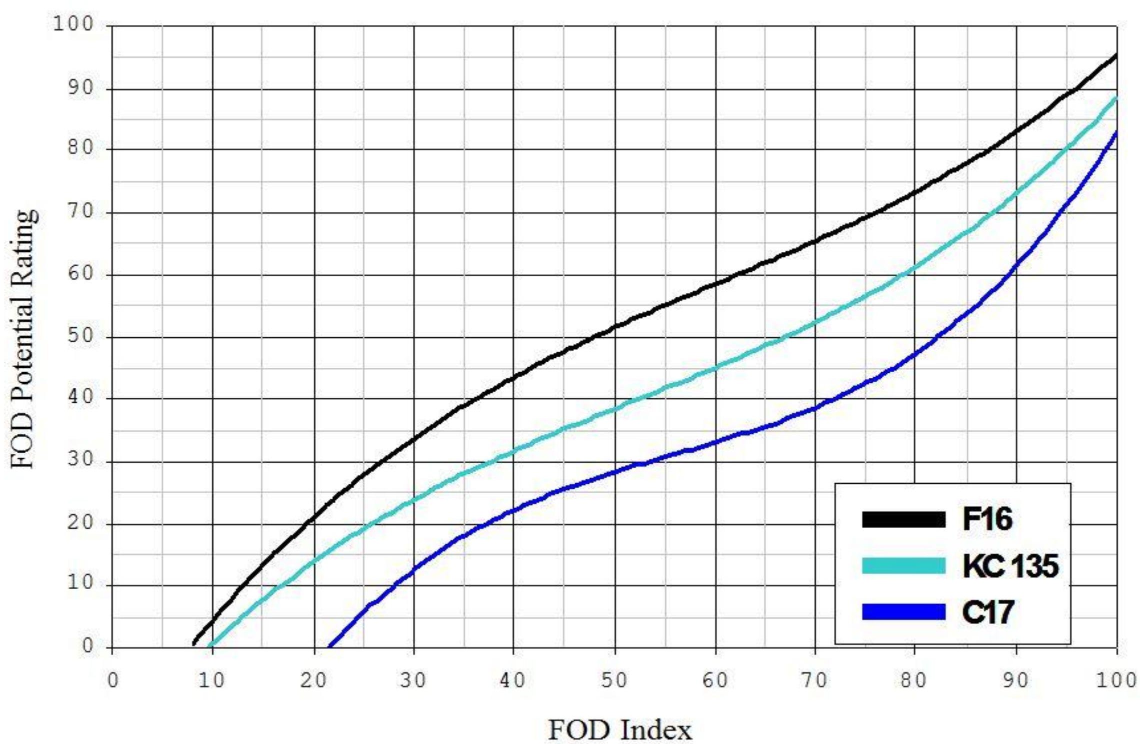


Table 8.6. FOD Index and FOD Potential Rating Scales.

FOD Potential Rating	FOD Index					
	F-16		KC-135		C-17	
	ACC	PCC	ACC	PCC	ACC	PCC
Good: 0–45	0–32	0–41	0–44	0–60	0–59	0–77
Fair: 46–60	33–45	42–62	45–60	61–78	60–75	78–89
Poor: 61–100	46–100	63–100	61–100	79–100	76–100	90–100

Table 8.7. Recommended FOD Curve Applicability for Various Aircraft.

Standard Aircraft	For Aircraft Listed Below, Use FOD Index/FOD Potential Rating Relationship Curve for Standard Aircraft (Left Column)
F-16	A-37, AT-38, F-15, F-22, F-35, T-37, T-38
KC-135	A-300, A-310, A-320, A-321, A-330, A-340, A-380, AN-124, B-1, B-2, B-52, B-707, B-720, B-737, B-747, B-757, B-767, B-777, C-21, C-32, C-38, C-40, C-135, DC-8, DC-10, E-3, E-4, E-8, EC-18, EC-135, IL-76, KC-10, L-1011, MD-10, MD-11, T-1A, T-43, VC-25, VC-137
C-17	A-10, B-717, B-727, C-5, C-9, C-12*, C-20, C-22, C-23*, C-27, C-37, C-38, C-41, C-130*, C-295, CN 235, CV-22, DC-9, MC-12, MD-81, MD-82, MD-87, MD-90, MV-22*, P-3*, RC-26, RQ-4, T-6*
* denotes turboprop- or turboshaft-equipped aircraft	

8.1.5. **Determining the EA.** This section describes a procedure for determining the EA for any airfield pavement section or branch (i.e., runway, apron, or taxiway) based on four factors: PCI, Friction Index (runway pavements only), Structural Index, and FOD Index (optional).

8.1.5.1. **Step One: Determine Indices.** Determine the appropriate PCI, Friction Index (runway pavements only), Structural Index, and FOD Index (optional) for each pavement section.

8.1.5.1.1. **PCI.** Review the most recent airfield pavement condition survey report and determine the PCI for each pavement section. Conduct PCI surveys if the current condition is not accurately reflected in the latest airfield pavement condition survey report. Rate the section in accordance with Figure 8.1 and the instructions in paragraph 8.1.4.1.

8.1.5.1.2. **Friction Index.** Review the most recent AFCEC runway friction characteristics report for the base to determine the skid/hydroplaning potential of runway pavements. Divide the runway into 500-foot-long (152-meter-long) segments and determine the Friction Index of each segment. Correlate the segments to pavement sections and determine the Friction Index for each section. Rate the sections in accordance with Table 8.3 and the instructions in paragraph 8.1.4.2.

8.1.5.1.3. **Structural Index.** Review the latest AFCEC airfield pavement evaluation report for the base and determine the Structural Index of each section. When performing ACN/PCN calculations, use an ACN for the **most critical** mission aircraft on a given section at the aircraft's **average** takeoff weight and the published PCN based on 50,000 passes of a C-17. (**Note:** Different aircraft may be used in the calculations for different sections, such as when a particular section is used only by fighter aircraft while other sections receive a mix of traffic that includes heavier aircraft.) Rate the section in accordance with the instructions in paragraph 8.1.4.3. **Base engineers should consult with Base Operations to determine the critical mission aircraft and average takeoff weight.**

8.1.5.1.4. **FOD Index (Optional).** Determine the FOD Index using the PCI survey data. The FOD Index is determined from the PCI calculated by considering only the distresses/severity levels capable of producing FOD. Determine the FOD Potential Rating for each pavement section based on the appropriate aircraft and in accordance with Figures 8.3 and 8.4, Table 8.6, and the instructions in paragraph 8.1.4.4. (**Note:** Different aircraft may be used in determining the FOD Potential Ratings for different sections, such as when a particular section is used only for parking transport aircraft while other sections receive fighter aircraft.)

8.1.5.2. **Step Two: Determine EAs for Each Airfield Section.** EAs of Adequate, Degraded, or Unsatisfactory are assigned to each airfield section based on the criteria in Table 8.8. All rating factors must meet the criteria; i.e., if all factors do not meet the criteria, the section rating is assigned based on the lowest factor rating. For example, a runway section would be rated Adequate only if the PCI is ≥ 71; and the Friction Index is > 0.49; and the Structural Index (ACN/PCN) is less than 1.10; and the FOD Potential Rating is ≤ 45.

Table 8.8. EA Criteria.

Assessment/Rating Category	PCI	Friction Index (Runway Pavements Only)	Structural Index	FOD Potential Rating
Adequate	71–100	> 0.49*	< 1.10	0–45
Degraded	56–70	0.34–0.49*	1.10–1.40	46–60
Unsatisfactory	0–55	< 0.34*	> 1.40	61–100
*Applies to GripTester at 40 mph (65 km/h) only. For other testing equipment, use the values corresponding to the ratings of Good, Fair, and Poor in Table 8.3.				

8.1.5.3. **Step Three: Determine the EA for a Branch or Project Requirement.** The EA can be determined for a branch or project requirement by computing the weighted area average PCI for the branch or project, Friction Index (runway pavements only), Structural Index, and FOD Potential Rating (optional) for each section and comparing the values to the criteria in Table 8.8. An example of computing a weighted average PCI is shown in section 8.1.8. Table 8.9 shows an example of computing an EA for a runway, where Section R01A is 150 by 1000 feet (46 by 305 meters), Section R02C is 150 by 8000 feet (46 by 2,438 meters), Section R03A is 150 by 500 feet (46 by 152 meters), and Section R04A is 150 by 500 feet (46 by 152 meters). Comparing the weighted values in Table 8.9 to the criteria in Table 8.8, the EA for the runway is Degraded, the lowest rating of the four factors.

Note: The weighted average Structural Index can result in a Degraded or Unsatisfactory rating for a branch or project even though the PCI and other factors are rated Adequate. In this situation, examine the individual Degraded section(s) to determine if they can support the mission requirements. (Use the AGLs table in the latest AFCEC pavement evaluation report.) If the mission requirements are met, rate the branch/project as Adequate.

Table 8.9. EA Example.

Section	Area, square feet (square meters)	PCI	Friction Index (GripTester at 40 mph [65 km/h])	Structural Index	FOD Potential Rating	EA
R01A	150,000 ft^2 (13,935 m^2)	78	0.55	0.88	35	Adequate
R02C	1,200,000 ft^2 (111,484 m^2)	87	0.40	0.88	25	Degraded
R03A	75,000 ft^2 (6,968 m^2)	76	0.40	1.25	39	Degraded
R04A	75,000 ft^2 (6,968 m^2)	65	0.40	1.50	63	Unsatisfactory
Weighted Values		**85 (Adequate)**	**0.42 (Degraded)**	**0.93 (Adequate)**	**29 (Adequate)**	**Degraded**

8.1.5.4. **Step Four: Report the EAs by Branch.** It is also recommended that the results be displayed on a color-coded airfield layout plan, with green indicating Adequate, yellow indicating Degraded, and red indicating Unsatisfactory sections. An example airfield layout plan illustrating EAs by section is shown in Figure 8.5, while EAs by branch (i.e., based on weighted section values) are shown in Figure 8.6.

Figure 8.5. Sample Airfield Layout Plan Rated by Section.

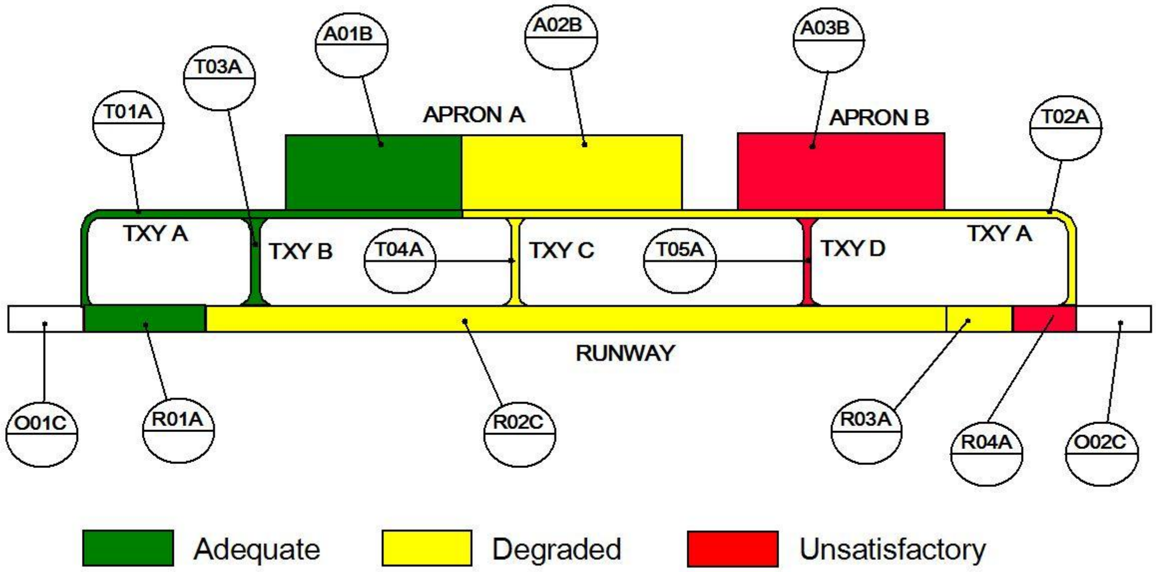
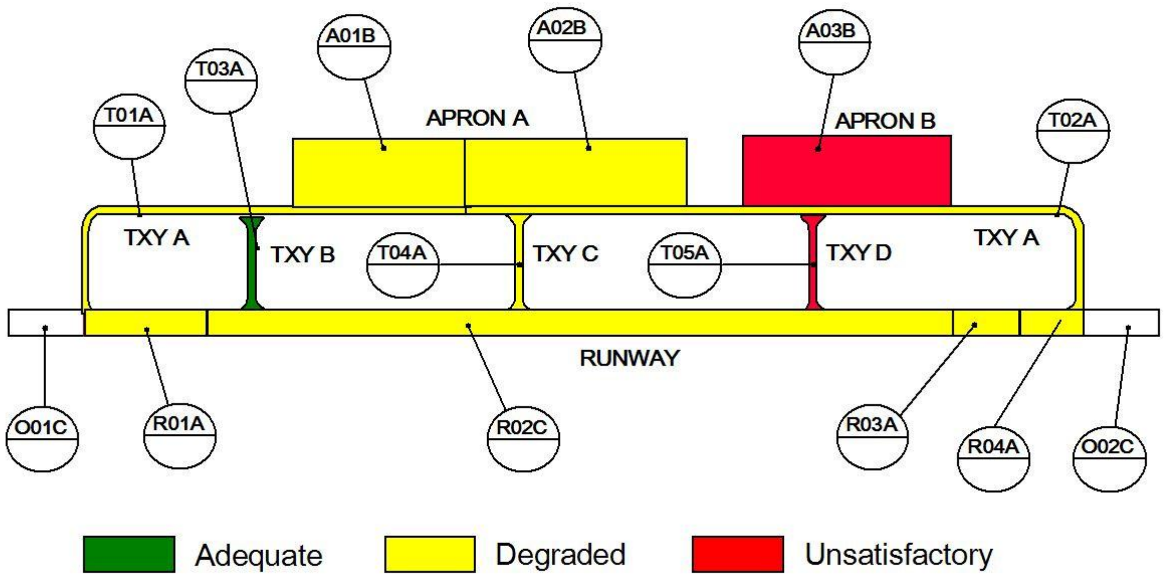


Figure 8.6. Sample Airfield Layout Plan Rated by Branch.



8.1.6. **Project Prioritization.** The following procedure outlines a method for objectively establishing priorities for projects that fall into the same assessment category (i.e., Adequate, Degraded, or Unsatisfactory).

8.1.6.1. **Procedure.** Determine the PCI, Friction Index, Structural Index, and FOD Potential Rating (optional) for the section related to each project. Use Figure 8.7 to determine the deduct values for the Friction Index, Structural Index, and FOD Potential Rating (optional). Friction deduct charts are shown for both the Mu-Meter and the GripTester. These deduct values may be capped at a maximum value of 10 for data that falls outside the ranges of values depicted. Subtract each deduct value from the PCI to determine a priority order (lowest numerical result ranks first in priority).

8.1.6.2. **Example.** Assume that three runway sections fall within the Degraded category as determined by the criteria in Table 8.8. Pertinent information for determining the section project prioritization for this example is shown in Table 8.10.

Figure 8.7. Deduct Values for Friction Index, Structural Index, and FOD Potential Rating.

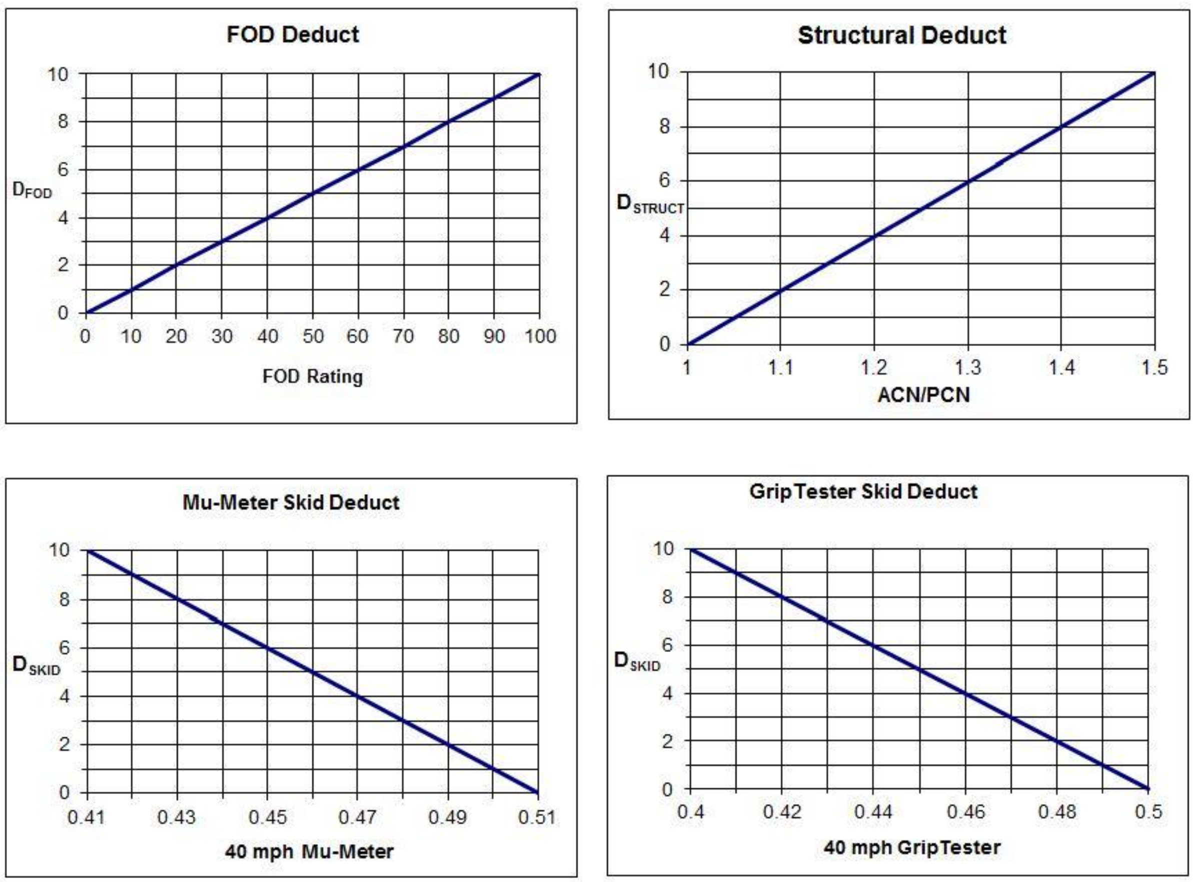


Table 8.10. Determining Funding Priority.

Section	PCI	Friction Index (GripTester)	FOD Potential Rating	Structural Index
R11A	75	0.48	10	1.4
R12A	56	0.43	30	1.3
R13A	56	0.43	20	1.3
Rating Calculations				
R11A	75−2−1−8 = 64			
R12A	56−7−3−6 = 40			
R13A	56−7−2−6 = 41			
The priority for funding is R12A, then R13A, then R11A.				

8.1.7. **Combining .** When sections are combined to form projects, use an area-weighted process for determining the rating. For instance, if Sections R12A and R13A in Table 8.10 were included in a single project, the combined rating would be:

$$\text{Rating (Combined)} = \frac{\text{Rating R12A(Area R12A)} + \text{Rating R13A(Area R13A)}}{\text{Area R12A} + \text{Area R13A}}$$

8.1.8. **Numerical Rating System.** Some MAJCOMs may want to rate the general "health" of all facilities, including pavements, on a numerical rating scale. This section describes a procedure for calculating a pavement rating using a weighted PCI. A weighted PCI can be calculated manually or by using PAVER:

8.1.8.1. Assume a 10,000- by 150-foot (3,048- by 46-meter) runway comprised of the sections described in Table 8.11.

Table 8.11. Numerical Rating System Example.

Section	**Dimensions**	**PCI**
R21A	1,000 by 150 feet (305 by 46 meters)	78
R22C	8,000 by 150 feet (2,438 by 46 meters)	70
R23A	500 by 150 feet (152 by 46 meters)	54
R24A	500 by 150 feet (152 by 46 meters)	52

8.1.8.2. The manual computation:

$$\text{Weighted PCI} = \frac{\text{R21A PCI(R21A Area)} + \text{R22C PCI(R22C Area)} + \text{R23A PCI(R23A Area)} + \text{R24A PCI(R24A Area)}}{\text{R21A Area} + \text{R22C Area} + \text{R23A Area} + \text{R24A Area}}$$

$$\text{Weighted PCI} = \frac{78(1000\times150) + 70(8000\times150) + 54(500\times150) + 52(500\times150)}{(1000\times150) + (8000\times150) + (500\times150) + (500\times150)}$$

Weighted PCI = 69 = health of runway

8.1.9. **Assessing Value Added.** The procedure above can also be used to determine "value added" to a facility by a project. For example, assume an M&R project raises the PCI of R23A and R24A to 80 without affecting any of the other indices. The new rating for the runway would be 71.8; therefore, the project increased the health of the runway by 2.8 points.

8.1.10. **Rating Scales.** A MAJCOM may want to use a different scale for rating facility health. For example, using a range of 85 to 100 for the rating of Good may be desirable. This can be accomplished by applying a proportioning operation to the weighted PCI (see Table 8.12).

Table 8.12. Proportioning Operation Applied to the Weighted PCI.

Rating	Weighted PCI	Proportioning Operation	Numerical Rating
Good	100 71	([PCI-71] x [15/30])+85	100 85
Fair	70 56	(PCI-56)+70	84 70
Poor	55 0	(PCI-70/55)	69 0

8.2. EA for Roads and Parking Lots. The factor used to determine the EA for roads and vehicular parking lots is the PCI as determined by ASTM D6433. The criteria for determining the EA are shown in Table 8.13 and depicted in Figure 8.8; use these criteria to determine an EA for each section.

Table 8.13. EA PCI Criteria for Roads and Parking Lots.

EA	PCI
Adequate	71–100
Degraded	56–70
Unsatisfactory	0–55

Figure 8.8. EAs for Roads and Parking Lots.

8.2.1. **Combining Rating System, and Value Added.** Use the procedures outlined in paragraphs 8.1.7, 8.1.8, and 8.1.9.

8.2.2. **Project Prioritization.** The PCI is used to establish the priority for projects that fall into the same engineering assessment category (Adequate, Degraded, or Unsatisfactory); however, projects for primary roads should be ranked higher than those for parking lots and secondary roads. See the AF Transportation AMP and Chapter 9 for Key Performance Indicators for roads and pavements.

Chapter 9

ASSET MANAGEMENT

9.1. Background. The Air Force has established a goal to reduce the amount of infrastructure that requires funds in accordance with AFPD 32-10. AFPD 32-10 states "Provide and retain the minimum number of installations and facilities necessary to effectively support Air Force missions and people at the lowest life-cycle cost and in a sustainable way. The Air Force will inactivate or dispose of installations and facilities that are excess to requirements." To accomplish this goal, a procedure was developed to determine the funding required to maintain essential infrastructure at a prescribed level of service at the lowest possible cost. Infrastructure was divided into five activities: transportation networks, utilities, facilities, waste management, and natural infrastructure. The transportation networks include airfield and roadway pavements, vehicle parking areas, curbs and gutters, drainage structures, culverts, bridges, sidewalks, markings, traffic signals, signs, lighting, rails, docks, piers, entry points, snow and ice removal, and sweeping.

9.2. Activity Management Plan (AMP). AMPs are developed for each major CE activity to include Airfield and Transportation Networks. AMPs include information on Real Property inventory, Levels of Service (LOS), Key Performance Indicators (KPI), and the planned investments (projects/requirements) identified to achieve the required LOS. This chapter outlines the criteria for airfield, road, and parking lot pavements. To more accurately establish requirements, each of these areas is divided into primary, secondary, and tertiary pavements as defined in sections 9.3.1 and 9.3.2. Strict implementation of these rankings is critical to the ability to stratify and prioritize requirements.

Note: LOS and KPI criteria are evolving and are subject to revision. Consult the current AF Transportation Network AMP for the latest revisions.

9.3 Level of Service. The LOS for airfield, road, and parking lot pavements is the same—to provide pavements that will support the Air Force mission by balancing risk to operations with resource constraints.

9.3.1. **Airfield Pavements.**

9.3.1.1. **Primary Pavements.** Primary pavements are mission-essential pavements such as runways, parallel taxiways, main parking aprons, arm-disarm pads, alert aircraft pavements, and overruns (when used as a taxiway or for takeoff). In general, only pavements that have aircraft use on a daily basis or frequently used transient taxiways and parking areas are considered primary.

9.3.1.2. **Secondary Pavements.** Secondary pavements are mission-essential but occasional-use airfield pavements, including ladder taxiways, infrequently used transient taxiway and parking areas, overflow parking areas, and overruns (when there is an aircraft arresting system present). In general, any pavements that do not have daily use by aircraft are secondary.

9.3.1.3. **Tertiary Pavements.** Tertiary pavements include pavements used by towed or light aircraft, such as maintenance hangar access aprons, aero club parking, wash racks, and overruns (when not used as a taxiway or to test aircraft arresting gear). Paved shoulders are classified as tertiary. In general, any pavement that does not support aircraft taxiing under their own power or is used only intermittently is considered a tertiary pavement.

9.3.1.4. **Unused Pavements.** Unused pavements include any pavements that are abandoned or scheduled for demolition.

9.3.2. **Roads and Vehicle Parking Areas.** Surface Deployment and Distribution Command (SDDC) traffic engineering pubs and HQ USAF/LEEVX Base Comprehensive Planning Transportation Planning Bulletin define several categories of roads including; interstate (limited access), arterials, collectors, and local streets (see Figure 9.1). In general, these categories align with pavement rank. There may be instances where the mission may dictate a higher priority as defined below.

Figure 9.1. Characteristics of Roadway Classes.

CRITERIA	FREEWAYS & EXPRESSWAYS	ARTERIAL	COLLECTOR	LOCAL
Average Trip Length (mi.)	Over 3	Over 1	Under 1	Under 1/2
Average Travel Speed (mph)	50-55	25-45	25-35	25-30
Average Daily Traffic Volume (Both Directions)	25,000 to 100,000	8,000 to 25,000	2,000 to 8,000	fewer than 2,000
Access Control	Partial to Full	Partial	Minimum to Partial	Minimum
Service to Activities	Through Traffic high volume	High to Med. Vol.	Local Areas Neighborhoods	Individual sites
Spacing (mi.)	2 or over	1/2 - 1	1/4 - 1/2	300-500'
Traffic Control	Free Flow	Traffic Sig. Stop signs	Stop Signs Traffic Sig.	Stop sign or yield
Average No. of Lanes	4 to 8	4 to 6	2 to 4	2

9.3.2.1. **Primary Pavements.** Primary pavements include arterials which are defined as a class of street serving a major movement of traffic not served by a freeway. This includes installation roads and streets that serve as the main distributing arteries for traffic originating outside and within an installation and that provide access to, through, and between the various functional areas or collector or local streets that service mission critical facilities. Classification of vehicle parking areas as primary pavements should be restricted to those areas associated with access to mission-essential facilities, such as alert facilities, munitions facilities, and medical facilities.

9.3.2.2. **Secondary Pavements.** Secondary pavements include collector streets that gather and disperse traffic between the larger arterial highways and less important streets, that have intersections at grade, and that are equally important in providing traffic movement and access to abutting properties. In addition, most parking areas that support daily traffic on a base are considered secondary pavements, unless a specific mission dictates otherwise.

9.3.2.3. **Tertiary Pavements.** Tertiary pavements include local streets that are streets or roads primarily for access to residence, business or other abutting property. Installation roads and streets that provide access from other collector roads and streets to individual units of facilities of a functional area are included in this category. Unsurfaced roads and abandoned in-place but usable roads are classified as tertiary. Any parking area that is not used on a daily basis or is excess to the standard facilities requirements is considered a tertiary pavement.

9.3.2.4. **Unused Pavements.** Unused pavements include any pavements that are abandoned or scheduled for demolition.

9.4. Key Performance Indicators. The criteria in this section were established to ensure that airfield, road, and parking lot pavements LOS are adequately maintained. The four key performance indicators are PCI, FOD Index, Friction, and Structural capability. The targets for these four key performance indicators are used to define risk factors shown in tables 9.1 and 9.2. These risk factors in combination with knowledge of the mission requirements are used to manage the assets and activities to minimize the life cycle cost and risk to the mission.

9.4.1. **Airfield Pavements.** Asset management pavement criteria for airfield pavements are shown in Table 9.1.

9.4.1.1. **Risk Factors.** Airfield pavements can be maintained at one of the four Risk Factors shown in Table 9.1 and discussed in the following subparagraphs.

9.4.1.1.1. **Low Risk.** This is the optimum condition to minimize risk to mission and life cycle cost. Localized or global preventive maintenance may be required to reduce the rate of deterioration and extend pavement life.

9.4.1.1.2. **Moderate Risk.** This condition is less than optimum based on the life cycle cost to maintain the pavement and may have minor impact on mission requirements. Localized repair or localized/global preventive maintenance is needed. Increased FOD inspection and sweeping frequency may be required to minimize FOD potential.

9.4.1.1.3. **Significant Risk.** This condition is not based on the life cycle cost to maintain the pavement. Pavements maintained at this level will require increased monitoring and sweeping, etc., to reduce FOD and mitigate risk to mission. Preventative maintenance and repairs are required to maintain operational safety. Some workarounds may be required to meet mission requirements. Expect mission restrictions.

9.4.1.1.4. **High Risk.** Pavements in this condition require increased monitoring, sweeping and maintenance. Aircraft maintainers will need to increase monitoring of tires and FOD. Some aircraft ground movements may need to be rerouted. Continuous workarounds may be required to meet mission requirements. Expect urgent unscheduled M&R. Major M&R/rehabilitation needed to improve pavement condition. Expect mission restrictions. Pavements below this condition will likely require waivers to support AMC mission aircraft. Expect major delays due to repair times when pavement fall below this condition.

9.4.1.1.5. **General.** The following subparagraphs provide general M&R and reconstruction guidance. A project should be programmed before the pavement reaches these conditions.

9.4.1.1.5.1. Sections with a PCI greater than or equal to 71 generally require preventative maintenance and minor repair.

9.4.1.1.5.2. Sections with a PCI of 56 to 70 generally require major and minor M&R.

9.4.1.1.5.3. Sections with a PCI of 41 to 55 require major and minor M&R or reconstruction.

9.4.1.1.5.4. Sections with a PCI of 26 to 40 require major repair or reconstruction.

9.4.1.1.5.5. Sections with a PCI less than or equal to 25 require reconstruction.

Table 9.1. Key Performance Indicators, Targets and Airfield Pavement Risk Factors.

Risk Factor	Primary	Secondary	Tertiary
Low	PCI ≥ 71 for any section Weighted PCI ≥ 85 for any branch FOD Potential Rating ≤ 45	PCI ≥ 56 for any section Weighted PCI ≥ 85 for any branch FOD Potential Rating ≤ 45	PCI ≥ 56 for any section Weighted PCI ≥ 71 for any branch FOD Potential Rating ≤ 45 Paved shoulders ≥ FAIR
Moderate	PCI ≥ 56 for any section Weighted PCI ≥ 85 for any branch FOD Potential Rating ≤ 45	PCI ≥ 56 for any section Weighted PCI ≥ 71 for any branch FOD Potential Rating ≤ 45	PCI ≥ 41 for any section Weighted PCI ≥ 56 for any branch FOD Potential Rating ≤ 45 Paved shoulders ≥ FAIR
Significant	PCI ≥ 56 for any section Weighted PCI ≥ 71 for any branch FOD Potential Rating ≤ 45	PCI ≥ 41 for any section Weighted PCI ≥ 56 for any branch FOD Potential Rating ≤ 45	PCI ≥ 26 for any section Weighted PCI ≥ 41 for any branch FOD Potential Rating ≤ 60 Paved shoulders ≥ FAIR
High	PCI ≥ 41 for any section Weighted PCI ≥ 56 for any branch FOD Potential Rating ≤ 45	PCI ≥ 26 for any section Weighted PCI ≥ 41 for any branch FOD Potential Rating ≤ 60	PCI ≥ 26 for any section Weighted PCI ≥ 41 for any branch FOD Potential Rating ≤ 60 Paved shoulders ≥ FAIR

Friction	Mu ≥ 0.53 for each 1000-foot (305-meter) segment (GripTester @ 40 mph [65 km/h]) or Mu ≥ 0.36 for each 1000-foot (305-meter) segment (GripTester @ 60 mph [96 km/h])	NA	NA
Structural	The average operational weight of the mission aircraft is less than the AGL for Air Force Pass Intensity Level II or ACN/PCN ≤ 1.1, ACN based on average operational weight of the mission aircraft and PCN based on 50,000 passes of a C-17	The average operational weight of the mission aircraft is less than the AGL for Air Force Pass Intensity Level III or ACN/PCN ≤ 1.3, ACN based on average operational weight of the mission aircraft and PCN based on 50,000 passes of a C-17	The average operational weight of the mission aircraft is less than the AGL for Air Force Pass Intensity Level IV or ACN/PCN ≤ 1.5, ACN based on average operational weight of the mission aircraft and PCN based on 50,000 passes of a C-17

9.4.1.2. **Runway Friction Requirements.** If measured coefficient of friction is less than 0.53 (based on Griptester at 40 mph) and less than 0.36 (based on Griptester at 40 mph) for any two consecutive 500-foot (152-meter) segments, determine the cause(s) and extent of the friction loss and take appropriate corrective action. Corrective action may consist of improving texture, grooving, restoring transverse slope, or removing rubber on a recurring basis. If the measured coefficient of friction is less than 0.43, issue a Notice to Airmen (NOTAM) and immediately improve friction characteristics.

9.4.1.3. **FOD Potential Rating.** The FOD Potential Rating is discussed in paragraph 8.1.4.5.

9.4.1.4. **Condition Surveys.** Condition surveys are usually not performed on paved shoulders. In addition, there is currently no standard condition survey procedure for double bituminous surface treatment (DBST). A rating of GOOD, FAIR, or POOR is assigned based on a cursory visual survey using the cursory PCI procedure for shoulders and the simplified PCI scale. Ratings for DBST overruns are based on a determination of whether the DBST is preventing moisture from entering the base material from the surface.

9.4.1.5. **Structural.** See Figure 4.1 for pass intensity levels. PCNs for the Navy and Army are based on the projected passes of the critical mission aircraft for the specific base for a 20-year life. PCNs for the Air Force are based on 50,000 passes of the C-17.

9.4.2. **Roads and Vehicle Parking Areas.** Risk Factor for roads and vehicle parking areas is provided in Table 9.2.

Table 9.2. Key Performance Indicators, Targets and Risk Factor for Roads and Vehicle Parking Areas.

Risk Factor	Primary Pavements	Secondary Pavements	Tertiary Pavements
	PCI ≥ 56 for any section Weighted PCI ≥ 71 for any branch	PCI ≥ 41 for any section Weighted PCI ≥ 56 for any branch	PCI ≥ 26 for any section Weighted PCI ≥ 56 for any branch

9.4.2.1. General. Pavement requirements shall be identified in the out year POM (as part of the AMP process) to ensure pavements are maintained IAW criteria in Tables 9.1 and 9.2. A project must be programmed and prioritized in the upcoming budget year before sections reach the following condition:

9.4.2.1.1. Sections with a PCI greater than or equal to 71 generally require preventative maintenance and minor repair.

9.4.2.1.2. Sections with a PCI of 56 to 70 generally require major and minor M&R.

9.4.2.1.3. Sections with a PCI of 41 to 55 require major and minor M&R or reconstruction.

9.4.2.1.4. Sections with a PCI of 26 to 40 require major repair or reconstruction.

9.4.2.1.5. Sections with a PCI less than or equal to 25 require reconstruction.

JUDITH A. FEDDER, LT GENERAL, USAF
DCS/Logistics, Installations & Mission Support

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

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AFI 32-9005, *Real Property Accountability and Reporting, August, 2008*

UFC 1-800-08, *Transfer and Acceptance of Military Real Property*,

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Prescribed Forms

None

Adopted Forms

AF Form 847, *Recommendation for Change of Publication*, 22 September 2009

Abbreviations and Acronyms

AC—asphalt concrete

AC—Advisory Circular (FAA publication)

ACN—Aircraft Classification Number

AFFSA—Air Force Flight Standards Agency

AFIT—Air Force Institute of Technology

AFRL—Air Force Research Laboratory

AGL—allowable gross load

AMP—Activity Management Plan

ASTM—American Society for Testing and Materials

BCE—base civil engineer

CAD—computer-aided design

CBR—California Bearing Ratio

CFME—continuous friction measuring equipment

DBST—double bituminous surface treatment

DTIC—Defense Technical Information Center

EA—Engineering Assessment

ERDC—USACE Engineer Research and Development Center

ETL—Engineering Technical Letter

FAA—Federal Aviation Administration

ft2—square feet

FOD—foreign object damage

HQ AFCESA—Headquarters Air Force Civil Engineer Support Agency

AFCEC—Air Force Civil Engineer Center

AFCEC/CO—Air Force Civil Engineer Support Center, Operations Directorate

AFCEC/COAP—Air Force Civil Engineer Center, Asset Visibility Division, Airfield Pavement Evaluation Branch

HQ USAF—Headquarters Air Force

HWD—heavy weight deflectometer

ICAO—International Civil Aviation Organization

k—modulus of soil reaction

km/h—kilometers per hour

m2—square meters

M&R—maintenance and repair

MAJCOM—major command

mph—miles per hour

NAVFAC—Naval Facilities Engineering Command

NGA—National Geospatial-Intelligence Agency

NOTAM—Notice to Airmen

PAVER—pavements management software used by DOD, government, and private industry

PCC—portland cement concrete

PCI—Pavement Condition Index

PCN—Pavement Classification Number

PM—program manager

TSMCX—USACE Transportation Systems Center

UFC—Unified Facilities Criteria

USACE—U.S. Army Corps of Engineers