Preventive Maintenance at General Aviation Airports Volume 2: Guidebook

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AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP REPORT 138

Preventive Maintenance at General Aviation Airports

Volume 2: Guidebook

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), Airlines for America (A4A), and the Airport Consultants Council (ACC) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

Research problem statements for the ACRP are solicited periodically but may be submitted to the TRB by anyone at any time. It is the responsibility of the AOC to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

Once selected, each ACRP project is assigned to an expert panel, appointed by the TRB. Panels include experienced practitioners and research specialists; heavy emphasis is placed on including airport professionals, the intended users of the research products. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, ACRP project panels serve voluntarily without compensation.

Primary emphasis is placed on disseminating ACRP results to the intended end-users of the research: airport operating agencies, service providers, and suppliers. The ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties, and industry associations may arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by airport-industry practitioners.

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FOREWORD

By Marci A. Greenberger
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ACRP Report 138: *Preventive Maintenance at General Aviation Airports* is published as a two-volume set. Volume 1 is a primer for airport governing- and policy-board members on the importance and value of a preventive maintenance program. Volume 2 is a guidebook for airport managers, maintenance managers, and all line personnel on how to plan, prioritize, and conduct preventive maintenance for physical infrastructure assets.

This Volume 2 Guidebook assists airport and maintenance management and all staff responsible for maintenance and repair of the airport's physical infrastructure assets in understanding preventive maintenance (PM) programs. It includes guidance on conducting PM for typical airport physical infrastructure assets. Volume 2 also contains a CD-ROM that includes system checklists that airport staff can customize for their use, as well as a PowerPoint presentation that can be shown to governing boards or communities on the importance of budgeting for preventive maintenance.

General aviation airports of all sizes are an integral part of the National Aviation System. Many of these airports have aging facilities, changing facility demands to accommodate the changes in the general aviation industry, and diminishing revenue sources. These trends coupled with limited staff and budgets have made it difficult to properly maintain the facilities beyond responding to immediate needs. Airport management responds well to those needs, but these efforts leave little time for true maintenance planning.

PM programs can be effective at ensuring that physical assets operate reliably and efficiently. However, preventive maintenance is not always funded. Delta Airport Consultants, Inc., as part of ACRP Project 10-18, conducted research on the benefits and value of an airport preventive maintenance program, as well on the typical physical infrastructure assets at airports and the considerations for developing a preventive maintenance program for those assets. Airport policy- and governing-board members will find the primer informative on the need and the value that a preventive maintenance program provides. Airport management and their staff will find that the guidebook illustrates how to set up a preventive maintenance program and provides specific guidance for specific assets. The primer and guidebook will be useful for general aviation airports of all sizes.

CONTENTS

Note: Photographs, figures, and tables in this report may have been converted from color to grayscale for printing. The electronic version of the report (posted on the web at www.trb.org) retains the color versions.

CHAPTER 1

Introduction

1.1 Background

General aviation airports play an important role in the nation's aviation system. They provide access by air and serve the aviation needs of local communities. They have a significant economic impact on their community, region, and state. However, it is costly to properly operate, maintain, and develop an airport. Also, many airports have aging facilities, changing demands, and few revenue sources. Unfortunately, airport preventive maintenance (PM) is often neglected and given little to no priority when establishing local budgets or schedules. A sound maintenance program is critical for extending the life of airport facilities and to keep the airport as safe and efficient as possible. A lack of preventive maintenance can result in premature failure of infrastructure and additional costs that would not otherwise have been the case.

This guidebook provides hands-on information to help with the development and execution of an airport PM program for general aviation airports. The companion primer (Volume 1 of this report) provides basic information about airport infrastructure and PM programs. These documents were developed using the knowledge and experience of the authoring team along with a review of literature, industry outreach, and on-site visits and interviews involving a diverse group of airports and state aviation agencies from around the country. Appendix A contains a list of the airports and state aviation agencies that provided information to help with the development of this guidebook.

The following airport infrastructure systems are introduced in the primer and are discussed in detail in Chapter 4 of this guidebook:

- Airfield electrical vault,
- Airfield lighting,
- Airfield markings,
- Airfield pavements,
- Airfield signs,
- Airfield visual and navigational aids,
- Airport-owned utilities,
- Deicing facilities,
- Drainage systems,
- Fencing and gates,
- Fueling facilities,
- Hangars,
- Landside infrastructure,
- Maintenance equipment,
- Maintenance and equipment storage buildings,
- Obstructions to imaginary surfaces,

- Terminals and administration buildings,
- Turf and safety areas, and
- Vehicles.

1.2 Purpose of Guidebook

The purpose of this guidebook is to help airport management, maintenance staff, fixed-base operators, tenants, consultants, state aviation officials, and maintenance service providers with their airport maintenance responsibilities. This guidebook provides:

- An overview of PM, why it is important, and some principles of a PM program;
- Information about the key elements of a PM program;
- PM procedures for specific airport infrastructure systems;
- Comprehensive checklists for scheduled PM; and
- References for additional information and help.

1.3 How to Use the Guidebook

This guidebook primarily targets airport management and staff and provides guidance on the why, where, when, and how of PM programs. The primer is primarily directed toward airport governing officials, policy makers, and airport managers who are responsible for approving airport resources, budgets, staffing levels, and strategic plans for their airports.

This guidebook's organization flows from an overview of PM, what it is, why it is important, the general principles of a sound program, and how to establish a PM program, and then moves to specific guidance and generic checklists for each airport infrastructure system.

Key questions for airport management, staff, and others to ask and where answers may be found in the guidebook are shown in Figure 1.1. In addition, Appendix B provides a list of useful sources of information about airport infrastructure and preventive maintenance.

Each airport is unique. The actual program and activities that occur at airports differ significantly based on the complexity and age of an airport's infrastructure and the available resources. Although this guidebook cannot specifically address the unique needs of each airport, it will help the reader better understand the important elements of a PM program, and it provides generic checklists for each infrastructure system that may be adapted to each airport based on varying infrastructure, staff levels, budgets, and other resources.

The intended audiences and how they may use this guidebook are:

- ***Airport management and staff*** are generally interested in the development of the overall PM program. Their focus is typically on identifying requirements, establishing a good program, and executing it on a daily basis. This audience will primarily benefit from Chapters 3 and 4.
- ***Airport owners and policy makers,*** such as board members, elected officials, economic development staff, and community leaders, need a good understanding of general aviation, general aviation airport services, and facilities that provide those services. This knowledge will in turn help them make budgets, adopt community visions, recognize funding opportunities, and understand the importance of preventive maintenance. This audience will primarily benefit from Chapters 2 and 3 of this guidebook as well as the primer.
- ***Airport tenants*** such as FBOs lease areas or facilities provided by the airport, but some develop their own facilities or participate in the airport owner's preventive maintenance program. This audience will benefit from Chapter 4.

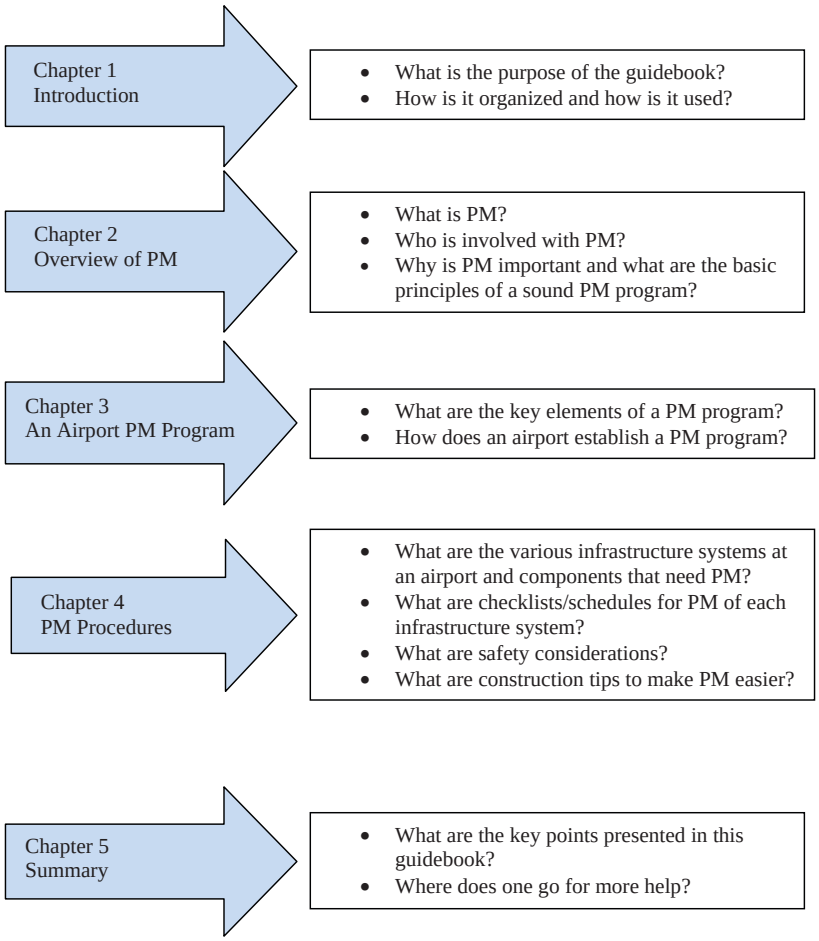

Figure 1.1. Guidebook content.

- ***Local/state/federal agencies*** will benefit from all chapters depending on the staff's role with airports and preventive maintenance.
- ***Airport consultants*** are normally familiar with general aviation airports, their infrastructure systems, and the principles that make up a good PM program. This audience will primarily benefit from Chapters 3 and 4.

This guidebook and the companion primer supplement other guidance that is available, such as FAA Advisory Circulars and orders, state aviation agency guidelines, and maintenance manuals for specific equipment or vehicles. Many of these publications are listed in the bibliography in Appendix B.

CHAPTER 2

Preventive Maintenance—An Overview

2.1 Introduction

It is important that airport management officials, staff, and others responsible for maintaining airports have an appreciation of what preventive maintenance is, its importance, and how to go about developing and implementing a PM program at their airport. This chapter provides an overview of preventive maintenance for general aviation airports and will answer questions such as:

- What is preventive maintenance and how does it relate to other types of maintenance?
- Why is preventive maintenance important?
- What entities are involved with preventive maintenance?
- How does preventive maintenance relate to other airport plans and programs?

Chapter 3 will provide information about the development of a preventive maintenance program for airports, and Chapter 4 will provide information about PM procedures.

2.2 What Is Preventive Maintenance?

Most airports perform some type of maintenance on their facilities. Generally, the operating conditions of runways and airfield lighting systems are monitored regularly by someone. If there is loose pavement on the runway, a light is not working, or a hangar door will not open, someone quickly addresses the problem. However, few airports have comprehensive preventive maintenance programs that include the regular assessment of the condition of infrastructure systems and scheduled maintenance of the many components of each airfield system.

The maintenance of general aviation airports is frequently divided into the following types:

- **Operational.** There are certain aspects of operating an airport that require maintenance activities due to weather, environmental conditions, and electrical/mechanical manufacturer's calibration of equipment. Snow and foreign objects must sometimes be removed from pavements. Lighting systems and approach aids for pilots must be calibrated. These are examples of operational requirements that require maintenance activities and may affect the condition of infrastructure. These types of operational activities are generally driven by regulatory and airfield safety requirements and are discussed in detail in sources such as FAA Advisory Circulars. Operational maintenance will not be a subject of this guidebook.
- **Reactive.** Reactive maintenance is basically characterized by an attitude of use it until it breaks or fix it when it breaks. A perceived advantage to this type of maintenance is that manpower and capital costs are not incurred until something actually breaks. The reality is that many general aviation airports are primarily in a reactive mode and are spending more to repair equipment than they would be spending with a preventive maintenance approach. While waiting for something to break (e.g., an HVAC unit), the life of the equipment is shortened, resulting

in earlier replacement. This results in an increased capital cost in the long run. Also, some facilities do not break in a traditional sense, and their outright failure can be significant to an airport's mission. For example, joints in a runway pavement that are not kept sealed can result in water seeping into the pavement base structure and eventually causing serious pavement failure. This might require expensive rehabilitation or replacement of pavement systems. Simply reacting to this type of failure is not acceptable to the airport user or the airport's budget. Airports cannot staff or plan for reactive maintenance. Multiple system failures will reduce staff availability, affect services provided to tenants and customers, reduce revenue, and may even require closure of the airport.

- **Preventive.** Preventive maintenance can be defined as those actions performed to detect, preclude, or mitigate the degradation of an infrastructure system or its components. Preventive maintenance involves routine scheduled activities intended to keep a system performing at its best, with goals of preventing its breakdown and extending its useful life. Preventive maintenance has several advantages over those of a reactive program. By performing preventive maintenance on a facility as envisioned when it was designed, the full design life of the facility may be realized. Preventive maintenance (e.g., lubrication, filter changes, sealing pavement joints) will generally help equipment run more efficiently and will ensure that infrastructure functions more safely and efficiently. This results in reduced costs and improved user satisfaction. Airports can plan and assign staff appropriately by applying scheduled preventive maintenance.
- **Predictive.** Predictive maintenance is an approach that involves testing and monitoring of equipment and facilities to detect symptoms that are out of specification and, thus, predicting potential failures. This approach is especially useful for vehicles and equipment. Some airports use a mix of preventive maintenance and predictive maintenance standards to ensure minimal impact on the operational capability of the airport. For purposes of this guidebook, preventive maintenance will include some aspects of predictive maintenance.

2.3 Why Is Preventive Maintenance Important?

As indicated previously, one of the purposes of preventive maintenance is to extend the life of a facility and avoid incurring capital replacement costs prematurely. This allows capital funds to be available for other projects such as improvements or expansion rather than required rehabilitations or replacements. For this reason and many others, it makes good sense for airports to adopt a preventive maintenance program. These reasons are discussed in the following and include safety, economics, reduction in energy usage, system longevity, legal/regulatory issues, environmental impacts, and community marketing.

Safety. Airport maintenance directly contributes to keeping airports and their facilities safe for users. Pilots expect pavements to be smooth and to drain well and expect clear approach paths, pavement marking to be legible, and airfield lighting systems to be reliable. Preventive maintenance helps ensure that those systems used by pilots are functioning properly. Similarly, well-maintained fueling facilities and airport vehicles help improve safety for their users.

Economics. Preventive maintenance extends the life of facilities and avoids costly and early replacement or rehabilitation. Preventive maintenance may result in the identification of the need for timely rehabilitation before a system fails or before more costly rehabilitation is needed. An example of this is with pavement rehabilitation. Pavement performance and the economic impact of waiting too long for rehabilitation are shown in Figure 2.1.

Another example of how a poorly maintained facility can adversely affect an airport's financial well-being is a hangar that is rusted so badly that aircraft cannot be stored in it, resulting in lost hangar rental revenue (see Figure 2.2).

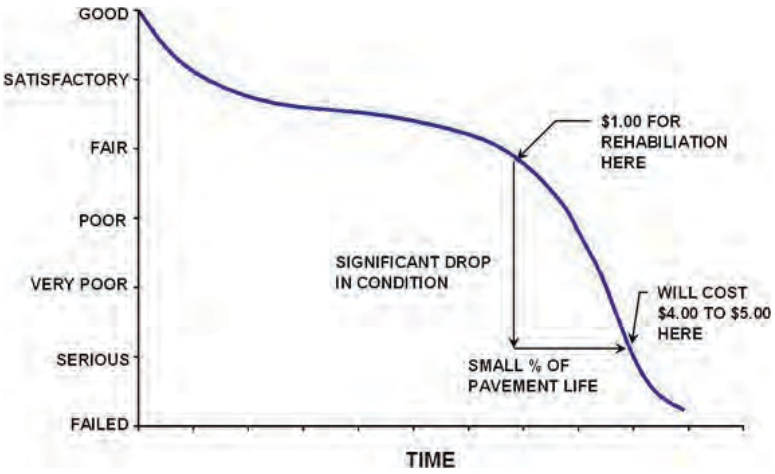

Figure 2.1. Typical pavement life cycle. Source: FAA Central Region, Guidance – Airport Obligations: Pavement Maintenance.

The other reasons discussed here for preventive maintenance have an economic effect too. An aircraft or personal accident related to poor airport maintenance is not only tragic but can be costly to the airport owner. Increased energy usage caused by poorly maintained electrical systems is also costly. An airport that is so poorly maintained that it drives away a corporation that wishes to base an operation there results in an adverse economic impact on the community from the loss of jobs and tax revenue.

It is difficult to quantify the specific monetary value of preventive maintenance for all infrastructure. The type of maintenance, the nature of the infrastructure, and various components of each system vary widely (e.g., roof, HVAC, motors, door hinges, pavement joints, drainage swales). However, the value of preventive maintenance is generally intuitive. For example, pavements typically last their design life of 20 to 30 years if properly maintained. Proper maintenance may include surface treatments every few years, which over the design life might total $1 million, followed by a major rehabilitation or reconstruction at the end of the life, which could cost $2 million to $5 million for a general aviation airport runway. If the surface treatments are not done over the life of the pavement, a large rehabilitation or reconstruction would likely be needed at 10 to 15 years. So, over the course of the life of this runway, the additional cost would be $2

Figure 2.2. Rusted hangar not usable for aircraft storage. Source: Delta Airport Consultants, Inc.

million to $5 million for the premature failure of the pavement caused by the lack of preventive maintenance. In addition to this pavement example, a roof can be used to generally demonstrate the value of maintenance. The cost of maintaining a roof is often much less than letting a roof prematurely fail, causing interior building damage and possible adverse impacts on the customer. This is particularly true in the earlier years of a roof's life, but late in a roof's life it may be more cost-beneficial to replace the roof.

Reduction in Energy Usage. Poorly maintained electrical and mechanical systems lead to the increased use of energy. Airfield lighting systems with aging cable and loss of energy will drive electrical bills up. This can be managed through an effective preventive maintenance program. Similarly, poorly maintained HVAC units or weatherproofing in a general aviation terminal building will increase energy costs. These excess energy costs are ongoing and can become significant over time.

System Longevity. The life of many airport infrastructure systems can be extended with proper preventive maintenance. Examples of PM in this area include pavement crack sealing, servicing HVAC equipment, regular oil changes for airport vehicles, checking and replacing defective airfield lighting system components, greasing hangar door components, and keeping drainage swales free of debris so pavements can drain properly.

Legal/Regulatory Issues. There are legal, regulatory, and contractual reasons for preventive maintenance. Airport owners wish to reduce their liability and risks, and good preventive maintenance of facilities can help in this regard. Tenants with leases of airport land or hangars expect well-maintained airport facilities, and often the lease itself addresses the airport owner's responsibility. State and federal capital improvement grants include contractual obligations that require airport owners to keep the airport safe, operational, and well-maintained. FAA grants specifically require airports to have a pavement preventive maintenance program. FAA grant assurances become airport obligations when airports accept federal funds for airport development. Grant obligations require airport improvements to be maintained for their design life, typically 20 years. Failure to comply with grant assurances can significantly affect an airport's ability to receive future federal funds.

Environmental Impacts. Some airport infrastructure can adversely affect the environment if not well-maintained. Examples are drainage systems that start backing up and allow poor-quality runoff to environmentally sensitive areas. Fuel leakage from poorly maintained fueling facilities will harm the environment. Most communities and states have environmental regulations that directly affect aspects of an airport's preventive maintenance requirements.

Community Marketing. An airport is often the front door to a community. If it is well-maintained and attractive in appearance, it conveys a message that the community protects its investments and cares about those who use its facilities. Businesses deliberating about where to base themselves not only look at location and the ability of the airport to serve their needs, but they will also consider the condition of the airport.

2.4 What Entities Are Involved with Preventive Maintenance?

Preventive maintenance is not simply a program or responsibility placed on the shoulders of the airport manager to handle alone. Other entities help with direction, resources, and knowledge. Preventive maintenance is the joint responsibility of the airport owner (e.g., city/county), the policy-making board, airport manager, and airport maintenance staff. Although airport management typically makes recommendations or requests certain resources, the airport owner and policy-making board normally approve the budget and other resources for a preventive maintenance program. Airport management and staff then execute the program.

Airports owned by a city or county often have access to non-airport resources for some maintenance activities. These activities include motor vehicle fleet maintenance, public works staff to help maintain HVAC or buildings, and routine maintenance such as lawn mowing and cleaning ditches. When non-airport staff can help with these tasks, airport staff can better focus on those tasks related to airport-unique systems such as airfield lighting.

State departments of transportation and aviation offices may be able to help with maintenance activities. Some states have robust programs to help airports; others are unable to do much other than provide guidance. A strong state/airport partnership can help significantly with an airport maintenance program. These partnerships include a state funding program, advisory help, and an active state presence by state officials through an inspection program. Following is a list of some of the activities that states may offer to help general aviation airports with their maintenance programs.

- State airport inspections.
- Grant programs that include eligible maintenance work.
- Development of a formal pavement management plan with specific goals and funding to improve pavement condition.
- Supporting airport efforts to gain FAA funding for work such as pavement and lighting rehabilitation.
- Providing airports with a fixed amount of funds each year to use for the maintenance of facilities.
- State purchase of crack-sealing equipment for airports to use.
- State-sponsored training for airport staff. Examples are pavement maintenance and storm-water management.
- Statewide contracts for activities such as airfield marking, pavement joint sealing, and airfield electrical repairs. Doing this on a statewide basis helps to reduce the cost for individual airports.
- Combining the maintenance work of several airports under a single FAA grant coordinated and sponsored by the state. An example is rehabilitation of rotating beacons at several airports in the state.
- State aviation office coordination with other state agencies for the use of equipment to perform maintenance activities at airports.

Some states offer many of these activities in their programs; some offer little or none. Airport officials should contact their state aviation office directly or search the state website for more specific information about what maintenance activities their state will help fund.

The FAA Airport Improvement Program is limited in what it can fund for airport maintenance. The work that is eligible for funding depends on current congressional authorization and is normally limited in available funding. Projects such as needed pavement and lighting rehabilitation may also be eligible. Airports are encouraged to work with both their FAA and state aviation offices to determine how they may get help.

Tenants and airport users can be an important source of information about the condition of facilities. A tenant that rents an airport-owned hangar should be encouraged to let airport management know when some aspect of the hangar needs attention. An example is bearings on a door that are becoming noisy. However, airport management still needs to make periodic inspections of the hangar. Airports should have a process whereby pilots can report conditions to the airport through the fixed-base operator servicing them.

Consultants help airports with engineering design and preparation of plans and specifications for the more complex maintenance work. Consultants can also provide help to airports in setting up an airport maintenance program.

2.5 Principles of a Preventive Maintenance Program

There are certain principles that help guide the development of an airport's preventive maintenance program. These principles provide direction to an airport that has no program and will help airports evaluate and improve existing programs.

1. The preventive maintenance program should be planned, developed, and executed with a focus on the very reasons for having such a program, as discussed earlier in this chapter. These reasons include keeping the airport as safe as possible, preserving and increasing system longevity as economically as possible, meeting legal and regulatory requirements, mitigating negative environmental impacts, and embracing the notion that the airport is the front door to the community.
2. Maintenance objectives need to be fully integrated with the overall airport objectives, mission, and plans. In other words, PM cannot be done independently or in a vacuum without consideration for the operational needs of the airport or the airport's capital improvement plans. For example, a decision to reseal runway pavement joints should take into consideration future plans for a runway rehabilitation as well as the need to keep the runway open to users.
3. Maintenance objectives and standards should be established for each facility. These standards should include both a periodic condition assessment and regular maintenance activities with schedules, checklists, tracking, and recordkeeping.
4. Appropriate resources should be committed to perform the preventive maintenance. This includes funding, time, personnel, equipment, tools, and materials. Maintenance staff and departments should be well organized, and all preventive maintenance activities and follow-up needs should be reported and tracked. Staff should be appropriately trained and fully understand their responsibilities. This includes training related to job safety and hands-on maintenance skills. Resources should be available to establish and maintain a system to identify, track, and receive notification of scheduled preventive maintenance measures. This system and the maintenance should be continued through staff and seasonal changes.
5. Airport management should include maintenance personnel in the early stages of decision making when purchasing major equipment or designing new infrastructure. Maintenance personnel can help ensure that systems are designed and constructed to facilitate effective maintenance, recurring maintenance costs are minimized, and facility life is as long as it can reasonably be.
6. The PM program should include those activities and resources necessary for the airport to comply with local, state, and federal regulations. For example, there are environmental regulations, fuel storage regulations, airport operation regulations for 14 CFR Part 139 certificated airports, federal labor laws, local permits, and many other local, state, and federal requirements that need to be met.

CHAPTER 3

An Airport Preventive Maintenance Program

3.1 Introduction

This chapter provides a road map for the development and implementation of a preventive maintenance program for an airport. For airports with minimal or no preventive maintenance program, suggested steps to develop or improve a preventive maintenance program are discussed in this guidebook and include those in Figure 3.1.

Throughout development and execution of a preventive maintenance program, important stakeholders such as maintenance staff, policy makers, tenants, and users should be educated and involved, as appropriate. Key policy makers need to adopt the program.

3.2 Facility Condition Assessment

When establishing a new PM program for an airport, the facilities should first be inventoried and their conditions assessed. Airport management needs to be familiar with the airport's infrastructure systems, their components, condition, and expected life before failure. There are well-established criteria for assessing and documenting the condition of airfield pavements, but to-date there has been little formal guidance for other types of airport infrastructure systems. In some cases the assessment may be as simple as a visual inspection of the system (e.g., airfield markings). In other cases, such as with terminal buildings, the assessment will be much more complex and may involve the assistance of contractor personnel to evaluate the condition of HVAC, electrical, and plumbing systems. Chapter 4 provides a description of the components in each of these infrastructure systems and provides inspection checklists that may be used to assist in the evaluation of the systems. However, assets such as HVAC systems, roofs, buildings, and pavements may require the help of professionals to assess their condition.

Once a PM program is established, a facility condition assessment should be a regular activity. For example, building roofs should be inspected not only at the beginning of a new PM program, but twice a year looking for blistering, plugged drains, or damage from adverse weather.

Airport management may wish to focus the initial assessment efforts to establish a preventive maintenance program on the critical assets. These are the assets that, if they failed, would have a significant impact on safety at the airport or the airport's ability to serve users. Each airport will have to determine its own critical assets, but they typically include the primary runway system, major taxiway(s) system, parking apron, terminal building, and access roads.

3.3 Life-Cycle Considerations

Airport infrastructure and the individual components have life expectations that depend on how well they are maintained. A motor on an automated gate will fail if not maintained in a

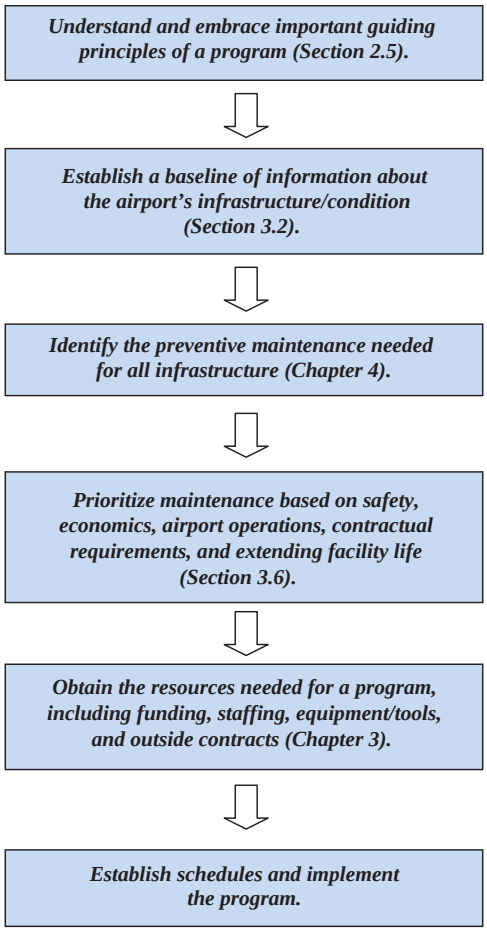

Figure 3.1. Steps to develop or improve a preventive maintenance program.

certain manner. Fan belts that show signs of fraying can easily be predicted to fail in the near future. Pavements with unsealed cracks will fail before similar pavements with sealed cracks. At some point, all facilities will reach the end of their economic lives, even those that are well-maintained. One key to an effective PM program is to know when that life span is expected to be reached and to understand if and when specific PM activities can reasonably extend that life or if major rehabilitation or replacement is the better option. For example, underground electrical cable and transformers for an airfield edge lighting system typically last up to 20 years. If the system is 15 years old or older, and frequent failures of sections of the system are happening, it is likely time to plan for system-wide rehabilitation. Continuous repair of transformers and replacement of burned-out bulbs in an aging system in lieu of system rehabilitation may not be cost-effective. See Section 2.3 of this guidebook for additional discussion about the economic benefits of preventive maintenance.

An annual review of the condition of each element of airport infrastructure is recommended, along with development of plans for timely replacement of deficient systems. These plans should be incorporated into budgets and capital improvement plans.

Life-cycle considerations are important when trying to decide whether to maintain, repair, or replace infrastructure. This is especially the case with vehicles, HVAC systems, roofs, and

pavements. Questions that airports may wish to consider when deciding whether to continue to maintain or replace infrastructure include the following:

- Is the infrastructure or component near or beyond its expected life?
- Do the facility's reliability and consequences of its failure pose an unacceptable risk?
- Will the continued maintenance costs and repair/rehabilitation costs exceed the cost of replacement?
- Does the facility's performance have a track record of being unacceptable, and will corrective maintenance measures lead to acceptable performance?
- Is additional facility capability or capacity needed, and will replacement of the system provide that?

Key elements to be considered in decision making are not always capital costs. Customer service, user requirements, safety, and the consequences of failure all should be considered when deciding whether to continue with preventive maintenance or replace a system or component.

3.4 Budgeting

Airports need to prepare annual budgets that include the PM program. The budget would cover staffing, materials, tools and equipment, spare parts, and any significant local costs for capital projects related to PM (e.g., a new drainage pipe). The annual assessment of the condition of facilities and the periodic PM for infrastructure will provide information to help establish the budget requirements. When entities such as the state or FAA are able to help fund eligible projects, the local share needs to be covered in the budget.

The amount of infrastructure an airport has, the age of facilities, and staffing levels affect the required budget for PM. Airports vary widely in the amount of funding they dedicate to PM. The airport interviews conducted in the development of this report found that these airports dedicated from 6% to 40% of their budget to maintenance. Airports in colder climates and airports that were financially self-sufficient tended to dedicate more funding to PM than did other airports.

During the course of the airport interviews, a commonly heard statement was "We just don't have enough money to perform the maintenance that needs to be done." This statement is a corollary to the phrase "There's never enough time to do it right, but there's always enough time to do it over." Ignoring or delaying PM indefinitely will never save the airport money in the long run. Poorly maintained equipment and infrastructure will fail sooner and more often than properly maintained equipment. Frequently, the cost of the ultimate repairs is several times more than the cost would have been to perform the PM. Budgeting for and performing PM is an area where the airport simply cannot afford to be shortsighted.

There are a number of states with funding programs specifically designated for maintenance at airports. States typically use general revenue and fuel taxes to help finance their programs. Airport officials should contact their state aviation office and become aware of these types of funding sources in their state and take advantage of them to the fullest extent possible. One robust state program funds eligible projects, including the following:

- Pavement maintenance and repairs, including pothole repair, grass removal, crack sealing, and pavement surface treatments such as slurry seals;
- Removal of vegetation that causes pavement deterioration, impeded drainage, and deterioration of facilities and that obstructs the visibility of fenced areas;

- Replacement of pavement markings;
- Obstruction removal on airport property or on property where the sponsor has the rights to top or completely remove the obstruction;
- Repairs of airfield lighting systems, visual aids, automated weather observation systems, ground communication outlets, and pilot briefing systems;
- Emergency repairs of a facility that will prevent its destruction or deterioration if not performed immediately;
- Replacement of bulbs, gaskets, transformers, cables, wind cones, and such used in eligible lighting and visual aid devices;
- Repairs to fueling systems, including repairs to electrical systems, pumping systems and lines, and containment systems, as well as rust removal and painting;
- Repairs to terminal buildings and maintenance equipment storage buildings, as well as associated systems and equipment that are eligible for funding under the state's airport capital improvement program;
- Quarterly or annual inspections of airport lighting systems, visual aids, automated weather observation systems, and emergency generators;
- Obstruction removal and replacement of cones due to normal wear for grass runways; and
- Maintenance equipment such as mowers, tractors, mower attachments, spray attachments for vegetation control, sweeper attachments, snow blades, front-end loaders, trucks, and small utility vehicles.

Much of this list is more extensive than basic PM, but airport management should be aware of and consider the state's ability to help with all maintenance, repair, and rehabilitation. The state's ability to help can directly influence how extensively an airport might perform PM on an aging facility.

3.5 Organizational Structure and Staffing

How should an airport be organized and staffed to perform preventive maintenance? There is no single answer to this question. Many small general aviation airports handle all airport operations and maintenance with one or two people. Sometimes the airport manager does it all. Large and very busy general aviation airports with several hundred based aircraft in major metropolitan areas tend to have larger staffs handling maintenance and operational requirements such as snow removal. Some airports are also able to rely on other resources, such as the city department of public works. However, non-airport department staffs may have other priorities that may affect the level of service provided to the airport.

Whatever staff handle the PM program, they need to be properly trained and competent to perform the job(s). Some airports are able to have specialists that can focus on basic airfield electrical systems, high-voltage systems, vehicle maintenance, building systems such as HVAC and roofs, and turf/drainage. Other airports have the same person do all of this. Regardless, the staff need to be properly trained, have the appropriate work licenses, and fully understand the requirements of working at an airport (i.e., where they can and cannot go on the airfield). Airport management needs to be prepared for the times when key staff retire, depart for other positions, or are simply unable to go to work at critical times to perform PM. Formal checklists, good recordkeeping, and some redundancy in staff capabilities can help in this regard.

Appendix C provides samples of basic job descriptions for employees that perform various levels of airport maintenance.

3.6 Prioritizing Preventive Maintenance

The cost of preventive maintenance and major rehabilitation of systems often exceeds available funding. Airport management and policy makers should use an objective process to help set priorities for maintenance activities and projects. To make cost-effective decisions between full replacement or continued maintenance of facilities such as HVAC systems in buildings, managers can use life-cycle considerations (see Section 3.3). Also, prioritization should reflect considerations such as:

- **Safety.** Daily inspections and maintenance should ensure that the airport infrastructure is safe for pilots and other airport users. This should be a top priority.
- **Operations.** There should be a focus on the most critical assets first. For example, work on a major runway should have a higher priority than work on an infrequently used taxiway or apron.
- **Economics.** Evaluate the cost that may be incurred if PM is delayed. For example, an overflowing ditch may be causing damage to adjacent pavements, so delaying ditch maintenance may result in an increased cost to repair pavement or edge lighting damage.
- **Contractual Obligation.** Leases with airport users typically have requirements that the airport owner will properly maintain facilities owned by the airport. For example, an aircraft owner fully expects to be able to open the hangar door. Also, the state/federal grant obligations requiring that pavement and other facilities must be maintained need to be taken seriously. Future funding for airport projects may be denied if routine PM of existing facilities is ignored, regardless of the reason.
- **Accessibility.** The main access road and the appropriate amount of auto parking need to be properly maintained so that they remain usable and users can access the airport from the landside. Similarly, the main taxiways and aprons that provide access to the terminal area have high priorities for PM.
- **Other.** There are other considerations that airport management might use to help prioritize preventive maintenance. For example, an airport master plan may indicate that the airport has excess aircraft parking apron. Some of this apron may be old surplus apron. The proper decision might be to abandon maintenance actions on the unused apron areas while the airport focuses on other higher priorities.

3.7 Using Contracts and Other Agencies

Airports sometimes are required or have the option to contract with outside entities to perform routine preventive maintenance work that may be beyond the capabilities of the airport staff. Examples of this are HVAC service, herbicide application, equipment/vehicle maintenance, service to motorized gates, formal pavement condition assessments, and high-voltage electrical work. In those cases where the airport is owned by a municipality, the airport sponsor might consider including the airport in any applicable contracts that are being let by the municipality. Examples are areas such as HVAC maintenance and vehicle maintenance. Outside contractors are often used for highly specialized navigational facilities such as automated weather observing systems.

In addition, the resources of other agencies may be available to assist the airport with its PM needs. City public works departments were previously mentioned as a possible resource for assistance. In some cases, the state aviation division may provide resources for airports to use in the performance of their PM. At least one state has purchased crack-sealing equipment that is available to any airport in the state to use. The state provides training on how to use the equipment, and the airport is responsible for purchasing the crack-sealing material. This has resulted in

considerable savings to airports and a significant improvement in the maintenance of pavements at airports throughout the state.

3.8 Tools and Equipment

A good PM program includes provision of the appropriate tools and equipment needed to effectively perform the maintenance. While the specific type of required tools and equipment will vary from airport to airport depending on the complexity and amount of infrastructure and the climate, general requirements include:

- Hand tools,
- Mowers,
- Weed trimmers,
- Snow removal equipment,
- Maintenance vehicles,
- Maintenance equipment storage, and
- Personal safety equipment for maintenance personnel.

In addition to tools and equipment, airports should maintain an inventory of spare parts for replacement of those items that are normally required as a result of actual or anticipated failure. Examples are airfield lightbulbs, isolation transformers for light fixtures, and fan belts.

3.9 Work Orders and Recordkeeping

Once a PM program has been developed, staff and budget are in place, and schedules of activities and priorities are established, the program is implemented. An important part of implementing a PM program is to use an effective work order system to keep track of and schedule activities. This system can also be used for follow-up work that is identified from periodic inspections.

Work order and recordkeeping systems range from a simple paper filing system that contains daily, weekly, monthly, and annual inspection forms to a fully automated system such as a computerized maintenance management system (CMMS). There are various commercial vendors that offer CMMS products for airports. The actual system used at the airport will depend on the complexity of the airport and the availability of resources for maintaining the recordkeeping system. If this system is automated, costs can more easily be tracked, trends monitored, and management can easily monitor progress. Also, automation helps with retention of records and preventing knowledge loss due to change in personnel. Regardless of whether a work order system is automated, there is still significant benefit from being able to track schedules and completion of work through even a manual system. As long as the system provides a means to schedule inspections and PM, records the results of the inspections, and can be used to track maintenance and spot trends, it can be an effective tool in a PM program.

Work orders are forms that are used to identify maintenance work (PM or repair work) that needs to be accomplished, records what action was taken to correct the situation, who performed the work and when, and whether any further action is required. They are frequently used in situations where the person who schedules the work or identified the problem is not the person who will perform the actual maintenance. The person completing the work writes what action was taken on the form and returns it to be filed. Work orders are extremely useful in verifying that PM has been performed and in tracking maintenance actions and spotting maintenance trends. A work order system, of course, also needs a tracking mechanism such as calendar alerts for when the work is due.

Recordkeeping systems should include checklists and inspection forms for the airport and each infrastructure system. These checklists should identify the components for inspection and the PM activities that need to be performed. Upon completion of the inspections or completion of a maintenance action, the checklist or work order should be filed in some manner. This may be as simple as placing it in a three-ring binder or filing it in a folder according to the type of equipment worked on or the month in which the maintenance was performed. Automated maintenance records provide a readily available and searchable history of work activities and help with sharing of knowledge from routine inspections or the compilation of maintenance information for reports.

Regardless of the type of recordkeeping system used, recordkeeping is a valuable tool in a PM program. When used properly it can assist in discovering maintenance trends, formulating future maintenance plans, and justifying the need for maintenance funding.

CHAPTER 4

Preventive Maintenance Procedures

4.1 Introduction

Preventive maintenance is an activity intended to prevent failures or discover them. This implies that facilities must be inspected on a periodic basis in order to determine their conditions and if any maintenance actions are required to preserve their lives or return them to operational conditions. Two main elements of an inspection process are what is to be inspected and when (how often) do the inspections occur. In order to standardize this process and ensure that a facility is being properly inspected, it is suggested that each person conducting the inspection follow the same procedures and conduct the inspections on the same periodic schedule.

Use of individual checklists will help ensure that inspections are done properly and consistently irrespective of who conducts them. These checklists may include routine maintenance that is to be performed in conjunction with the inspection. In most cases, there are different inspections for the same infrastructure or piece of equipment that are done on different schedules. For example, a wind cone may require a daily inspection to ensure that there are no faulty lightbulbs, a monthly inspection of the condition of the wind-sock fabric, and a semi-annual inspection to check the bearings on the frame assembly and apply grease if necessary.

Sections 4.3 and 4.4 provide checklists that may be used for a general inspection of the airport facilities and for inspecting and performing maintenance on specific systems at the airport. Since these checklists are intended to be used for all sizes of general aviation airports, they are written in a generic manner and may include items that are not applicable to a specific airport. The checklists are available on the CD-ROM that accompanies this report. Airport staff are encouraged to modify the checklists as necessary to fit their particular situation based on types of infrastructure and available resources. Although the checklists provide suggested activities and schedules, airport management will need to determine what is needed for its airport based on the complexity and amount of infrastructure and staff abilities.

4.2 Safety Considerations

Safety is the responsibility of each individual at the airport, regardless of their position. Safety must be practiced in every inspection and maintenance activity that is performed. In order for a PM program to be successful, the technicians performing the inspections and maintenance must be properly trained on the equipment on which they will be working. If a particular maintenance action is beyond the capability of the airport's technicians, an outside contractor having the required expertise should be used to perform the maintenance. The airport should consider sending maintenance personnel to specialized training classes that may be available at a larger commercial airport or provided by an outside agency such as the American Association of Airport Executives (AAAE) or the state's aviation department. It should be noted

that AAAE provides both basic and advanced airport safety and operational specialist courses and has a certification program available to airport employees called the Airport Certified Employee (ACE) program. This program provides education in four disciplines: airfield operations, airfield lighting maintenance, security, and communications.

Each individual engaged in performing maintenance at the airport should be provided with, and use, the appropriate safety equipment needed for the task being performed. This may include items such as gloves, safety glasses, brightly colored and reflective safety vests, work boots with steel toes, and hard hats. Specialized equipment or clothing may be required for those activities that are more hazardous or involve the handling or application of chemicals.

Many larger general aviation airports have formal safety training courses that employees must complete before they are permitted to work in the airport environment. At most smaller airports, however, it is left to the airport manager to provide the necessary training to an employee or obtain the training from a larger airport. Airport management should consider training airport staff concurrent with other city/county maintenance crews. It is suggested that, at a minimum, the following areas be included as part of an employee's safety and security training.

General Airport Safety. This includes vehicle movement about the airport and any airport security requirements. Vehicle training should include the following topics:

- Review of the airport diagram and movement and non-movement areas.
- What is a runway incursion and how to prevent one from occurring.
- Airfield markings and signs.
- Airfield lighting and its meaning.
- Any hot spots that may exist at the airport.
- Proper communication procedures with the tower or with aircraft at non-towered airports.
- Proper use of vehicle lights.
- Aircraft traffic patterns and proper lookout procedures.
- Aircraft right-of-way regulations.
- Preferred routes to various areas of the airport.
- Maintaining situational awareness and avoiding distractions (e.g., phone calls and texting).
- Avoidance of working in runway/taxiway safety areas when these pavements are open to aircraft use. These safety areas are to help aircraft that may overshoot/underrun or veer off pavements. FAA airport design standards (Advisory Circular 150/5300-13) provide these dimensions.

The FAA has published a brochure entitled "FAA Guide to Ground Vehicle Operations" that is available on its website. This booklet can be printed and used as a training guide for employees. Having personnel trained in the proper operation of vehicles and radio communication while working on the airfield is extremely important. Maintenance staff must be trained and be comfortable with radio communication.

Airport Security. This training may include the following topics:

- Security systems in use at the airport (fences, gates, cameras, etc.).
- Fence inspections and reporting of needed repairs.
- Gate systems and their proper operation.
- Entry and exit procedures.
- Building/hangar security requirements.
- Reporting of unauthorized or unknown personnel at the airport.
- Airport "watch" programs and the role of maintenance personnel.
- Airport access control and badging, including procedures for issuing and monitoring access control.

Electrical Safety. Electrical safety on airfield lighting systems should be of the highest priority for everyone working on or in the vicinity of airfield equipment. Unlike the typical voltage circuit that most people are familiar with, airfield lighting operates on a series-circuit (also referred to as a constant-current) system that is rated up to 5,000 volts. Only qualified and trained personnel should perform maintenance or troubleshooting procedures on airfield lighting equipment. Safety training for these systems should include:

- Equipment inspection. Prior to working on any electrical equipment, it should be inspected for any signs of damage.
- Lock-out/tag-out procedures. Prior to working on any piece of electrical equipment, the electrical circuit should be shut down in accordance with the applicable lock-out/tag-out procedures. These procedures must be followed without deviation for the protection of maintenance personnel and the equipment.
- Emphasis that an energized circuit should never be opened or broken in any manner.
- Re-lamping of airfield fixtures. Re-lamping of fixtures should only be accomplished when the circuit is de-energized. This is often overlooked but could be extremely hazardous to maintenance personnel if there is a short in the isolation transformer supplying power to the equipment.
- Fire extinguisher availability. A fire extinguisher should be readily available any time work is being performed on electrical equipment.
- First aid. Personnel should be trained on the type of injuries that may be caused by an electrical circuit and the proper first aid to treat those injuries.

Chemical Safety. The most common types of chemicals that maintenance personnel will come in contact with at the airport are various cleaning solutions for equipment maintenance and herbicides that are used to control vegetation growth. Regardless of the type of chemical being used, the airport should maintain a library of safety data sheets for each chemical. These sheets should be available to employees to read and familiarize themselves with the hazards of the chemicals and the appropriate emergency medical treatment in case of exposure to them. Employees should be provided with any specialized protective clothing or equipment that is necessary for the handling of the chemicals.

With regard to herbicides, in almost all cases only trained and licensed employees are authorized to handle and dispense herbicides at an airport. Specialized training and certification are required that will include specific safety procedures for the type of herbicide being applied. In no case should an unlicensed or untrained employee handle or dispense herbicides.

Equipment Safety. Airports use a variety of equipment in maintaining the physical condition of the facilities, including equipment as small as a weed eater and as large as front-end loaders and dump trucks with snowplows or snowblowers attached. In almost all cases, the equipment would have been purchased with an owner's manual of some type that included a section on the proper operation of the equipment and safety procedures to be followed while using it. Maintenance personnel should receive individual and specific training on the use of each piece of equipment they are expected to operate and have access to owner's operation and maintenance manuals that should be used for all equipment systems. Larger pieces of equipment may require formal training or the issuance of a special license by the state in which the airport is located before the employee is authorized to operate it.

4.3 Airport Inspections

It is important that an airport owner or operator have an airport self-inspection program to monitor specific airport conditions in order to identify any unsatisfactory conditions that are in need of corrective action. In addition, the regular monitoring of conditions allows the owner

to evaluate the various infrastructure systems on the airport and schedule PM as it becomes necessary. For example, if the inspector notes cracks forming in a particular pavement section the owner can plan for and schedule when the cracks will be sealed or a seal coat applied to the pavement.

At airports certificated under 14 CFR Part 139, a self-inspection program must be part of the airport owner's airport certification program and is required under Part 139.327. However, all airports, whether certificated under Part 139 or not, should conduct a daily self-inspection to ensure that prompt corrective action is taken to eliminate unsafe conditions at the airport. FAA Advisory Circular 150/5200-18, Airport Safety Self-Inspection, discusses airport self-inspection procedures in detail and identifies items that should be included in a self-inspection program.

The FAA self-inspection Advisory Circular lists four types of self-inspections that may be done at an airport:

- Regularly Scheduled—an inspection that is conducted daily. It is recommended that at least part of the inspection be conducted during hours of darkness to better evaluate the condition of the various lighting systems.
- Continuous Surveillance—an inspection of activities (construction, etc.) or facilities that should be done anytime airport personnel are in the air operations area.
- Periodic Condition—an inspection of facilities that is done on a regular interval but less often than daily. This may be a weekly, monthly, or quarterly inspection. These periodic inspections are general in nature and done when management believes they are needed or opportunities arise. They are not intended to take the place of the more detailed inspections of each facility but rather to supplement them.
- Special Inspection—an inspection conducted following a complaint or an unusual occurrence at the airport, such as an accident, incident, or significant meteorological event.

The use of checklists to conduct these airport inspections is highly desirable for two reasons. First, a checklist helps to ensure standardization and that no items get overlooked during the inspection. Second, the checklist constitutes a written record that the inspection was conducted and of the condition of the facilities at the time the inspection was completed. Airports certificated under Part 139 are required to retain the regularly scheduled inspection checklists for 12 months. It is recommended that all airports maintain a file of their inspection checklists for the previous 12 months. Reviewing the conditions reported on previous inspections can reveal trends and document the rate of deterioration of a piece of infrastructure that may aid in the scheduling of PM.

The checklists for airport inspections in Exhibit 4.1 were developed with input from a number of sources, including the FAA, state aviation agency and industry publications, and airport staff on-the-job experiences and anecdotes obtained through the research team's interviews and site visits. The checklists are intended to serve as a guideline for airports to use in formulating their own checklists more specifically to their airports. As stated in the introduction to this chapter, these checklists are available on the CD-ROM that accompanies this guidebook and are intended to be modified by the airport to meet their requirements. All airports do not have all of the infrastructure represented by these checklists, nor does their infrastructure necessarily have all of the components identified. Airport staff may also wish to provide individual links within the checklists to items such as vehicle manuals and other manufacturer guidance.

Airport maintenance personnel should identify what actions are needed based on the inspections and capture the actions in a log or work order system that provides for trackable required action and completion dates.

Exhibit 4.1. Checklists for airport inspections.

ANYTOWN MUNICIPAL AIRPORT
Airport Daily Self-Inspection Checklist

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Runway 9/27	Cracks/spalling			
	Foreign object debris (FOD)			
	Pavement lips			
	Markings			
	Lights			
	Signs			
	Approach lights			
	REILs			
	VASI/PAPI			
	Rubber deposits			
Runway 18/36	Cracks/spalling			
	FOD			
	Pavement lips			
	Markings			
	Lights			
	Signs			
	Approach lights			
	REILs			
	VASI/PAPI			
	Rubber deposits			
Taxiway A	Cracks/spalling			
	FOD			
	Pavement lips			
	Markings			
	Lights			
	Signs			
Taxiway B	Cracks/spalling			
	FOD			
	Pavement lips			
	Markings			
	Lights			
	Signs			
Taxiway C	Cracks/spalling			
	FOD			
	Pavement lips			
	Markings			
	Lights			
	Signs			
Taxiway D	Cracks/spalling			
	FOD			
	Pavement lips			
	Markings			
	Lights			
	Signs			

(continued on next page)

Exhibit 4.1. (Continued).

Area	Item	√	Remarks	Action Taken or Work Order #
Apron	Cracks/spalling			
	FOD			
	Markings			
	Lighting			
	Tie-downs			
	Aircraft secured			
Safety areas	Obstructions			
	Ruts/erosion			
	Drainage			
	Debris			
Navigation aids (Navaids)	Rotating beacon			
	Segmented circle			
	Wind sock			
	Localizer			
	Glide slope facility			
	Approach lights			
Buildings/hangars	Security			
	Damage			
Security	Fences			
	Gates			
	Signs			
	Cameras			
	Wildlife			
Fuel farm	Security			
	Leaks			
	Vegetation			
	Standing water			
Weather station	AWOS/ASOS			
	Vegetation			
Off-airport	Unexpected cranes or construction in runway approaches or transition areas			
Landside	Buildings			
	Parking lots			
	Access roads			
	Lighting			
	Signs			
	Marking			
	Drainage			
	Debris			
	Landscaping			

Additional comments/remarks:

_____

_____

_____

_____

_____

Exhibit 4.1. (Continued).

ANYTOWN MUNICIPAL AIRPORT
Airport Continuous Surveillance Checklist

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Vehicles inside security fence	Authorized			
	Outside airport operations area (AOA)			
	Parked correctly			
	Speed			
	Following rules			
Personnel inside security fence	Authorized			
	Outside AOA			
	Following rules			
Security	Fences			
	Gates open			
Wildlife	Birds			
	Animals			
	Carcasses			
	Burrows			
Miscellaneous	FOD			
	Obstructions exist?			
	Trash			
Construction activities	Vehicles marked			
	Vehicles on haul routes			
	Personnel in proper areas			
	Personnel safety equipment			
	Barricades			
	FOD			
	Trash			
Safety plan	Is there a safety construction plan and is it being followed?			

Additional comments/remarks:

_____

_____

_____

_____

_____

(continued on next page)

Exhibit 4.1. (Continued).

ANYTOWN MUNICIPAL AIRPORT
Airport Periodic Condition Inspection Checklist

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Runways	Cracks			
	Surface condition			
	Rubber deposits			
	Marking visibility			
	Glass beads in markings			
Taxiways	Cracks			
	Surface condition			
	Marking visibility			
	Glass beads in markings			
Aprons	Cracks			
	Surface condition			
	Marking visibility			
	Glass beads in markings			
Lights and signs	Visibility			
	Damage			
	Frangible fittings			
	Delamination of sign faces			
Navaids	Beacon lenses			
	VASI/PAPI aiming			
Obstructions	Lighting			
	Shrubs/trees			

Additional comments/remarks:

_____

_____

_____

_____

_____

Exhibit 4.1. (Continued).

ANYTOWN MUNICIPAL AIRPORT
Airport Special Inspection Checklist

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Runways	Pavement damage			
	FOD			
	Ponding			
Taxiways	Pavement damage			
	FOD			
	Ponding			
Aprons	Pavement damage			
	FOD			
	Ponding			
Markings	Damage			
	Visible			
Lights and signs	Damage			
	Operable			
	Obstructed			
Snow and ice	Pavement condition			
	Snowbank clearance			
	Braking action			
	Lights and signs not obscured			
	Stormwater drains clear			
Buildings	Damage			
Landside	Damage			
	Debris			

Additional comments/remarks:

_____

_____

_____

_____

_____

4.4 Infrastructure Checklists

This section discusses each individual infrastructure system at the airport and the PM to be performed on the system. For each system, the components that make up the system will be addressed along with issues that should be taken into consideration during construction, particular problem areas that one may encounter, and periodic checklists that may be used to conduct PM on the system. Since each of these systems will vary depending on the airport, the checklists are written in a generic manner and, as with the airport inspection checklists, airport staff are encouraged to modify these checklists to fit individual circumstances or to follow the procedures contained in the manufacturer's maintenance manuals. Although the guidebook checklists used manufacturer guides as one basis for their development, the suggestions herein should not take the place of manufacturer's guidelines such as those included in manuals for HVAC systems, motors, and regulators. Airport staff may also wish to provide individual links within the checklists to items such as vehicle manuals and other manufacturer guidance.

The checklists are available individually on the CD-ROM included with this guidebook. Although these generic checklists used pertinent FAA and industry literature in their development, users may wish to download those checklists that apply to their airport and add links as noted in the preliminary discussion that precedes each system in this guidebook. For example, certain noted FAA Advisory Circulars and the manufacturer or vehicle user manuals often provide recommended maintenance. Users may wish to provide links to these documents within their checklists for easy reference.

For those not familiar with airport infrastructure, the companion primer to this guidebook provides a brief basic description of each system and provides photographs of each.

Important references for all facilities are any manufacturer or vehicle manuals, in addition to the following FAA Advisory Circular:

FAA Advisory Circular 150/5340-26C, Maintenance of Airport Visual Aid Facilities, Issued June 20, 2014.

For airport pavement maintenance, the following are important Advisory Circulars:

FAA Advisory Circular 150/5380-6C, Guidelines and Procedures for Maintenance of Airport Pavements, Issued October 10, 2014.

FAA Advisory Circular 150/5380-7B, Airport Pavement Management Program (PMP), Issued October 10, 2014.

AIRFIELD ELECTRICAL VAULT

(See checklist in Exhibit 4.2)

Components

1. Vault building. Building construction typically consists of precast concrete, cement block, or prefabricated steel. Older vaults may be of wood-frame construction or steel transformer enclosures.
2. Electrical equipment. The airfield electrical vault houses the equipment (constant-current regulators, electrical cutouts, panel boards, lighting contactors, etc.) necessary to power the airfield electrical components. These include runway and taxiway lights, signs, and visual and navigation aids.
3. HVAC systems. The vault may be air conditioned or heated to help stabilize the internal temperature of the vault throughout the year.
4. Constant-current versus voltage systems. The airfield lighting power systems can be powered by either a constant-current system or a voltage system. Most airport runway and taxiway lighting circuits are powered by a constant-current system composed of constant-current regulators (CCRs) that are located in the airfield electrical vault. In some applications at small general aviation airports, the runway and taxiway lighting circuits are powered by a voltage system that is also located in the airfield electrical vault or at a stand-alone exterior electrical equipment rack located near the midpoint of a runway/taxiway and just outside the associated safety areas.

Tips for Construction

1. Careful consideration must be given to the location of the vault on the airfield. Since all of the airfield electrical power will pass through the vault, it is not easily or inexpensively relocated if it is placed where it may interfere with future airport development plans.
2. When sizing the vault, remember to take into consideration any future electrical development plans, such as new runways or taxiways that will require lighting. Most electrical vaults are not designed to be easily expanded; therefore, undersized vaults will need to be replaced in the future. Constructing an oversized vault that will be able to accommodate future expansion of electrical equipment is always less expensive than replacing a vault at a later date.
3. Many airports use space in the vault for the storage of spare electrical components (bulbs, transformers, etc.). Remember to take this into consideration when planning the size of the vault.
4. Some electrical components are sensitive to large temperature fluctuations. Heating or air conditioning an electrical vault is relatively inexpensive and could extend the life of electrical equipment and save on repair costs.
5. Any personal safety equipment that is required for working in the vault should be stored in the vault in order to be readily accessible to maintenance personnel.
6. It is advisable to locate new vaults centrally to the ultimate airside components to help limit excessive cable run lengths.
7. The location of the vault should take into consideration existing and future development as well as underground obstructions.
8. Initial construction and related improvements and expansions should be completed neatly and consistently. Circuits and cables should be labeled and color coded, and all cabling should be run in conduit or cable trays.

Problem Areas

1. While spare electrical components may be stored in the vault, these buildings are not intended as a general storage area, and care must be taken not to allow them to become crowded with non-electrical items.

Figure 4.1. Vault layout with ease of maintenance. Source: Delta Airport Consultants, Inc.

2. The vault may be sited away from other buildings in a relatively remote area of the airport. Therefore, it may be attractive to rodents as a nesting place. Mice and other rodents can do serious damage to electrical wiring and other components and may cause catastrophic failures of airfield electrical systems.
3. Water intrusion into the vault can cause electrical shorts and failure of airfield electrical systems. Ensure that weather stripping around doors is secure and that all conduits leading into or out of the vault are properly sealed.
4. Undersized vaults tend to get crowded with equipment and can be difficult for personnel movement during maintenance work (Figure 4.1).
5. Numerous cables and conduits are often run underground near vaults and need to be avoided during new construction.

Exhibit 4.2. Airfield electrical vault inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Airfield Electrical Vault Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Daily				
Building	Visible damage			
	Vegetation			
	Security			
	Evidence of rodents			
Regulators	Check local/remote control on each step			
Radio control system	Check radio controller operation with aircraft radio			
Monthly				
Building	Weather stripping			
	Evidence of leaks			
	Check fire extinguisher date and pressure			
HVAC system	Proper operation			
	Filter condition			
Regulators	Check high-voltage cable connections at CCRs and S1 cutout			
Timer	Check clock time on control system			
Annually				
Building	Rust/chipped paint			
	Condition of roof			
	Operation of doors			
HVAC system	Perform annual maintenance			
Regulators	Check output current on each step			
	Inspect housing for rust spots			
	Perform short-circuit test			
	Perform open-circuit test			
General electrical system	Inspect lightning arrestor connections			
	Check relays, wiring, and insulation			
	Inspect S1 cutouts			

AIRFIELD LIGHTING

(See checklist in Exhibit 4.3)

Airfield lighting consists of runway lights, taxiway lights (Figure 4.2), threshold lights, and obstruction lights.

Components

1. Glass globe. The glass globe sits atop the light fixture and focuses the beam of light in the proper direction. Depending on its purpose, the globe will be clear, blue, split clear and yellow, or split red and green in color.
2. Head assembly. The head assembly on an incandescent-type fixture holds the light socket for the bulb, and the globe fastens to the top of the head assembly. The head assembly on a light-emitting diode (LED) fixture holds the optical assembly, which includes the LED luminous sources. The LED runway light fixture has two separate directional sources of light output, whereas the LED taxiway light fixture has one omnidirectional source of light output, similar to an incandescent fixture.
3. Lamps. Lamps are of different intensity depending on the location and purpose of the light.
4. Clamp band and O-ring seal. The clamp band fastens the globe to the head assembly of an incandescent fixture, and the O-ring is located between the globe and head assembly to prevent water intrusion.
5. Optical assembly cover clip and O-ring seal. LED-type fixtures use different snap-in-place clips, based on the manufacturer, to fasten the optical assemblies to the head assembly. In most types of LED fixtures, an O-ring is located between the optical assembly and the head assembly to prevent water intrusion. Optical assembly sealing will vary from one manufacturer to another.
6. Riser. The riser attaches the head assembly to the frangible coupling. Risers come in different lengths depending on the location of the light and the climatic conditions.
7. Frangible coupling. The frangible coupling connects the riser to the base of the light fixture. This coupling is designed to break away in cases where the light is struck by equipment or aircraft.
8. In-pavement light housing. An in-pavement light housing is a metal cap containing lights and is mounted on a base assembly installed in the pavement so that the light minimally protrudes above the level of the pavement and can be run over by aircraft and airport equipment.

Figure 4.2. Taxiway edge light. Source: Delta Airport Consultants, Inc.

9. Isolation transformer. The isolation transformer provides electric current to the light from an underground high-voltage/constant-current electric circuit. The transformer may be housed in a metal can buried in the ground under the light or may simply be installed in the ground itself. There are different transformer sizes and related uses (e.g., runway vs. taxiway vs. signs). Verify use of correct size before installation. Use of the wrong size will either cause the fixture to perform incorrectly or cause use of excessive energy.

Tips for Construction

1. Airfield lighting cables may be run through conduits into light cans that the light is mounted to or may be directly buried in the ground. If the circuit is buried directly in the ground, the light fixtures are mounted on stakes that are driven into the ground. While the direct-buried system is less expensive to install, the can and conduit system is easier to maintain and troubleshoot and generally has a longer life span due to the protection provided to the cable and transformers by the conduit and cans.
2. Consider built-in ability to drain light cans to prevent standing water and ice build-up inside the cans. Cans can be drained directly out of the bottom at sandy sites or tied to a nearby under drain system in poorly draining soils.
3. If a direct-buried system is used, consideration should be given to installing mats around each of the light fixtures to prevent the growth of vegetation adjacent to the light.
4. Placing a number tag on each of the light fixtures will aid in identifying burned-out lights to maintenance personnel and makes it easier to track problem lights.

Problem Areas

1. Constant-current circuits can be extremely hazardous to work on by anyone who is not properly trained and familiar with the characteristics of this type of circuit. Work, including the replacement of burned-out bulbs, should never be performed with the circuit turned on.
2. Improperly sealed light cans may allow water to intrude into the can and may cause shortage-/leakage-to-ground problems with the lighting circuit.
3. Burrowing animals seem to be fond of chewing on direct-buried cables.
4. Mowers often damage lights.
5. Airfield circuits should have a Megger test performed every year to determine the continuity of the circuit. Constant-current circuits are well known for wasting power through small amounts of current insulation leakage to ground in the circuit. Megger testing will help isolate problem areas such as defective cable runs or individual poorly functioning transformers.
6. All cable connections should be sealed with an L-823 cable connector kit and a heat shrink kit over both ends of the connector kit. Simply wrapping the connection in electrical tape or rubber tape will not stop water intrusion. Most problems with leakage to ground in a circuit can be found at the fixture's primary connections to the isolation transformer.
7. Frangible couplings frequently break. Make sure to have extras in stock.

Exhibit 4.3. Airfield lighting inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Airfield Lighting Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Daily			
Check for proper illumination of fixtures			
Concrete base or fixture stake not more than 3-in. above grade			
Verify radio controls work			
Weekly			
Check for vegetation around lights			
Check for dirty globes			
Check for obstructions in channels of in-pavement lights			
Monthly			
Check for misaligned fixtures			
Check for moisture in globes or on lenses			
Check for dirt in fixture drain holes			
Check for dirt in frangible coupling weep holes (stake-mounted fixtures only)			
Semi-Annually			
Check for improper ground elevation			
Check for corrosion or chipped paint			
Check for water in cans			
Annually			
Check for cracks, corrosion, and shorts (Megger all circuits)			
Check for loose wire connections			
Following Snow Removal			
Check in-pavement lights for damage			

Additional comments/remarks:

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AIRFIELD MARKINGS

(See checklist in Exhibit 4.4)

Components

1. Coatings. Coatings or binders approved by the FAA for use on airfield surfaces include waterborne paint, solvent paint, epoxy, methyl methacrylate, and preformed thermoplastic. However, durable coatings like epoxy, methyl methacrylate, and preformed thermoplastic should be limited to taxiway, apron, and roadway markings.

   Waterborne paint is used at the majority of airports in the United States when pavement markings are installed on runways, taxiways, and aprons (Figure 4.3). Waterborne paint was developed to comply with environmental concerns and was in common use by the mid-1980s. There are three types of waterborne paint approved by the FAA, and each provides different benefits:

   - TT-P-1952E, Type I paint dries within 15 to 30 minutes, depending on humidity and other weather conditions. Type I is specified when dry time is not a concern. In other words, it can be used during daylight when weather conditions are conducive to paint drying.
   - TT-P-1952E, Type II paint dries within 5 to 10 minutes, depending on humidity and other weather conditions. Type II should be specified when more humid conditions may occur, but observance of dew point relative to surface temperature must still be monitored, especially during nighttime operations.
   - TT-P-1952E, Type III paint dries within 5 to 30 minutes, depending on the thickness of the application, as well as the humidity and other weather conditions. Type III paint can be applied at a thicker rate (e.g., 60 ft^2 per gallon or 30 mils) than either Type I or Type II because of a cross-linking resin contained in the material. However, it can also be applied at the traditional rate of 115 ft^2 per gallon or 15 mils.

   Solvent paint – AA-2886B is a low-viscosity solvent paint and may be used on airfield pavements. Solvent paints have a wider temperature range for application that allows them to be applied under colder conditions.

   Methyl methacrylate and epoxy are two-component products that are 100% solids, resulting in no shrinkage of the material once cured.

   Preformed thermoplastic has been in use for several years at larger commercial airports for taxiway holding position markings, surface-painted signs, and other detail markings that benefit from the use of the durable material. However, some general aviation airports have elected to use these markings to reduce maintenance frequency.

Figure 4.3. Airfield marking (good visibility).
Source: Delta Airport Consultants, Inc.

2. Glass beads. Glass beads are used in pavement markings to provide visibility of the marking during darkness, but they also provide durability to the waterborne coatings. The durability of the markings depends on the quality of materials and application practices.

   Glass beads approved by the FAA are TT-B-1325D, Type I, III, and IV. Type I and Type IV are low-index glass beads and often require reapplication more frequently than does Type III. Type III is a high-index glass bead and is brighter. Each type has expected performance characteristics (levels of retro-reflectivity) when applied well. FAA Advisory Circular 150/5370-10, P-620 has established target retro-reflectivity values at installation to improve visibility based on the color of the coating and the type of bead used.

Tips for Construction

1. Cleaning existing markings prior to the application of new coatings will prolong the life of the markings and, in some cases, may preclude the need for new material. Surface preparation (cleaning) of the area to be painted before installing new markings should always be specified to remove anything that would inhibit the bond of the new marking to the old coating(s).
2. Only specify a degree of paint removal to accomplish the needs of the airport, and consider that more than one method may be necessary to reduce damage to the underlying pavement.
3. Equipment should be used that is appropriate to the size of the project.
4. All equipment should be properly calibrated to ensure correct coverage rates and uniform material distribution.
5. Glass beads should be dispensed automatically with the coatings.
6. Select the proper materials tailored to the airport environment and operations. Some traffic paints may be better suited to one airport, type of environment, or specific problem that may not challenge another airport.
7. Concise specifications should specify materials tailored to the airport's pavement, environment, and operations and should include performance criteria for applicators.
8. Ensure proper surface preparation of new concrete to remove curing compounds.
9. Layout of new marking patterns should be verified by an inspector prior to application of the coatings. Guide marks should be installed for the applicator to ensure proper alignment and placement.
10. Calibration of marking equipment should be conducted to ensure proper coverage rates for specified materials with uniform distribution.
11. When marking new asphalt, initial markings should be painted at half the normal paint thickness and without glass beads. A second coat of paint, with glass beads, should be applied 30 days later after the asphalt has had time to cure. This will prevent the oil in the asphalt from bleeding through the final coat of paint and causing it to darken.
12. Outline markings in black when placed on light-colored pavement. This may apply to concrete and faded asphalt.

Problem Areas

1. Marking installation is often done without regard to best practices, resulting in reduced life of the markings. The Innovative Pavement Research Foundation's *Airfield Marking Handbook* outlines best practices for the installation of airfield markings.
2. Marking maintenance requirements are subjective. As a result, it is challenging to identify when markings become ineffective for safe navigation.
3. Under certain climatic conditions, mold or algae will form on markings and reduce their reflectivity. In these circumstances, periodic cleaning of markings to remove or preclude the formation of mold is recommended.

4. Existing markings are bonded to the micro-texture of the pavement; when they are removed, some of the pavement will be removed with the marking, causing scarring. Carefully select the type of paint removal method that will be used to reduce the damage to the pavement.
5. Snow removal equipment can severely damage airfield markings if not properly operated. The use of wheels on snowplow blades to hold the edge of the plow slightly above the pavement will significantly prolong the life of the markings.
6. The FAA standard for pavement markings (AC 150/5340-1, Standards for Airport Markings) has changed more than once in recent years. Before simply repainting existing markings that have faded, it is important that the airport verify that the existing markings meet the current FAA standards.
7. If the paint color is truly faded after years of exposure to the sun, water blasting can remove oxidized portions from the top of a marking without removing the glass beads. However, rejuvenating faded markings requires that the markings were originally applied well. If so, they can be cleaned multiple times, yielding big savings.

Exhibit 4.4. Airfield markings monthly inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Airport Markings Monthly Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Runway 9/27	Runway designation			
	Thresholds			
	Centerline			
	Touchdown zone			
	Aiming point			
	Side stripes			
	Chevrons			
Runway 18/36	Runway designation			
	Thresholds			
	Centerline			
	Touchdown zone			
	Aiming point			
	Side stripes			
	Chevrons			
Taxiway A	Runway lead-in lines			
	Centerline			
	Edge markings			
	Runway holding position lines			
	ILS holding position lines			
	Surface-painted signs			

(continued on next page)

Exhibit 4.4. (Continued).

Area	Item	√	Remarks	Action Taken or Work Order #
Taxiway B	Runway lead-in lines			
	Centerline			
	Edge markings			
	Runway holding position lines			
	ILS holding position lines			
	Surface-painted signs			
Taxiway C	Runway lead-in lines			
	Centerline			
	Edge markings			
	Runway holding position lines			
	ILS holding position lines			
	Surface-painted signs			
Taxiway D	Runway lead-in lines			
	Centerline			
	Edge markings			
	Runway holding position lines			
	ILS holding position lines			
	Surface-painted signs			
Apron	Taxi-lane centerline			
	Taxi-lane edge line			
	Non-movement area boundary lines			
	Surface-painted signs			
	Tie-down markings			

Additional comments/remarks:

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AIRFIELD PAVEMENTS

(See checklist in Exhibit 4.5)

The concept of preventive maintenance for GA pavements is very simple: if you have pavements in good condition, it is much more cost-effective to maintain them in good condition than to allow them to deteriorate and then try to rehabilitate or even replace them.

The first step is to verify that a pavement is a good candidate for preventive maintenance. This means completing a pavement evaluation to assess current conditions, as well as reviewing other background information about the pavement. The next step is to identify appropriate treatments that can be applied to the pavement. The final step is regular monitoring to determine how treatments are performing. Over time this information is used to improve both project selection and preventive maintenance treatment selection. See Appendix D for more detailed information about specific pavement maintenance treatments.

Components

1. An important element of a pavement is the pavement type. In most cases, the pavement type is determined by the type of material used as the pavement surface. The most common pavement materials are hot-mix asphalt (HMA) and Portland cement concrete (PCC). These are occasionally referred to as flexible pavements and rigid pavements, respectively. Some pavement surfaces consist of surface treatments.
2. Surface treatments include slurry seals, microsurfacing, chip seals, cape seals, and similar applications that have in common the application of an asphalt emulsion and a graded aggregate. When a surface treatment is placed over an aggregate base or a previously placed HMA surface, the pavement is still referred to as a flexible pavement; when placed over a PCC pavement, it is still a rigid pavement.
3. Pavements are composed of multiple layers of improved materials constructed on top of the in-place soil or subgrade material. All paved surfaces include a wearing course or surface, and some may include one or more underlying courses, identified as base and subbase courses. A typical pavement cross-section is shown in Figure 4.4. (Note: the term "bound" refers to a material that is stabilized, such as through the addition of a cement or asphalt binder.)
4. In some instances, the base and subbase layers are optional; the traffic, environment, and support conditions all are considered in determining which layers will be used in a project.
5. Almost every pavement will include joints, which are discontinuities within the pavement that exist because of the use of different materials, the separation of pavements moving in different ways, or because adjacent pavements were constructed at different placement times. Most concrete pavements also have contraction joints to facilitate the expansion and contraction of individual slabs.
6. Grooves cut in the pavement surface may also be a feature of some runways and high-speed taxiways. Grooves are cut into the pavement surface to improve the contact between aircraft tires and the pavement surface when water is present. This, in turn, will shorten the required stopping distance of a landing aircraft.

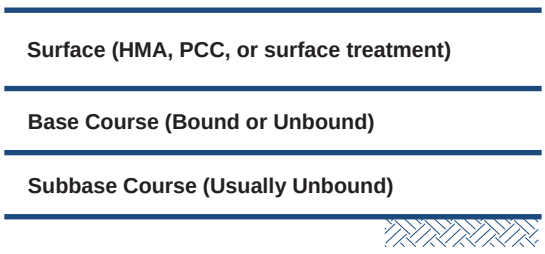

Figure 4.4. Typical pavement cross-section.

Tips for Construction

1. If the pavement is not properly constructed, it is more likely **not** to be a good candidate for preventive maintenance. There is extensive guidance available from both the FAA and industry on how to design and construct pavements. If applicable, state department of transportation specifications also address pavement construction.
2. The following are some general considerations for the proper construction of different pavement types:

   HMA Pavements
   - Material placement temperature
   - Tack coat and bond between HMA layers
   - Longitudinal construction joint
   - Segregation
   - Proper compaction

   PCC Pavements
   - Consolidation
   - Finishing without overworking or adding water
   - Timing of joint sawing
   - Proper joint sealing
   - Appropriate reinforcement

   Surface Treatments
   - Application rates
   - Temperature at placement
   - Controlling traffic until cure
   - Surface preparation
   - Friction treatment
3. Several components of the pavement contribute to drainage. Proper drainage is one key to longevity. The most important considerations are the pavement slope and the edge of the pavement. Most pavements are crowned, in which the pavement centerline is the high point of the pavement surface, and the pavement slopes in either direction to the outer edge. Ensure that there is no turf build-up at the pavement edge that would prevent proper drainage.
4. A paved shoulder is also an important component of many pavement structures. Paved shoulders can help to protect the outer edges of the pavement, protect unpaved areas from erosion and jet blast, provide a safe haven under certain operational emergencies, and contribute to the drainability of the pavement.

Problem Areas

1. There are two primary challenges associated with airfield pavement preventive maintenance: properly characterizing a pavement's overall condition to confirm that it is a good candidate, and selecting a treatment that addresses current conditions or anticipates future conditions in a cost-effective manner.
2. Most evaluations of a pavement's condition rely on monitoring the development and spread of distresses on the pavement's surface. Distresses can be quantified by type and severity, and can be further analyzed by categorizing them by their cause, such as load, environment, materials, and construction. A formal approach for evaluating pavements is described in ASTM D5340, Standard Test Method for Airport Pavement Condition Index Surveys. A less formal approach is found in the appendices to FAA Advisory Circular 150/5320-17A, Airfield Pavement Surface Evaluation and Rating Manuals: PASER Manual—Asphalt Airfield Pavements (Appendix A) and PASER Manual—Concrete Airfield Pavements (Appendix B).
3. From the perspective of pavement preventive maintenance, the objective of the evaluation is to confirm that conditions exist that may be improved (or slowed or prevented) by preventive

maintenance. Many distresses caused by environmental factors are in this category because they are often limited to the surface of the pavement.
4. Distresses caused by defects in materials or construction problems may be suitable for treatment by preventive maintenance. These should, of course, be identified and addressed during construction.
5. Distresses with underlying structural causes (that is, distresses caused by heavy loads or insufficient pavement structure) are rarely treated effectively with preventive maintenance. In some cases, confirming the presence of structural deficiencies will require supplementing a visual condition survey with coring and testing, deflection testing, or the application of other nondestructive evaluation techniques.
6. Treatment selection can be a fairly local activity, in that it will depend on the following:
   - Availability of specialty contractors.
   - Access to good quality materials.
   - Understanding of typical pavement performance as a result of local traffic and environmental factors.
7. Joints are inherently weak spots in the pavement and also provide an opportunity for moisture to enter into the pavement structure.
8. Turf growth at edge of pavements can restrict drainage if not properly maintained.

Periodic Evaluation

Periodic evaluation is frequently done by state aviation departments on a 1- to 3-year cycle.

Regular evaluations of pavement conditions are an essential component of safety management and are required for Part 139 airports. The identification of pavements that are candidates for preventive maintenance is more properly done through routine surveys performed as part of the process of pavement management. Whether formally required or not, the practice of pavement management will help the airport keep track of the pavement infrastructure, monitor pavement conditions, project when preventive maintenance is appropriate, and evaluate the impact of preventive maintenance practices.

The following are common components of a pavement management program:

- Inventory information regarding pavement structures in the airport network
  - Construction date for each pavement layer
  - Material type
- Performance data collected every 1 to 3 years
  - Visual survey, such as ASTM D5340
  - Optional structural evaluation
  - Cores and borings
  - Other evaluations
- Maintenance and rehabilitation treatment matrices
  - Feasible treatments
  - Trigger conditions
- Performance prediction models
- Treatment cost information and ability to develop short-term maintenance and repair budgets and medium- and long-term capital improvement program budgets

More extensive guidance on pavement management is found in FAA AC 150/5380-6, Guidelines and Procedures for Maintenance of Airport Pavements, and FAA AC 150/5380-7, Airport Pavement Management Program.

At the time of publication of this guidebook, a broader ACRP guidebook (from ACRP Project 09-11) about pavement maintenance was in development. Airport officials may also wish to review that document for information about pavement treatments and preventive maintenance when it is published.

Exhibit 4.5. Airfield pavement inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Airfield Pavement Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Monthly			
Inspect pavement for cracks or other signs of distresses			
Categorize distresses by type and severity			
Annually			
Conduct formal pavement evaluation (1)			
Seal cracks as required			
Seal coat pavement if required			
Check turf growth at edge; ensure pavement drains properly			
Spring inspection to check for accelerated cracks/settlement due to freeze/thaw			
Update pavement management and capital improvement plans as warranted by pavement condition			

(1) May be done by state aviation department on a cycle other than annual.

Additional comments/remarks:

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AIRFIELD SIGNS

(See checklist in Exhibit 4.6)

Components

1. Sign framework. The framework houses the electrical components of the sign and provides support for the sign panels.
2. Electrical components. The electrical components of a sign include the internal wiring, power transformers/rectifiers, lamp holders, lamps, and grounding. Electrical components will vary from one manufacturer to another.
3. Lamp. Lamps are of different sizes and intensity depending on the manufacturer of the sign.
4. Riser. The riser attaches the framework of the sign to the frangible coupling.
5. Frangible coupling. The frangible coupling connects the riser to the sign's concrete base. This coupling is designed to break away if the sign is struck by equipment or aircraft.
6. Isolation transformer. The isolation transformer provides a secondary electric current to the sign from an underground high-voltage/constant-current electric circuit. The transformer may be housed in a metal can installed in the ground adjacent to the concrete pad or in the pad itself.

Tips for Construction

1. Airfield sign cables may be run through conduits into cans or may be directly buried in the ground. While the direct-buried system is less expensive to install, the can and conduit system is easier to maintain and troubleshoot and generally has a longer life span due to the protection provided to the cable and transformers by the conduit and cans.
2. Signs are normally mounted on concrete pads (see Figure 4.5). Construct the concrete pad large enough that mowing equipment does not need to be driven unnecessarily close to the sign.
3. Place a number tag on each sign fixture for easy reference.
4. Order signs with an optional power on-off switch installed on the outside of the sign for lamp maintenance purposes only.

Problem Areas

1. Vegetation growing around signs can obscure the pilot's vision of the sign.
2. Ensure that all framework covers are properly secured so they do not become dislodged during storms or in high winds.

Figure 4.5. Well-maintained airfield sign.
Source: Delta Airport Consultants, Inc.

3. Intense sunlight and high temperatures can cause sign panels to deteriorate or become yellowed.
4. In extremely cold climates, airfield signs that are not properly sealed may allow moisture and cold air drafts to enter the sign and cause lamps to fail prematurely.
5. Sign panels are specific to the sign manufacturer and not interchangeable. Replacement panels need to be specifically ordered for each type of sign according to the sign manufacturer style.
6. Problems may be discovered and isolated during periodic Meggering of the airfield electrical/lighting systems.

Exhibit 4.6. Airfield sign inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Airfield Sign Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Daily			
Check for proper illumination of all fixtures			
Check for protrusions of a concrete base/foundation greater than 3 in. above grade			
Weekly			
Check for vegetation around signs			
Check for dirty panels			
Check for damage to framework			
Monthly			
Check for loose fasteners			
Check wire connections			
Semi-Annually			
Check for cracked or deteriorated wire			
Check for corrosion or chipped paint			
Annually			
Check for deteriorated gaskets			
Check light intensity for each step			
Check sign panels for deterioration or yellowing			
Megger home run cables			

Additional comments/remarks:

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AIRFIELD VISUAL AND NAVIGATION AIDS

(See checklists in Exhibit 4.7 through 4.12)

Components

1. Rotating beacon. A rotating light normally mounted on a tall pole or tower that is used to assist pilots in locating the airport at night. In some cases the beacon may be mounted on the top of a building.
2. Runway-end identifier light (REIL). Strobe lights located on each side of the approach end of a runway that serve to aid pilots in locating the end of the runway during periods of darkness or reduced visibility.
3. Precision approach path indicator (PAPI). Calibrated light system located near the touchdown point of the runway that gives visual glide slope information to pilots approaching the runway.
4. Visual approach slope indicator (VASI). A calibrated light system serving the same purpose as a PAPI. Many VASI systems have been replaced by the newer PAPI system (see Figure 4.6).
5. Pulse light approach slope indicator (PLASI). Another calibrated light system that serves a similar purpose as the PAPI and VASI. PLASI systems are ideal for heliport operations due to the minimal siting requirements.
6. Approach lighting systems. One of a variety of lighting systems composed of a configuration of lights leading to the approach end of a runway that are used to aid pilots in sighting and lining up with the runway at night and during conditions of reduced visibility.
7. Wind indicator. A wind sock (see Figure 4.7) is a visual indicator that displays the direction and approximate velocity of the wind at the airport. The airport may have more than one wind sock to aid pilots in determining which runway to use for takeoffs and landings.
8. Lamps (bulbs). Each of the previous systems uses various sizes and intensities of lightbulbs in carrying out their purpose.

Tips for Construction

1. Rotating beacons mounted on folding poles are generally easier to maintain than those that require the maintenance technician to climb the pole or tower.
2. REILs, PAPIs, VASIs, and PLASIs are normally mounted on concrete pads. Construct the concrete pad on which the unit is mounted large enough that mowing equipment does not

Figure 4.6. PAPI unit. Source: Delta Airport Consultants, Inc.

Figure 4.7. Wind sock. Source: Delta Airport Consultants, Inc.

need to be driven unnecessarily close to the unit. Some airports mount the PAPI and VASI units on one large pad rather than on separate smaller pads to make mowing easier.

3. LED REIL, PAPI, and PLASI systems are available that require smaller power cables and/or constant-current regulators to operate and are less expensive to maintain.
4. For shock hazard protection, provide a separate earth-electrode system (EES) ground around each light unit consisting of a (minimum) #2 American wire gage (AWG) bare copper wire ring, 24-in. (minimum) depth, attached to a ¾-in. and 10-ft copper-clad ground rod at each corner. Ground the fixture housing to the EES with a #2 AWG bare copper wire.
5. Install service disconnects at the equipment location for future maintenance since system components are often located a long distance from the power source.

Problem Areas

1. Vegetation growing around light units can obscure the pilot's vision of the unit.
2. Care must be taken when opening and closing the housing of a light unit. Be alert when opening the housing. It is not uncommon for wasps and other insects to nest inside these units.
3. When opening and closing the housing of a PAPI, VASI, or PLASI unit, take care that the unit's vertical angle is not disturbed. For this reason, some units have the aiming device brackets on the outside.
4. Ensure that all housing covers are properly secured so that they do not become dislodged during storms or in high winds.
5. Use only qualified personnel to align VASI/PAPI units in accordance with FAA standards. It is a big liability for untrained maintenance personnel to assume this responsibility.

Exhibit 4.7. Airfield rotating beacon inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Rotating Beacon Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Daily			
Check for proper illumination of all fixtures			
Weekly			
Check for vegetation around base of pole or tower			
Monthly			
Check for proper RPM (count number of flashes per minute)			
Check and clean lenses			
Check that lights are aimed at proper angle			
Semi-Annually			
Check for proper input voltage/rated amperage			
Check operation of photoelectric control			
Check for corrosion or chipped paint on pole or tower			
Lubricate bearings and gears			
Check condition of lightning rod			
Annually			
Check for loose or broken wiring			
Check condition of gaskets			
Check that beacon is mounted level			
Check fall protection equipment			

Additional comments/remarks:

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Exhibit 4.8. Airfield REIL inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
REIL Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Daily			
Check for proper illumination of fixtures and that they flash together			
Check for protrusions of a concrete base/foundation greater than 3 in. above grade			
Weekly			
Check for vegetation around unit			
Monthly			
Check and clean lenses			
Check that unit is aligned properly			
Semi-Annually			
Check for corrosion or chipped paint on unit			
Check for presence of moisture in unit			
Annually			
Check for loose or broken wiring			
Check condition of gaskets			

Additional comments/remarks:

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Exhibit 4.9. Airfield PAPI and VASI inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
PAPI Inspection
VASI Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Daily			
Check for proper illumination of fixtures			
Check for protrusions of a concrete base/foundation greater than 3 in. above grade			
Weekly			
Check for vegetation around base of unit			
Check and clean outer surface of protective glass			
Monthly			
Check elevation angle of units			
Check and clean color filters and lenses			
Clean interior of unit			
Ensure mount is rigid			
Semi-Annually			
Check for proper input voltage/rated amperage			
Check operation of photoelectric control			
Check for corrosion or chipped paint on unit			
Check for loose or broken wiring			
Check condition of gaskets			

Additional comments/remarks:

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Exhibit 4.10. Airfield PLASI inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
PLASI Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Daily			
Check for proper illumination of fixtures			
Check for protrusions of a concrete base greater than 3 in. above grade			
Weekly			
Check for vegetation around base of unit			
Check and clean outer surface of protective glass			
Monthly			
Check elevation angle			
Check and clean color filters and lenses			
Clean interior of unit			
Ensure mount is rigid			
Semi-Annually			
Check for proper input voltage/rated amperage			
Check and clean air filter			
Check operation of fans			
Lubricate shutter chains and sprocket teeth			
Check chain tension			
Check operation of photoelectric control			
Check for corrosion or chipped paint on unit			
Check for loose or broken wiring			

Additional comments/remarks:

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Exhibit 4.11. Airfield approach lighting systems inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Approach Lighting Systems Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Daily			
Check for proper illumination of fixtures and proper sequence of flashing lights			
Check for protrusions of concrete base/foundations greater than 3 in. above grade			
Weekly			
Check for vegetation around base of fixtures and towers			
Monthly			
Check elevation and aiming of lights			
Check and clean lenses			
Semi-Annually			
Check for proper input voltage			
Check for corrosion or chipped paint on tower			
Check for loose or broken wiring			
Check condition of gaskets			

Additional comments/remarks:

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Exhibit 4.12. Airfield wind indicator inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Wind Indicator Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Daily			
Check for proper illumination of all lamps, including the obstruction light			
Check for protrusions of a concrete base/foundation greater than 3 in. above grade			
Weekly			
Check for vegetation around base of unit			
Check that wind sock is securely fastened to cage			
Monthly			
Ensure pole is straight and undamaged			
Check condition of wind-sock cage			
Semi-Annually			
Lubricate bearings			
Check for corrosion or chipped paint on pole			
Check for loose or broken wiring			
Check security of light fixtures			

Additional comments/remarks:

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AIRPORT-OWNED UTILITIES

(See checklists in Exhibit 4.13 through 4.15)

Components

1. Wells. In many areas, municipal water systems do not extend to the airport property. In these cases, airports are required to install wells to supply water to the airport. In some cases, the airport serves as a utility supplier in that it sells water from a common well system to the tenants at the airport.
2. Septic tanks. In those instances where there are no sanitary sewer lines running to the airport, septic tanks and drain fields are required. In most cases there is a separate septic tank for each building equipped with a water line. Depending on the lease arrangements, the airport may be responsible for the maintenance of the septic systems.
3. Electric systems. While in almost all cases electricity to the airport is supplied by a public utility, the airport may have solar panel installations that supply power to one or more buildings. The airport may also contain a solar farm and sell the power generated to the local electric utility.
4. Fiber-optic systems. Fiber-optic installations are becoming more prevalent at airports as airport tenants have a demand for faster Internet connections or data lines. In some cases, the airport may own the fiber-optic system on the airport property and charge the tenants to connect to and use the system. When properly constructed, a fiber-optic system does **not** require any preventive maintenance other than visually inspecting outdoor installations for mechanical or environmental damage. No maintenance should be attempted as long as the system is communicating properly.

Tips for Construction

1. Use a certified and licensed well driller and pump installer when constructing a well.
2. Position the well away from buildings, waste systems, or chemical storage facilities.
3. Keep the top of the well at least 1 ft above ground level, and slope the ground away from the top of the well.
4. Consider installing an effluent filter on the outlet sanitary tee of the septic tank. This will prevent solids from leaving the tank and clogging the drain field.
5. The area over a septic tank drain field should be left undisturbed, with only a mowed grass cover. Do not plant trees or shrubs near the drain field as their roots may clog or damage the drain pipes.
6. To simplify tank access for inspection and maintenance, install a watertight concrete riser over the septic tank.
7. The reflectivity of solar panels must be checked to determine that they will not create a light hazard to pilots in the traffic pattern around the airport.
8. Bury fiber-optic cable deep enough to prevent inadvertent dig-ups.
9. Install protective caps on every connector, mating adapter, and equipment port of fiber-optic cables.
10. Ensure that all fiber-optic patch panels and equipment racks have lockable doors.
11. Fiber-optic cables must be installed so that they are stress-free, and installers must adhere to the bend radius guidelines for the cable.

Problem Areas

1. Do not try to repair a malfunctioning well unless your maintenance personnel are certified to do the work. Hire a certified contractor instead—it will probably save money in the long run.
2. Be careful mowing around the well pipe. A damaged casing could introduce pollutants into the well.

3. Septic systems are not sanitary sewer systems. Chemicals and nondegradable items can clog or damage the septic system. Oil and grease will also clog the drain field.
4. Do not allow surface water to drain toward the septic tank or drain field.
5. Do not allow automobiles or heavy equipment to drive over a septic tank drain field.
6. Do not use caustic drain openers to clean the drains of a septic system. The use of boiling water as a drain cleaner is recommended.
7. Dirty solar panels will significantly reduce the amount of power produced.
8. When cleaning solar panels, do not spray cold water onto a hot panel. Clean panels in the early morning or in the evening.
9. Dirt is the enemy of fiber-optic cables. Only allow authorized personnel to access the cabling system.

Exhibit 4.13. Well inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Well Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Monthly			
Check condition of well cover and cap			
Remove vegetation from around well cover			
Semi-Annually			
Check piping for leaks			
Annually			
Perform a flow test			
Test water for bacteria and nitrates			
Check pump motor performance			

Additional comments/remarks:

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Exhibit 4.14. Septic tank inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Septic Tank Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Monthly			
Ensure drain field is clear of shrubs or small trees			
Inspect drain field for signs of excess water			
Inspect riser for damage			
Semi-Annually			
Clean septic tank filter			
Annually			
Determine if tank needs to be pumped out			

Additional comments/remarks:

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Exhibit 4.15. Solar panel inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Solar Panel Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Monthly			
Inspect panels for cracks, chips, delamination, or water intrusion			
Check condition of batteries			
Quarterly			
Clean panels with water or mild detergent			
Semi-Annually			
Inspect mounting frame for damage, loose bolts, and corrosion			
Inspect wiring for cracks or deterioration			
Inspect panel boxes for rodents, insects, corrosion, and signs of burning			

Additional comments/remarks:

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DEICING FACILITIES

(See checklist in Exhibit 4.16)

Components

1. Aircraft deicing pad. A designated site at the airport where aircraft receive deicing treatment. The pad consists of an inner area for the parking of the aircraft and an outer area for maneuvering mobile deicing vehicles.
2. Environmental runoff mitigation measures. These may consist of some type of drainage system in or around the deicing pad that leads to a storage tank, a sanitary sewer system, or an on-airport treatment facility.
3. Deicing storage building. A building that houses the mobile deicing vehicles, deicing chemicals, and, possibly, crew shelter and toilet facilities.
4. Mobile deicing vehicles. Specially equipped vehicles used to apply deicing fluid or anti-icing fluid to aircraft.
5. Vacuum truck. Used for deicing fluid collection units.

Tips for Construction

1. Environmental requirements for deicing runoff discharges vary from state to state. Many general aviation airports do not meet the environmental thresholds requiring them to collect and dispose of deicing fluid. It is not the intent of this guidebook to discuss these thresholds. Each airport will need to consult with its state environmental department to determine what procedures it must follow to meet environmental regulations for the handling of deicing and anti-icing fluids. *ACRP Report 14*: *Deicing Planning Guidelines and Practices for Stormwater Management Systems* (Dean et al., 2009) describes best management practices for managing airport deicing runoff.
2. When siting a deicing pad, ensure that all facilities are sited in accordance with the approved airport layout plan and object-clearing criteria described in FAA AC 150/5300-13, Airport Design.
3. It is desirable to locate deicing pads in such a manner as to avoid long taxi times to the runway ends from the pads in order to prevent the reoccurrence of ice or frost during the taxi.
4. The deicing pad must be constructed so that it is large enough to allow the free movement of mobile deicing vehicles around the aircraft.
5. Locate deicing pads so as to allow other aircraft that do not need treatment to taxi around aircraft being deiced.
6. Aircraft receiving treatment should not obstruct the air traffic control tower's line-of-sight view of the movement area.
7. To prevent contamination, storage tanks and fluid transfer systems must be designed in accordance with the fluid manufacturer's recommendations.
8. Refer to FAA AC 150/5300-14C, Design of Aircraft Deicing Facilities, for specific design criteria for deicing facilities.

Problem Areas

1. The proper handling and disposal of deicing and anti-icing fluid is not an inexpensive process. Care must be exercised in choosing the appropriate type of treatment and disposal system.
2. If fluids are discharged into a sanitary sewer system, the amount of fluid discharged must be constantly monitored to prevent damage to the sewage treatment plant's equipment.
3. Low concentrations of deicing fluid may be allowed to simply run off the deicing pad and seep into the surrounding soil or run into stormwater drains. However, it is possible that this practice could be prohibited in the future by environmental regulations, which would require that the airport install storage tanks or treatment facilities.

Exhibit 4.16. Deicing facilities inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Deicing Facilities Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Daily			
Perform operational check of all mobile deicing vehicles			
Monthly			
Check for deterioration or cracks in deicing pads			
Check deicing pad drains for sediment or trash			
Check piping and tanks for leaks			
Annually Prior to Snow Season			
Check operation of all collection system pumps			
Inspect storage tanks and piping for damage, leaks, and corrosion			

Notes:
1. Follow either the terminal/administrative building or hangar PM checklists as appropriate, depending on the type of building used for deicing storage.
2. Follow drainage systems checklists for PM of ditches and detention basins used for deicing fluid runoff containment.

Additional comments/remarks:

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DRAINAGE SYSTEMS

(See checklists in Exhibit 4.17 through 4.19)

Components

1. Natural streams. In some cases, an airport may have an existing stream or creek flowing through a portion of the airport property.
2. Drainage ditches. Ditches are manmade open channels that carry stormwater off the airport.
3. Swales. Swales use grass or other vegetation to filter sediment and other materials out of stormwater. They normally look like flat-bottomed channels with grass growing in them.
4. Detention ponds. Detention ponds are designed to hold stormwater and then slowly release the water through some type of control structure. They are typically dry except following a storm event.
5. Retention pond. A typically wet pond used to manage stormwater runoff to prevent flooding and downstream erosion and to improve water quality in an adjacent river, stream, lake, or bay.
6. Catch basins. Catch basins trap sediment and some oils that can pollute water bodies.
7. Leaching basin. A drainage pit with sand and gravel sides constructed to allow water to dissipate.
8. Control structures. Control structures direct or restrict the flow of water into or out of a drainage facility.
9. Storm pipe. Storm sewer pipes convey water and may be constructed from several types of materials. In some cases, storm pipes are perforated to allow stormwater to infiltrate into the ground.
10. Underdrain. A concealed drain with openings through which water enters when the water table reaches the level of the drain.
11. Junction boxes. Junction boxes connect two or more drainage facilities.
12. Manholes. Manholes are large cylindrical vaults normally set at sewer pipe connections.
13. Trash racks. Trash racks are barred covers placed over pipe openings. They prevent large objects, animals, and people from entering the pipe.
14. Energy dissipaters. Energy dissipaters slow the flow of water and are essential in preventing erosion at storm drain outfalls.
15. Headwalls. Headwalls are structures placed at pipe inlets and outlets that prevent erosion at storm drain outfalls.
16. Seawalls. Seawalls are structures constructed to prevent erosion at vertical shorelines.
17. Oil/water separators. Oil/water separators are used to collect water contaminated by petroleum products and allow the water to be discharged while containing the oil products.

Tips for Construction

1. Pesticides, herbicides, and fertilizers are never to be used in stormwater control facilities.
2. Some stormwater control facilities are classified as confined spaces, where work requires special OSHA-approved training and equipment. Examples are junction boxes, manholes, and in some types of construction, catch basins. In these confined-space situations, the best option may be to contract with a licensed sewer-cleaning contractor to perform the inspections and maintenance.
3. Drainage ditches should be constructed so that water will not pond and the water is free-flowing through the ditch.
4. Drainage ditches, swales, and detention ponds rely on vegetation to prevent erosion of the embankment. The proper seed mixture should be developed depending on the climate of the region to ensure a healthy stand of vegetation.

5. Creating areas of standing water is highly discouraged due to the wildlife attractant it provides. If ponds are present at or in the vicinity of the airport, consideration should be given to placing netting over the water to discourage waterfowl from using them as landing areas.
6. It is best to remove nuisance plants from ditches, swales, and streams in the spring before they go to seed.
7. Eliminate the potential of standing water in all system components.
8. Areas used for washing and maintaining aircraft and vehicles should include filters in the drainage system.

Problem Areas

1. Natural streams or watercourses may be wildlife attractants if not properly maintained. Water should not be allowed to pond, and the vegetation on the banks of streams should be cut to discourage wildlife from nesting.
2. When mowing vegetation along streams, ditches, or swales, it is best to remove the cut vegetation to prevent it from washing down and blocking the channel at some point.
3. The roots of trees growing along berms can lead to berm failure. Trees should be cut and removed from all berms.
4. The disposal of waste from the maintenance of drainage facilities will need to be conducted in accordance with federal, state, and local regulations.
5. Storm pipes are difficult to inspect and normally require specialized equipment for inspection and repair. The use of a sewer-cleaning company is suggested.
6. Be careful to maintain open ditches so that they do not become jurisdictional wetlands.

Exhibit 4.17. Drainage system monthly inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Drainage System Monthly Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Natural stream	Check vegetation growth along banks			
Ditches	Check vegetation growth			
	Mow if required			
Swales	Mow to keep grass at optimum height (6 to 12 in.)			
	Clear inlets and outlets			
Detention ponds	Check vegetation growth—mow if required			
	Inspect for pollutants			
	Remove trash			
	Evidence of burrowing animals or beaver dams			
	Outlet devices clear of obstructions			
Catch basins (1)	Clear inlet of trash and debris			
	Inspect structure for cracks or damage			
Control structures	Inspect structure for damage			
	Remove trash and debris from inlets and outlets			
Trash racks	Inspect for damage			
	Remove trash and debris			
Headwalls	Remove trash and debris			
Oil/water separators (1)	Remove trash and debris			
	Inspect oil accumulation (remove if more than 1 in of oil)			
	Inspect discharge water for pollutants			

(1) Confined space. Special OSHA-approved training and equipment required.

Additional comments/remarks:

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Exhibit 4.18. Drainage system semi-annual inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Drainage System Semi-Annual Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Natural stream	Cut vegetation			
	Inspect for erosion			
Ditches	Check for free flow of water			
	Inspect for erosion			
Swales	Inspect for erosion			
Detention ponds	Inspect for erosion			
Catch basins (1)	Test cover-locking mechanism			
	Inspect ladder rungs			
	Remove trash in sump			
Junction boxes (1)	Inspect for damage			
	Remove trash and debris			
	Test cover-locking mechanism			
	Inspect ladder rungs			
Manholes (1)	Inspect for damage			
	Remove trash and debris			
	Test cover-locking mechanism			
	Inspect ladder rungs			
Energy dissipaters	Inspect for missing or moved rocks			
	Inspect for erosion			
	Clean pipe perforations if required			
Headwalls	Inspect for damage			
Seawalls	Inspect for erosion			
Oil/water separators (1)	Inspect vault for damage			
	Inspect piping			
	Inspect baffles and coalescing plates			
	Test cover-locking mechanism			
	Inspect ladder rungs			

(1) Confined space. Special OSHA-approved training and equipment required.

Additional comments/remarks:

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Exhibit 4.19. Drainage system annual inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Drainage System Annual Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Natural stream	Remove sediment if required			
Ditches	Remove sediment if required			
	Reseed bare areas			
Swales	Remove sediment if required			
	Reseed bare areas			
Detention ponds	Repair eroded areas			
	Reseed bare areas			
	Remove sediment if required			
Catch basins (1)	Repair cracks or damage			
	Remove sediment if required			
Storm pipe (1)	Inspect pipe for damage			
	Remove sediment if required			
Junction boxes (1)	Repair cracks or damage			
	Remove sediment if required			
Manholes (1)	Repair cracks or damage			
	Remove sediment if required			
Energy dissipaters	Remove sediment if required			
Seawalls	Repair cracks or damage			
	Reseed bare areas			
Oil/water separators (1)	Remove sediment if required			

(1) Confined space. Special OSHA-approved training and equipment required.

Additional comments/remarks:

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FENCES AND GATES

(See checklists in Exhibit 4.20 and 4.21)

Components

1. Posts. Fence posts may be either metal or wood. Galvanized steel posts are normally used for chain-link fences. Painted steel posts are commonly used for barbed-wire fences, and occasionally wood posts are used for barbed-wire fences. The most common use of wood posts is for wildlife control fences, which may be as tall as 10 feet.
2. Fence material. For security purposes, chain-link fences are the most common fence material used at airports. The chain-link fence may be galvanized steel or may be coated with a colored paint or plastic to give the fence a more pleasant appearance. Three strands of barbed wire may be placed at the top of chain-link fences to increase security and discourage large animals from attempting to jump over the fence. Wildlife control fence is normally a wire fence with openings approximately 4 inches by 6 inches designed to stop large animals from entering the airport property. Barbed-wire fences are sometimes found at airports but have limited utility since they mainly serve to keep cattle from entering the airport; smaller animals can go under or between the strands of barbed wire, and larger wildlife, such as deer and elk, can jump over the fence.
3. Gates. While there are a wide variety of gates that can be found at airports, they basically fall into two categories: pedestrian gates and vehicular gates.
   - Pedestrian gates are usually either of the swing type or the full-length turnstile type of gate.
   - Vehicular gates may be a swing type of gate, a sliding gate, or a vertical lift style gate.
4. Gate opening systems. Gates may be operated either manually or electrically. For security purposes, electrically operated gates are commonly seen at airports. These gates are opened by either entering a code into a keypad located at the entrance to the gate or by swiping or holding a magnetic card in front of a card reader. The two most common types of automatic gate openers are hydraulic openers and electromechanical openers.

Tips for Construction

1. In areas where burrowing animals are a significant problem, the bottom of the fence material should be buried 2 feet into the ground or a concrete footer should be installed along the bottom of the fence.
2. In very cold climates, the freeze/thaw cycle may push fence posts out of the ground even if they are set in concrete. In some cases it may be advisable to not set the metal posts for chain-link fences in concrete. This allows for the posts to be simply pounded back into the ground if they are forced up during the winter. If a concrete foundation is used, consider stopping the concrete a few inches below final grade and backfilling with dirt over the top of the concrete. This eliminates the mushroom effect of concrete on a surface wider than the foundation, which can accelerate frost heave.
3. Where fences cross ditches, it may be necessary to install strands of barbed wire under the fence material to close the gap between the bottom of the fence and the bottom of the ditch.
4. If the in-pavement sensing wires for electric gates are installed in a conduit, they will be better protected and easier to replace in the event of a failure of the wiring.
5. Consider a wide (e.g., 4 feet) footer beneath the fence line to reduce the need for weed control, make mowing easier around fence lines, and prevent animals from burrowing under the fence.

Problem Areas

1. If the fence material does not extend to within 2 inches of the ground, smaller animals can enter the airport through the gap between the fence and the ground.

2. Wildlife fences will prevent the entrance of large animals onto the airport; however, smaller animals, such as rabbits and coyotes, can often pass through the fence material and gain entrance.
3. If the fence line is not treated with an herbicide, climbing plants and shrubs can grow along or on the fence and cause damage to the fence material.
4. In areas with significant ice or snow, electrically operated gates that use a wheel rolling on a steel plate to open the gate may malfunction due to ice forming on the steel plate.
5. Snow can block gates or affect gate movement.

Exhibit 4.20. Fence and gate monthly inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Fence and Gate Monthly Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Fences	Visible damage			
	Vegetation growing on fence			
	Warning signs			
	Evidence of animals burrowing			
	Washouts under fence			
	Evidence of attempted unauthorized entry			
	Rust/corrosion			
Gates	Visible damage			
	Check all safety controls			
	Condition of locking mechanisms			
	Check normal operation			
	Rust/corrosion			
	Condition of keypad or card reader			
	In-pavement sensors			

Additional comments/remarks:

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_____
_____
_____

Exhibit 4.21. Fence and gate semi-annual inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Fence and Gate Semi-Annual Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Fences	Condition of fence material			
	Loose posts			
	Evidence of rotting in wood posts			
	Condition of fence attachment hardware			
	Less than 2 inches between fence and ground			
	Apply herbicide to prevent vegetation along fence line			
	Remove any rust/corrosion			
Gates	Lubricate hinges			
	Lubricate locking mechanisms			
	Lubricate rollers			
	Lubricate automatic opening mechanism (chains, etc.)			
	Remove any rust/corrosion			
	Change combinations on keypads			
	Check operation of automatic reversing sensors			
	Clear vegetation etc. from path of swing and sliding gates			

Additional comments/remarks:

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_____
_____
_____
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FUELING FACILITIES

(See checklists in Exhibit 4.22 through 4.27)

Components

1. Fuel tanks. The tanks located at fueling facilities at airports come in a wide variety of sizes. The most common sizes at general aviation airports are 10,000 gallon and 12,000 gallon tanks. The tanks may be located underground or above ground and may be either single walled or double walled. Almost all new tanks today are of the double-walled variety.
2. Piping and valves. The piping configuration depends on the purpose of the tank. If the tank is meant to only fill refueling trucks, then all of the piping may be located on a skid directly in front of the tank. If the tank serves a self-fueling station, the piping may be much longer in order to reach the fueling station. Since much of the piping serves to both fill the tank from a tanker truck and fill refueler vehicles or aircraft, valves are strategically located in the piping to direct the flow of fuel depending on the situation.
3. Hoses. Flexible hoses are used to either fill the refueler vehicles or to fill aircraft.
4. Filter system. A filter system will be located at some point in the piping and is used to filter the fuel both going into the tank from a fuel tanker and coming from the tank into a refueler or aircraft.
5. Bonding cable. A bonding cable will be located on a reel in the vicinity of the tank and is used to bond (ground) the tank and piping to the refueler or aircraft to prevent a spark from occurring between the hose nozzle and the refueler or aircraft during refueling.
6. Emergency shutoff. An emergency shutoff button should be located in close proximity to the operator's station and will disconnect all electrical power going to the fuel system.
7. Self-fueling station. In some cases, the piping from the fuel tanks leads to a self-fueling station for pilots to be able to refuel their own aircraft. The self-fueling station usually consists of a credit card reader, hose reel, and bonding cable reel. In some cases, a fuel pump will also be located at the self-fueling station.
8. Containment area. Above-ground fuel tanks and their associated piping are normally located inside a containment area to prevent the runoff of fuel in the event of a spill. The containment area may be a plastic- or rubber-lined pit or may be a concrete pad with low walls. Depending on local or state environmental regulations, the containment area may need to be large enough to contain the tanker truck or refueler truck when it is transferring fuel to or from the tanks.
9. Fencing and gates. Depending on the location of the fuel farm, it may need to be surrounded by a security fence with access gates for the trucks.
10. Refueler trucks. The trucks used to refuel aircraft are essentially mobile fueling facilities and contain most of the components found in the main fuel farm, including a tank, piping and valves, hoses, filter system, and bonding cable reel. Separate inspection and PM checklists are provided for the refueler trucks.

Tips for Construction

1. Careful consideration must be given to the amount of fuel currently being sold at the airport and the predicted future amounts before deciding on the proper size of tank to be installed in the fuel farm.
2. Environmental laws differ between states. Consult your state environmental department to ensure that the design of your fuel farm meets all current and foreseeable future state regulations.
3. As fuel farms are somewhat expensive to construct and are not easily relocated, be sure to take into account the long-range plans of the airport before selecting a site for the fuel farm.

4. If the possibility of having to add additional fuel tanks in the future is foreseen, it is more cost-effective to construct a containment area large enough to account for the future tanks when the fuel farm is initially built.
5. Consider the route the tanker trucks will need to follow in order to get to the fuel farm to refill the tanks and the turning radius of a tanker truck. Avoid having to drive tankers on taxiways or aircraft aprons.
6. If the fuel farm is surrounded by a security fence, ensure that the access gates are large enough to accommodate the tanker trucks and any turns they may have to make in order to enter or exit the fuel farm.
7. Immediately touch up any paint that was chipped or scratched on the tanks or piping during the installation process to prevent corrosion from beginning.
8. Ensure that all warning placards and fuel identification labels are in place on the tanks, piping, hoses, and nozzles before placing the fuel farm into operation.
9. Give consideration to supplier delivery load sizes, additional cost for partial loads, and availability (scheduling lead time) of fuel deliveries.
10. Consider environmental and inspection requirements and insurance costs when selecting tank type (above or below ground).
11. Verify fire inspector requirements prior to construction.

Problem Areas

1. In areas of medium to high humidity, rust will quickly form on any unprotected metal.
2. Ensure that containment areas are kept free from debris and trash and that drains are not becoming clogged with dirt.
3. Do not allow fueling personnel to bypass or mechanically lock deadman controls in the operating position.
4. Ensure that vent systems are not obstructed by snow or ice before filling refueler trucks.
5. Leaks, no matter how small, must be immediately corrected.
6. Ensure that the proper number and size of fire extinguishers are present in the fuel farm and that the extinguishers are charged and the inspection date is current.
7. It is not uncommon for the hose nozzles at self-fueling stations to be abused by being dragged on the ground when the hose is retracted onto the reel. Regular inspection of these nozzles is required.
8. For some airports, airport management may not be directly involved with the technical aspects of fuel facility inspections. Often, an airport fixed-base operator performs these inspections. However, airport management should ensure that the inspections are being done and documented.

Exhibit 4.22. Fuel facility daily inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Fuel Facility Daily Inspection
Note: Add fuel provider inspection requirements

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Area clear of debris or trash			
No vegetation in area			
Evidence of leaks			
Hose/nozzle damage			
Tanks sumped			
Filters sumped			
Filter differential pressure (record)			
Bonding cable reel operable			
Fire extinguishers present			
Signs/placards in place			

Additional comments/remarks:

_____
_____
_____
_____
_____

Exhibit 4.23. Fuel facility monthly inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Fuel Facility Monthly Inspection
Note: Add fuel provider inspection requirements

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Condition of fence/gates			
Condition of warning/safety signs			
Condition of placards on tanks, piping, hoses			
Check and clean nozzle screens			
Perform membrane filter test (Jet-A only)			
Test for anti-icing additive (Jet-A) (should be 0.10–0.15 Vol. %)			
Perform free water test (15 ppm maximum)			
Test emergency shutdown system			
Test deadman control			
Check bonding cable continuity (should be <25 ohms)			
Check vents, dome covers, and gaskets			
Inspect grounding cables and rods			
Fire extinguishers (pressure in green, seal in place, insp. date)			

Additional comments/remarks:

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Exhibit 4.24. Fuel facility semi-annual/annual inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Fuel Facility Semi-Annual/Annual Inspection
Note: Add fuel provider inspection requirements

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Semi-annual			
Check dates on hoses			
Check cathodic protection			
Inspect line strainers			
Inspect water defense systems			
Test tank high-level controls			
Annual			
Replace filter elements			
Inspect tank interiors			
Pressure test hoses			
Have meter calibration checked			

Additional comments/remarks:

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Exhibit 4.25. Refueler daily inspection checklist (Note: also see vehicle checklist).

ANYTOWN MUNICIPAL AIRPORT
Refueler Daily Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Vehicle safety inspection			
Lights operational			
Evidence of leaks			
Hoses, swivels, nozzles, dust caps			
Tank sumped			
Filter sumped			
Filter differential pressure (record)			
Deadman controls			
Bonding cable, reel, clamps			
Nozzle pressure			
Safety interlocks			
Tank troughs and drains			
Bottom loading check			
Fire extinguishers present			
Signs/placards in place			

Additional comments/remarks:

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Exhibit 4.26. Refueler monthly inspection checklist (Note: also see vehicle checklist).

ANYTOWN MUNICIPAL AIRPORT
Refueler Monthly Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Condition of placards on tank, piping, hoses			
Check and clean nozzle screens			
Perform membrane filter test (Jet-A only)			
Test for anti-icing additive (Jet-A) (should be 0.10–0.15 Vol. %)			
Perform free water test (15 ppm maximum)			
Test emergency shutdown system			
Meter seals			
Test deadman control			
Check bonding cable continuity (should be <25 ohms)			
Check vents, dome covers, and gaskets			
Fire extinguishers (pressure in green, seal in place, insp. date)			

Additional comments/remarks:

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_____

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Exhibit 4.27. Refueler semi-annual/annual inspection checklist (Note: also see vehicle checklist).

ANYTOWN MUNICIPAL AIRPORT
Refueler Semi-Annual/Annual Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Semi-annual			
Check dates on hoses			
Inspect line strainers			
Inspect water defense systems			
Test tank high-level controls			
Annual			
Replace filter elements			
Inspect tank interior			
Pressure test hoses			
Have meter calibration checked			

Additional comments/remarks:

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_____
_____
_____
_____

HANGARS

(See checklists in Exhibit 4.28 and 4.29)

Components

1. Structural framing – Steel framing is most commonly used today. However, in rare instances, wood framing may be used and is commonly found in older hangars.
2. Wall panels – Again, metal panels are the most commonly used material today. Only in rare instances, and usually for decorative reasons, are other materials such as wood or stucco used.
3. Roof system – Depending on the size of the roof and the slope, either metal panels or a built-up roofing material will be used.
4. Doors
   A. Personnel – In many cases, the hangar does not have a separate door to allow for the entrance of people into the hangar without the need to open the main hangar door. When the hangar does have a separate personnel door, it may be located on an outside wall or be integrated into the main hangar door.
   B. Overhead – Some older hangars may be configured with a series of overhead doors separated by folding dividers containing the door tracks as the main hangar door. In most cases, however, overhead doors are only found in hangars where there is a separate entrance for vehicles and equipment.
   C. Sliding – Sliding doors are commonly found in all sizes of hangars. The doors may be manually operated by simply pushing them open and closed or, particularly in the case of larger doors, may be electrically operated. Smaller sliding doors hang on tracks installed on the hangar at the top of the door, while larger sliding doors roll on tracks installed in the pavement at the bottom of the door. Manual sliding doors are among the simplest to maintain.
   D. Bi-fold – Electrically operated bi-fold doors are a popular option found on many hangars due to their ease of operation. These doors open upward and fold in half as the door opens. They are more maintenance intensive than many other door systems, and some overhead space is lost in the door opening due to the manner in which the door folds open.
   E. Hydraulic swing – Hydraulic swing doors are operated by an electrically driven hydraulic pump. They are somewhat simpler than a bi-fold door in that they do not fold as they open but swing straight out from the front of the hangar and have fewer moving parts. Their main disadvantage is that there is a fairly large area that must be kept clear in front of the door to prevent the door from hitting anything when it is opened or closed.
5. Windows – Many hangars, particularly T-hangars, have no windows installed in the building at all. When windows are installed, they are commonly found in the main hangar doors. In some cases, windows are avoided as they are perceived as a possible security concern.
6. Skylights – The most common form of skylight found in a hangar is a clear or translucent panel installed in the roof in place of the normal steel panel. Skylights can help to reduce electric bills by providing natural light to the hangar, reducing the need for electric lights to be used in the daytime.
7. Gutters and downspouts – While not routinely found on hangars, gutters and downspouts can reduce the chance of runoff water entering under the main doors of the hangar. In some instances, particularly with T-hangars, the manner in which the hangar doors open prevents the installation of gutters and downspouts.
8. Insulation – Not all hangars are insulated, either because insulation is not required in the climate in which the hangar is located or to save on construction costs. Insulation would, of course, be required in any hangar with an HVAC system.

9. Electrical system – Hangar electrical systems may be as simple as a few overhead lights and one or two outlets. The size and intended use of the hangar will drive the requirements for the electrical system.
10. Plumbing system – Plumbing systems are normally only found in larger hangars or those that serve as a base for a business and contain work areas or offices. Care must be taken to ensure that no hazardous materials used in the hangar can find their way into a septic or sewer system.
11. HVAC system – As with plumbing systems, HVAC systems are normally only found in larger hangars or those that support a business.
12. Fire suppression system – The need to install a fire suppression system will depend on the size of the hangar, the intended use of the hangar, and the local fire codes.

Tips for Construction

1. Rust and corrosion will drastically shorten the life of a hangar and can lead to major maintenance costs. Therefore, the owner should specify that all metal surfaces be fabricated of corrosion-resistant materials or be protected by a corrosion-resistant coating.
2. Immediately following construction, ensure that all scratches in the protective coating of the walls and roof are touched up to prevent corrosion from occurring.
3. If gutters and downspouts are specified for the building, be sure the water exiting the downspouts is carried away from the building and does not pond in front of the hangar doors.
4. Locate electrical outlets strategically throughout the hangar to prevent overloading of one outlet or the excessive use of extension cords.
5. Insulating and properly ventilating the hangar will make the building more comfortable, even if there is no HVAC system in the hangar, and will lessen the formation of corrosion-causing condensation in the building.
6. Consult with the local fire marshal to determine if a sprinkler or fire suppression system will be required.
7. There are several choices available for hangar doors. Carefully consider the intended use of the hangar, the tenants, and the revenue potential before making a door selection.

Problem Areas

1. In areas of medium to high humidity, rust will quickly form on any damaged or unprotected metal.
2. Overloaded electric circuits are common when there are insufficient outlets or when tenants are permitted to install appliances or equipment such as air compressors in the hangar.
3. Birds and other small animals will attempt to nest in hangars and can damage the hangar, aircraft, and electrical wiring.
4. Improper storage of hazardous chemicals or combustibles may occur if hangars are not inspected regularly.
5. Electrically operated doors can be maintenance intensive. Regular inspections are necessary to prevent major and costly repairs—especially door motors and cables including limit switches.
6. Hangars that are privately owned and will revert to the ownership of the airport at the end of the lease period should be periodically inspected to determine the overall condition of the building. Owners of private hangars should not be permitted to allow the condition of the building to deteriorate as the end of the lease period approaches.
7. Hangar lease terms should include facility maintenance, and leases should specify how much work airport staff may conduct with aircraft still in the hangar. Avoid the liability of an aircraft being damaged while doing hangar maintenance.

Exhibit 4.28. Hangar monthly inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Hangar Monthly Inspection

HANGAR #: _____

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Exterior	Drainage			
	Vegetation			
Structural framing	Visible damage			
	Rust/corrosion			
Walls	Visible damage			
	Rust/corrosion			
	Dirty/discolored			
Roof	Visible damage or leaks			
	Rust/corrosion			
	Dirty/discolored			
	Condition of skylights			
Doors and windows	Damaged components			
	Proper operation			
	Weather stripping			
Gutters and downspouts	Visible damage			
	Clear of debris			
Electrical system	Lights and outlets operable			
	Extension cords			
	Unauthorized equipment			
Plumbing	Facilities operable			
	Leaks			
HVAC system	Proper operation			
	Filter condition			
Fire suppression system	Clear of obstructions			
	Leaks			
	Fire extinguishers			
Hazardous materials	Unauthorized flammables or chemicals present			
Storage	Unauthorized items			
Floor	Spills/stains			

Exhibit 4.29. Hangar semi-annual inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Hangar Semi-Annual Inspection

HANGAR #: _____

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Exterior	Drainage			
	Vegetation			
Structural framing	Visible damage			
	Rust/corrosion			
	Loose bolts			
	Tension of wind-brace rods/cables			
	Unauthorized modifications to framing			
	Unauthorized loads added to framing			
Walls	Visible damage			
	Rust/corrosion			
	Dirty/discolored			
	Loose fasteners			
	Seams/joints secure			
	Flashings secure			
Roof	Visible damage or leaks			
	Rust/corrosion			
	Dirty/discolored			
	Loose fasteners			
	Deformed panels			
	Sealants cracked or missing			
	Seams/joints secure			
	Flashings secure			
	Condition of skylights			
Personnel doors and windows	Damaged components			
	Rust/corrosion			
	Weather stripping			
	Lubricate hinges and locks			
	Closing devices			
	Proper operation			

Exhibit 4.29. (Continued).

Area	Item	√	Remarks	Action Taken or Work Order #
Sliding doors	Visible damage			
	Rust/corrosion			
	Door alignment			
	Loose fasteners			
	Condition of wheels/rollers			
	Lubricate wheels/rollers			
	Locking devices condition/operation			
Bi-fold doors	Visible damage			
	Rust/corrosion			
	Door alignment			
	Loose fasteners			
	Condition of hinges, rollers, door track			
	Condition of cables/lifting straps			
	Condition of cable drum, sheaves, cable clamps			
	Check cable/lifting strap tension			
	Check belt and chain tension and alignment			
	Lubricate electric motor, hinges, sheaves, chains, rollers, drum bearings			
	Inspect gear box and add oil as necessary			
	Check safety switches/devices			
	Check proper operation of door			
	Locking devices condition/operation			
	Refer to manufacturer's manual for additional PM requirements			

(continued on next page)

Exhibit 4.29. (Continued).

Area	Item	√	Remarks	Action Taken or Work Order #
Hydraulic swing doors	Visible damage			
	Rust/corrosion			
	Door alignment			
	Loose fasteners			
	Condition of hinges, hoses, hydraulic lines			
	Check hydraulic lines and lift cylinders for leaks			
	Lubricate electric motor, hinges, actuator attachment points			
	Check hydraulic fluid reservoir and add fluid as necessary			
	Check safety switches/devices			
	Check proper operation of door			
	Locking devices condition/operation			
	Refer to manufacturer's manual for additional PM requirements			
Overhead doors	Visible damage			
	Rust/corrosion			
	Door alignment			
	Loose fasteners			
	Track condition			
	Condition of hinges, cables, springs, and rollers			
	Lubricate hinges and rollers			
	Check proper operation of door			
	Locking devices condition/operation			
	Refer to manufacturer's manual for additional PM requirements			

Exhibit 4.29. (Continued).

Area	Item	√	Remarks	Action Taken or Work Order #
Gutters and downspouts	Visible damage			
	Clear of debris			
Electrical system	Electrical fixtures and wiring in good condition			
	Lights and outlets operable			
	Extension cords			
	Unauthorized modifications or equipment			
Plumbing	Facilities operable			
	Leaks			
HVAC system	Proper operation			
	Filter condition			
	Clean vents			
	Refer to manufacturer's manual for additional PM requirements			
Fire suppression system	Clear of obstructions			
	Leaks			
	Fire extinguishers charged, current inspection date			
Hazardous materials	Unauthorized flammables or chemicals present			
	Flammable liquids properly stored			
	Chemicals properly stored			
Storage	Unauthorized items			
Floor	Spills/stains			

Additional comments/remarks:

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LANDSIDE INFRASTRUCTURE

(See checklists in Exhibit 4.30 through 4.33)

Components

1. Access roads. These include the main entrance road to the airport and any circulation roads located outside the security fence of the airport.
2. Parking lots. All parking lots, whether for the general public or reserved for airport employees.
3. Lighting systems. These are usually in the form of light poles located along access roads or in parking lots.
4. Guidance signs. Signs located along access roads directing the public to parking lots or the terminal facilities.
5. Security systems. Other than the security addressed in the fencing and gates and building checklists, this would include any outdoor security cameras that may be located at the airport.

Tips for Construction

1. If pavement is not properly constructed, then no amount of PM will make up for its deficiencies. The pavement must be properly designed for the traffic and conditions that are anticipated or its expected life will be drastically reduced.
2. When installing or replacing light poles, consideration should be given to the use of tip-down poles to facilitate bulb replacement and regular PM.
3. Install bird protection/deterrents such as spikes on top of light and camera poles to deter landing and nesting.

Problem Areas

1. The pavement condition of access roads and parking lots is frequently overlooked as the airport focuses on airfield pavements. Repairing these pavements can be nearly as expensive as repairing airfield pavements, and PM of these pavements should not be ignored.
2. Lights and signs along roads and in parking lots are prone to being damaged by vehicles. Inspections for obvious damage should be done any time an airport employee is in the area.
3. Due to the nature of road and parking lot lights (mounted on tall poles), the use of a bucket truck to conduct PM may be required. This frequently results in PM being deferred until bulb replacement is required.
4. Due to the costs associated with using a bucket truck to perform PM on light poles and lights, it may be more cost-effective to replace all the bulbs at the same time and on a fixed schedule.
5. Outdoor lights and security cameras provide nesting places for birds and insects. Check for the presence of spiders and wasps before handling equipment.

Exhibit 4.30. Access road and parking lot pavement inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Access Road and Parking Lot Pavement Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Monthly			
Inspect pavement for cracks or other signs of deterioration			
Inspect markings for fading and deterioration			
Annually			
Conduct formal pavement evaluation (1)			
Seal cracks as required			
Seal coat pavement if required			
Repaint faded or missing markings			

(1) See information on airfield pavement.

Additional comments/remarks:

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Exhibit 4.31. Landside lighting system inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Landside Lighting System Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Annually			
Inspect pole foundations for cracks/deterioration			
Inspect anchor bolts and nuts, leveling nuts, and washers			
Inspect base plates for cracks/corrosion			
Remove access plates and inspect wiring connections and inside of poles for moisture			
Inspect poles for cracks and corrosion			
Clean lenses			
Inspect light fixtures for corrosion			
Replace bulbs			
Test photo sensors			
Check timers for proper operation			

Additional comments/remarks:

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Exhibit 4.32. Landside wayfinding sign inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Landside Wayfinding Sign Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Monthly			
Inspect for visible damage			
Annually			
Inspect sign foundation for cracks/deterioration			
Inspect anchor bolts and nuts, leveling nuts, and washers			
Inspect base plates for cracks/corrosion			
Inspect sign poles and framework for cracks and corrosion			
Clean sign panels			
Clean lights			
Replace bulbs			
Test photo sensors			
Check light timers for proper operation			

Additional comments/remarks:

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_____
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Exhibit 4.33. Security camera inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Security Camera Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Weekly			
Perform a file back-up of video recorded			
Monthly			
Check camera for proper operation, focus, camera view, and quality of picture			
Clean recording device and check operation of fan			
Quarterly			
Remove any items obstructing camera view			
Clean camera dome or protective lens			
Inspect inside camera housing for dust and insects; clean as necessary			
Inspect wires and connectors			

Additional comments/remarks:

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_____
_____
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_____

MAINTENANCE EQUIPMENT

(See checklists in Exhibit 4.34 through 4.36)

Components

1. Mowers. Airports use a variety of mowers to maintain the turf areas of the airport. These may range from small riding mowers for landscaped areas to large, bush-hog types of mowers that are pulled behind a tractor or multiuse vehicle to maintain the safety areas of the airport.
2. Snow removal equipment. Depending on the size of the airport and the amount of annual snowfall, this equipment may range from a small, 8-foot plow mounted on a pickup truck to a 30-foot plow, power broom, or snowblower mounted on a vehicle specifically designed for snow removal.
3. Tractors. Tractors are used for a variety of purposes, the most common being to pull large mowers. Tractors may also be equipped with hydraulic buckets for moving dirt or with snowplows.
4. Front-end loaders. Front-end loaders are frequently used as part of the snow removal process or for moving dirt and other materials.

Tips for Purchase

1. In selecting any piece of equipment for the airport, it is important to match the equipment to the job it will be expected to perform. Purchasing undersized or underpowered equipment may result in premature failure of the equipment and increased repair costs.
2. Some airports elect to purchase used equipment through auctions or through government resale activities. Care must be taken to ensure that equipment has been properly maintained and is not at or near the end of its useful life.
3. Any purchase agreement for new equipment should include training for maintenance personnel in the operation and routine maintenance of the equipment. Complete operations manuals and maintenance manuals should accompany the equipment and be kept at the airport regardless of who will be maintaining the equipment.
4. Consider all funding sources, such as state and federal grants.
5. Consider purchase of cab-enclosed equipment when the operator must monitor the radio.

Problem Areas

1. Personnel who are operating an unfamiliar piece of equipment or operate the equipment without performing any inspection prior to using the equipment are among the leading causes of damage to equipment.
2. Snowplows that are allowed to ride directly on the pavement surface can damage airfield markings, in-pavement lights, and pavement high points such as crowns. To preserve the markings and pavement, it is recommended that plows be equipped with wheels that raise the blade slightly above the pavement surface. This will also preserve the life of the plow blade.
3. Sharpening mower blades, particularly on large mowers, may be difficult and time-consuming; however, sharp blades reduce the wear on the drive shafts, universal joints, and bearings of the mower and help to extend the overall life of the mower.
4. In areas that are infrequently cut and where the vegetation has grown high, care must be taken to ensure that the mower does not run over objects that may damage the blades or the mower itself.
5. Runway and taxiway lights should be turned on during snow plowing operations to assist the drivers in seeing the lights and to prevent damage to them. Keep in mind that when plowing along the edge of a runway or taxiway, the weight of the snow being discharged from the plow may be sufficient to break frangible fittings on lights.
6. Allowing equipment to become overly dirty may hide leaks or other signs of needed repairs.

Exhibit 4.34. Mower daily inspection checklist (Note: also see vehicle checklist).

ANYTOWN MUNICIPAL AIRPORT
Mower Daily Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Visible damage to mower			
Safety shields in place			
Evidence of fluid leaks			
Fluid levels (engine, transmission, gear boxes)			
All fittings greased (universal joints, wheel bearings, steering assembly)			
Blades sharp and not bent			
Hydraulic hoses not damaged			
All lights (hazard, warning) operating			
Tire condition			
Brake check			

Weekly, monthly, semi-annual, and annual inspections/maintenance will be specific to the type and manufacturer of the mower. Refer to the owner's and maintenance manuals for instructions.

Additional comments/remarks:

_____
_____
_____
_____
_____

Exhibit 4.35. Snow removal equipment daily inspection checklist (Note: also see vehicle checklist).

ANYTOWN MUNICIPAL AIRPORT
Snow Removal Equipment Daily Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Visible damage to equipment			
Safety shields in place			
Evidence of fluid leaks			
Fluid levels (engine, transmission, gear boxes)			
All fittings lubricated			
Hydraulic hoses not damaged			
Condition of plow blade			
Condition of broom			
Snowblower discharge unobstructed			
Snowblower auger condition			
Snowblower impeller condition			
All lights (hazard, warning) operating			
Tire condition			

Weekly, monthly, semi-annual, and annual inspections/maintenance will be specific to the type and manufacturer of the equipment. Refer to the owner's and maintenance manuals for instructions.

Additional comments/remarks:

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_____

Exhibit 4.36. Powered equipment daily inspection checklist (Note: also see vehicle checklist).

ANYTOWN MUNICIPAL AIRPORT
Powered Equipment (Trucks, Loaders, etc.) Daily Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Visible damage			
Evidence of leaks			
Oil level			
Transmission fluid level			
Coolant level			
Hydraulic fluid level			
Belts and hoses			
Filters			
Lubricate per manufacturer's recommendations			
Battery and connections			
Lug nuts			
Tire condition and pressure			
Lights, lenses, and reflectors			
Brake check			
Warning lights and gauges			
Windows and mirrors			

Weekly, monthly, semi-annual, and annual inspections/maintenance will be specific to the type and manufacturer of the equipment. Refer to the owner's and maintenance manuals for instructions.

Additional comments/remarks:

_____
_____
_____
_____
_____

MAINTENANCE AND EQUIPMENT STORAGE BUILDINGS

Buildings that are designated for equipment storage or for performing maintenance on equipment vary widely in their configuration and construction. Some are used simply for storage and are constructed similar to aircraft hangars, while others may have finished interiors and contain offices, restrooms, and, possibly, sleeping areas.

The PM performed on these buildings will depend on the type of construction of the building and the facilities housed in the building. For this reason, a checklist that would be applicable to this group of buildings would be excessively long and would involve extensive editing by airport managers to fit the particular circumstances at their airports. It is suggested instead that airport managers use either the terminals and administrative buildings checklists or the hangar checklists and adapt them to fit the particular type of construction that exists for their maintenance and equipment storage buildings.

OBSTRUCTIONS TO IMAGINARY SURFACES

(See checklist in Exhibit 4.37)

Components (Federal Aviation Regulations Part 77 Imaginary Surfaces)

1. Primary surface. A surface that overlays the runway at the elevation of the runway centerline. The width of the primary surface is dependent on the classification of the runway and the type of approach (visual, non-precision, precision) that exists to the runway. The primary surface extends 200 feet beyond each end of the runway.
2. Transitional surface. Extends outward from the sides of the primary surface at a 7:1 (seven horizontal to one vertical) slope until reaching 150 feet above the established airport elevation. Also extends outward from the edges of the approach surface at a 7:1 slope for a distance of 5,000 feet.
3. Horizontal surface. A flat surface located 150 feet above the established airport elevation and centered on the runway. The radius of the surface from the runway ends is either 5,000 feet or 10,000 feet, depending on the classification of the runway.
4. Conical surface. Extends outward from the edges of the horizontal surface at a 20:1 slope for a distance of 4,000 feet.
5. Approach surface. A trapezoidal surface that is centered on the runway and extends outward from the edge of the primary surface. The slope, width, and length of the approach surface are dependent on the classification of the runway and the type of approach (visual, non-precision, precision) that exists to the runway.

Tips for Construction

1. Imaginary surfaces are not constructed, per se, but automatically come into existence anytime a runway is constructed. However, any construction that takes place at or in the vicinity of an airport must take into consideration the existence of these surfaces and be planned so as to not penetrate any of the surfaces.
2. For safety reasons, airports are encouraged to request that the locality in which they are located adopt zoning regulations that protect these surfaces and prevent construction of buildings, towers, and so forth that may penetrate the surfaces.
3. Imaginary surfaces may change without airfield improvements. Review and consider all changes to runway-specific instrument approach procedures, including impacts to imaginary surfaces and the resulting additional approach clearing requirements or property acquisition.

Problem Areas

1. Trees on airport property or adjacent land may eventually grow to a height where they penetrate one of the imaginary surfaces. Airports are encouraged to pursue easements on adjacent property that allow the airport to remove or trim trees that are in danger of penetrating an imaginary surface.
2. Localities that do not have zoning regulations protecting these surfaces may issue building permits that allow the construction of a building or tower that penetrates one of these surfaces. Agencies responsible for the issuance of building permits must be aware of the need for a building permit applicant to submit a Form 7460-1 to the FAA anytime construction is proposed that is in reasonable proximity to an airport. The building permit should not be issued until the FAA has reviewed Form 7460-1 and made a determination as to whether the construction would create an obstruction to the airport or constitute a hazard to air navigation.
3. The daily airport inspection should include observation of possible unregistered cranes or off-airport construction that might affect airport operations or require a Notice to Airmen.
4. Growth-control chemicals may require a license for spraying.

Exhibit 4.37. Imaginary surface semi-annual inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Imaginary Surface Semi-Annual Inspection

DATE: _____
INSPECTOR: _____

√ Satisfactory
X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Airport Property	Review latest obstruction survey			
	Remove trees or vegetation of a height within 10 feet of imaginary surface			
	Check condition of obstruction lights on buildings/towers			
Property Adjacent to Airport	Remove trees or vegetation of a height within 10 feet of imaginary surface			
	Unexpected cranes or construction			
	Check condition of obstruction lights on buildings/towers			
	Discuss proposed development in vicinity of airport with local officials			

Additional comments/remarks:

_____
_____
_____
_____
_____

TERMINALS AND ADMINISTRATIVE BUILDINGS

(See checklists in Exhibit 4.38 and 4.39)

Components

1. Structural framing. Steel framing is most commonly used; however, wood framing may also be used.
2. Walls. There are a wide variety of materials used for exterior walls. Interior walls are normally painted drywall.
3. Roof system. There are a variety of roofing materials that may be used. The most common are shingles, metal panels, and a built-up roofing material.
4. Doors. Electrically operated doors are commonly used as entrance doors to buildings due to the volume of people using them. Most interior doors are of the normal, single-swing type.
5. Windows. In older buildings, windows that are able to be opened are quite common. In newer buildings, windows are usually unable to be opened because of the HVAC requirements of the building.
6. Skylights. It is common to find skylights installed in terminals and administrative buildings, particularly in lounge areas. Skylights can help reduce electric bills by providing natural light to the building and reducing the need for electric lights to be used in the daytime.
7. Gutters and downspouts. Gutters and downspouts can reduce the chance of runoff water entering the building. In addition, gutters can direct runoff water from the roof away from the entrances of the building and make it more comfortable for people to enter the building.
8. Insulation. The amount and type of insulation used in the building is highly dependent on the climate in which the building is located and the type of HVAC system installed in the building.
9. Electrical system. The capacity of the electrical system will depend on the size of the building and the type of equipment to be installed in it. Conveyors, baggage handling systems, and any stores or restaurants in the building will significantly increase the required capacity of the electrical system.
10. Plumbing system. As with electrical systems, the capacity of the plumbing system is highly dependent on the size of the building and the type of facilities located in it.
11. HVAC system. A building's HVAC system is a major user of energy and needs to be properly sized for the building and properly maintained throughout its life.
12. Fire suppression system. The need to install a fire suppression system will depend on the size of the building and the local fire codes.
13. Security system. The complexity of the security system will depend on the use of the building and the need to control access to certain areas of the airport, such as to the area used by commercial airlines. The security system may also serve to automatically notify fire officials in the event of a fire in the building.

Tips for Construction

1. Rust and corrosion will drastically shorten the life of a building and can lead to major maintenance costs. Therefore, the owner should specify that all metal surfaces be fabricated of corrosion-resistant materials or be protected by a corrosion-resistant coating.
2. If gutters and downspouts are specified for the building, be sure the water exiting the downspouts is carried away from the building and does not pond in front of entrance doors.
3. Consult with the local fire marshal to determine if a sprinkler or fire suppression system will be required.

4. Consider the use of green materials in the construction of the building, but keep in mind that green materials may increase its cost.
5. Architectural features enhance the beauty of a building but may also significantly increase its cost.
6. Before designing a new terminal building, visit other newer terminals of approximately the same size that is envisioned. Speak with the airport managers about what they like in their building and what they would change.
7. Consider the future development that is planned for the airport when designing a terminal building and if any of that development will have an impact on the size of the terminal building needed in the near future.
8. Do not underestimate the amount of storage space that will be required in the building.

Problem Areas

1. Overloaded electric circuits are common if there are insufficient outlets or if tenants are permitted to install appliances or equipment that was not foreseen when the building was constructed.
2. Electrically operated doors can be maintenance intensive. Regular inspections are necessary to prevent major and costly repairs.
3. HVAC systems that are not properly sized or load balanced will result in higher than expected power bills and uneven heating or cooling of the building.

Exhibit 4.38. Terminal/administrative building monthly inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Terminal/Administrative Building Monthly Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Exterior	Visible damage			
	Drainage			
	Condition of exterior walls			
Roof	Visible damage or leaks			
	Rust/corrosion			
	Dirty/discolored			
	Condition of skylights			
Gutters and downspouts	Visible damage			
	Clear of debris			
Interior walls	Visible damage			
	Dirty/discolored			
Doors and windows	Damaged components			
	Proper operation			
	Weather stripping			
Electrical system	Lights and outlets operable			
	Extension cords			
	Overloaded circuits			
Plumbing	Facilities operable			
	Leaks			
HVAC system (1)	Proper operation			
	Filter condition			
	Perform recommended maintenance			
Storage areas	Unauthorized items			
	Overcrowded			
Floor	Spills/stains			
	Damaged carpet/tile			
Fire suppression system	Clear of obstructions			
	Leaks			
	Fire extinguishers (date and pressure)			
Security system	Check for proper operation of all modes			

(1) HVAC systems are often maintained through a contract and should be maintained per the manufacturer guidelines. Some basic maintenance steps for small systems are included with the semi-annual checklist.

Additional comments/remarks:

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_____

_____

_____

_____

Exhibit 4.39. Terminal/administrative building semi-annual inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Terminal/Administrative Building Semi-Annual Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Area	Item	√	Remarks	Action Taken or Work Order #
Exterior	Condition of landscaping			
	Lights and signs			
Roof	Condition of shingles			
	Loose fasteners			
	Deformed panels			
	Sealants cracked or missing			
	Seams/joints secure			
	Flashings secure			
	Condition of skylights			
Gutters and downspouts	Visible damage			
	Clear of debris			
	Loose hardware			
Interior walls	Repair minor damage			
	Touch up paint			
Doors and windows	Rust/corrosion			
	Lubricate hinges and locks			
	Closing devices			
	Test emergency operation of electric doors			
Electrical system	Electrical fixtures and wiring in good condition			
	Unauthorized modifications or equipment			
Plumbing	Damaged fixtures			
	Repair caulking			
HVAC system (1)	Clean vents			
	Refer to manufacturer's manual for additional PM requirements			
Storage areas	Inventory stored material			
	Dispose of unused material			
Floor	Evidence of wear in carpet/tile			
Fire suppression system	Refer to manufacturer's manual for additional PM requirements			
	Fire extinguishers (inspection and certification)			
Security system	Perform system test with monitoring company			

Exhibit 4.39. (Continued).

Area	Item	√	Remarks	Action Taken or Work Order #
(1) HVAC systems are often maintained through a contract and should be maintained per the manufacturer guidelines. Some basic maintenance steps for small systems include:				
HVAC – outdoor units	Inspect unit for proper refrigerant			
	Clean dirt, leaves, and debris from inside cabinet			
	Remove any obstructions from base-pan drain opening			
	Inspect, clean coil and cabinet			
	Inspect fan motor and blades for wear/damage; lube older models			
	Inspect control box, controls, wiring, and connections			
	Inspect compressor and associated tubing for damage			
HVAC – indoor units	Inspect, clean blower assembly			
	Older models – lube motor; inspect/ replace fan belt			
	Check combustion blower housing for lint/debris			
	Inspect evaporator coil, drain pan, condensate lines			
	Inspect for gas leaks			
	Inspect burner assembly; clean/ adjust if needed			
	Inspect ignition assembly; clean/ adjust if needed			
	Inspect heat exchanger or heating elements			
	Inspect flue system; check for proper attachment			
	Inspect control box, controls, wiring, and connections			
	Clean or replace filters			
	Monitor system start			
	Listen for abnormal noises during operation			

Additional comments/remarks:

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TURF AND SAFETY AREAS

(See checklists in Exhibit 4.40 through 4.42)

Components

1. Runway safety area (RSA). A surface surrounding the runway that is suitable for reducing the risk of damage to airplanes in the event of an undershoot, overshoot, or excursion from the runway. The size of the safety area varies depending on the classification of the runway and the type of approach available to it. The area must be cleared and graded, capable of supporting the weight of an aircraft, and free of objects except for those required to be in the area because of their function.
2. Runway/taxiway object free areas (OFAs). A surface surrounding the runway that is centered on the runway centerline. The area is intended to enhance safety by providing an area free of objects except for those that must be located within the area due to their function. The OFA is larger than the runway safety area in most cases, and its exact size is dependent on the classification of the runway.
3. Runway protection zone (RPZ). A trapezoidal-shaped area centered on the runway and beginning 200 feet beyond the runway's end. The size of the RPZ depends on the type of approach available to the runway. The purpose of the RPZ is to enhance the protection of people and property on the ground.
4. Other turf areas. Many airports choose to maintain the areas outside of the safety areas as turf areas for various reasons, such as to enhance security or to limit the attraction of wildlife.
5. Irrigation systems. Irrigation systems are normally only found in those areas of an airport that are landscaped in such a manner as to provide an attractive appearance, such as along access roads or in the vicinity of the terminal building.
6. Some airports have turf runways or taxiways. These surfaces have different maintenance requirements than other turf areas at an airport.

Tips for Construction

1. Like Part 77 imaginary surfaces, safety areas automatically come into existence anytime a runway is constructed. Safety areas must be constructed (graded) to meet FAA specifications. To prevent erosion, the growth of vegetation in safety areas is encouraged. The seed mixture for safety areas should be designed to match the environmental conditions for the area in which the airport is located.
2. Irrigation systems should be matched to the area to be irrigated. Sprinkler heads should effectively cover the area without spraying on streets, sidewalks, and so forth to avoid wasting water.
3. All irrigation systems should have back-flow prevention devices installed to prevent the contamination of water in the main supply lines. Back-flow prevention devices may only be tested or repaired by personnel licensed to do so.
4. Drains should be installed in irrigation piping to allow the system to be completely drained at the end of the irrigation season.

Problem Areas

1. The length of the grass or other vegetation in turf or safety areas must be carefully managed. It must be tall enough to discourage birds from using the area as a resting site, but short enough so as not to provide a nesting area for small animals, which could attract larger predators.
2. Some airports, in an attempt to increase income for the airport, have leased excess land to farmers for the raising of crops. Extreme care must be taken to ensure that the crops do not attract wildlife to the vicinity of the airport. Avoid crops in safety areas. Also, improper control of crops or vegetation can affect the use of airport infrastructure, such as by blocking the approach lighting equipment.

Exhibit 4.40. Turf and safety area monthly inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Turf and Safety Area Monthly Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Check height of vegetation			
Free of obstructions			
Remove debris in area			
Wildlife attractants present			
Evidence of animals nesting			
Erosion			
Drainage structures clear			

Additional comments/remarks:

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_____
_____
_____
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Exhibit 4.41. Irrigation system start-up/shutdown inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Irrigation System Start-Up/Shutdown Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Season Start-Up			
Turn on main water supply			
Inspect controller and set time and date			
Check all wire connections			
Replace controller back-up battery			
Replace filters or clean screens			
Verify operation of each zone			
Clear growth from around each head			
Repair broken/clogged heads			
Heads spraying in proper direction			
Check for leaks			
Shutdown/Winterization			
Turn off main water supply			
Turn off controller			
Drain irrigation pipes			

Additional comments/remarks:

_____

_____

_____

_____

_____

Exhibit 4.42. Irrigation system monthly inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Irrigation System Monthly Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Controller programmed for appropriate season			
Verify operation of each zone			
Clear growth from around each head			
Repair broken/clogged heads			
Heads spraying in proper direction			
Heads buried or standing up too high			
Blocked spray pattern			
Spraying streets or sidewalks			
Water spraying in fine mist (too much pressure)			
Check for leaks			

Additional comments/remarks:

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VEHICLES

(See checklist in Exhibit 4.43)

Components

1. Automobiles. May be used for the transportation of airport employees or may be the airport courtesy car that is lent out to visiting pilots for short periods of time.
2. Pickup trucks. Probably the most commonly found vehicle at a general aviation airport. They are used for a variety of duties because of their versatility.
3. Dump trucks. Commonly used in snow removal operations and for the hauling of heavy materials.
4. All-terrain vehicles. Usually found with a small hauling bed on the rear of the vehicle. Economic and versatile and used mainly for light maintenance work.

Tips for Purchase

1. Some airports elect to purchase used vehicles through auctions or through government surplus activities. Care must be taken to ensure that the vehicle has been properly maintained and is not at or near the end of its useful life. Courtesy cars are frequently purchased in this manner.
2. Check with the city, county, or state that owns the airport to determine if it has any negotiated purchase agreements for new vehicles.
3. When purchasing large trucks, ensure that the purchase agreement includes training personnel in their operation.

Problem Areas

1. Vehicle operators must be instructed to inspect the vehicle each day prior to its operation. This task is frequently ignored due to the operator's familiarity with the vehicle.
2. Vehicles that are used by several different operators may go past their required maintenance intervals if no one is assigned responsibility for the vehicle.
3. Larger, specialized vehicles (e.g., dump trucks) may sit for long periods of time without use. Driving the vehicle on a regular basis will help to prolong the life of the vehicle and maintain hoses, seals, batteries, and so forth.

Exhibit 4.43. Vehicle daily/monthly inspection checklist.

ANYTOWN MUNICIPAL AIRPORT
Vehicle Daily/Monthly Inspection

DATE: _____ √ Satisfactory
INSPECTOR: _____ X Unsatisfactory

Item	√	Remarks	Action Taken or Work Order #
Daily Inspection			
Visible damage			
Evidence of leaks			
Tire condition and pressure			
Lights, lenses, and reflectors			
Brake check			
Warning lights and gauges			
Turn signals and horn			
Windows and mirrors			
Windshield wipers/washers			
Monthly Inspection			
Oil level			
Coolant level			
Transmission fluid level			
Windshield-wiper fluid level			
Filters			
Belts and hoses			
Battery and connections			
Lug nuts			

Periodic inspections/maintenance (oil changes, etc.) will be specific to the type and manufacturer of the vehicle. Refer to the owner's and maintenance manuals for instructions.

Additional comments/remarks:

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_____

_____

_____

_____

CHAPTER 5

Summary

5.1 Key Points

The purpose of this guidebook is to help airport management, airport staff, and others responsible for the operation and maintenance of airports gain an understanding of what a good preventive maintenance program includes and how to develop and execute the program.

Although airports have considerable value to communities, they are expensive to build. A new basic general aviation airport typically costs several million dollars. Replacing failed infrastructure is also costly. Infrastructure at airports includes airfield pavement, runway/taxiway edge lighting, airfield signs, visual and navigational aids, airfield markings, hangars, terminal and administrative buildings, maintenance and storage buildings, fueling facilities, deicing facilities, airport-owned utilities, turf and safety areas, fencing and gates, drainage systems, maintenance equipment, airport vehicles, and landside infrastructure such as automobile parking, access control, roads, and lighting.

Preventive maintenance can be defined as those actions performed to detect, preclude, or mitigate the degradation of an infrastructure system or its components. These actions involve routine scheduled activities intended to keep a system performing at its best, with goals of preventing its breakdown and extending its useful life. Preventive maintenance has several advantages over those of a reactive program. By performing preventive maintenance on a facility as envisioned when it was designed, the full design life of the facility may be realized, thereby saving money.

Preventive maintenance (e.g., lubrication, filter changes, sealing pavement joints) will generally help equipment run more efficiently and will ensure that infrastructure functions more safely and efficiently. This results in reduced costs, improved airport safety, reduced energy consumption, improved longevity of facilities, and compliance with legal/regulatory requirements, and helps the airport owner better market the airport and the community.

Suggested steps for developing or improving an airport preventive maintenance program are:

1. Understand and embrace important guiding principles.
2. Establish a baseline of information about the airport's infrastructure and condition.
3. Identify the preventive maintenance needed for each infrastructure system.
4. Prioritize maintenance based on airfield safety, economics, operations, contractual requirements, and extension of the life of each facility.
5. Obtain resources (policy-maker and management team buy-in, funding, staffing, equipment/tools, and outside contracts). Ensure that staff are properly trained.
6. Implement the program, using appropriate checklists, work orders, recordkeeping, and the necessary equipment/tools.
7. Keep program up-to-date.

This guidebook includes detailed checklists for the preventive maintenance of airport infrastructure systems. These are available on the accompanying CD-ROM and may be modified for individual airports. Also on the CD-ROM is a PowerPoint presentation that covers the key points of both the primer and guidebook.

5.2 Where to Go for Help

Preventive maintenance is not simply a program or responsibility placed on the shoulders of the airport manager to handle alone. Other entities help with direction, resources, and knowledge. Preventive maintenance is the joint responsibility of the airport owner (e.g., city/county), policy-making board, airport manager, and airport maintenance staff. Other city/county agencies can provide resources and expertise. Many state aviation agencies help with both expertise and grants. Although eligibility is limited, FAA grants can help with some maintenance and rehabilitation of infrastructure. Also, vendors, manufacturers, and airport consultants are good sources of information.

The companion primer can help airport policy makers and new airport managers understand the importance of preventive maintenance. It provides basic information about airport systems and preventive maintenance programs.

Other sources of information about preventive maintenance programs, inspection practices, and safety are other airports that have good preventive maintenance programs, insurance companies, local hospitals, schools, and large companies. These entities often have expertise in maintenance practices and can help an airport set up or improve its preventive maintenance program. Manufacturers of airport facilities or components (e.g., vehicles, HVAC systems, electrical equipment, approach aids) are excellent sources of information for airports. Airports that do not already have manuals for their equipment should contact the manufacturer to obtain them.

Appendices B, C, and D provide a list of information sources, sample job descriptions for maintenance personnel, and additional information regarding several pavement treatments.

APPENDIX A

Airports/States Providing Assistance

The following airports provided information and staff interviews that helped in the production of this document:

Ada Municipal – Ada, OK
Bismarck Municipal – Bismarck, ND
Bowman Field – Louisville, KY
Columbus Municipal – Columbus, IN
Dawson Community – Glendive, MT
DeKalb-Peachtree – Atlanta, GA
Dillant-Hopkins – Keene, NH
Double Eagle II – Albuquerque, NM
Greely-Weld County – Greeley, CO
Lincoln – Lincoln, NE
Meacham International – Fort Worth, TX
Monroe Municipal – Monroe, WI
Morristown Municipal – Morristown, NJ
North Las Vegas – Las Vegas, NV
Olympia Regional – Olympia, WA
Rio Vista Municipal – Rio Vista, CA
Southern Illinois – Carbondale, IL
Sumter – Sumter, SC
Venice Municipal – Venice, FL

State aviation agencies from the following states provided information and interviews that helped in the production of this document:

Arizona
California
Colorado
Florida
Iowa
Maine
Michigan
Mississippi
New York
North Dakota
South Carolina
Texas
Virginia
Washington

APPENDIX B

Bibliography

This appendix identifies valuable sources of information about the maintenance of specific airport systems and airport maintenance programs. The bibliography includes all publications cited in the report.

FAA Documents

FAA Advisory Circular 150/5200-18C, Airport Self-Inspection Practices, issued April 23, 2004.
FAA Advisory Circular 150/5210-24, Airport Foreign Object Debris (FOD) Management, issued September 30, 2010.
FAA Advisory Circular 150/5220-10E, Guide Specification for Aircraft Rescue and Fire Fighting (ARFF) Vehicles, issued June 1, 2011.
FAA Advisory Circular 150/5220-20A, Airport Snow and Ice Control Equipment, issued September 24, 2014.
FAA Advisory Circular 150/5220-21C, Aircraft Boarding Equipment, issued June 29, 2012.
FAA Advisory Circular 150/5300-13A, Airport Design, issued February 26, 2014.
FAA Advisory Circular 150/5320-5D, Airport Drainage Design, issued August 15, 2013.
FAA Advisory Circular 150/5320-12C, Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces, issued March 1997, updated February 7, 2007.
FAA Advisory Circular 150/5320-17A, Airfield Pavement Surface Evaluation and Rating Manuals, issued September 10, 2014.
FAA Advisory Circular 150/5340-5D, Segmented Circle Airport Marker System, issued September 25, 2013.
FAA Advisory Circular 150/5340-26C, Maintenance of Airport Visual Aid Facilities, issued June 20, 2014.
FAA Advisory Circular 150/5340-30H, Design and Installation Details for Airport Visual Aid, issued July 21, 2014.
FAA Advisory Circular 150/5345-12F, Specification for Airport and Heliport Beacons, issued September 24, 2010.
FAA Advisory Circular 150/5345-27E, FAA Specification for Wind Cone Assemblies, issued September 26, 2013.
FAA Advisory Circular 150/5345-28G, Precision Approach Path Indicator (PAPI) Systems, issued September 29, 2011.
FAA Advisory Circular 150/5345-42G, Specifications for Airport Light Bases, Transformer Housings, Junction Boxes and Accessories, issued January 23, 2013.
FAA Advisory Circular 150/5345-43G, Specification for Obstruction Lighting Equipment, issued September 26, 2012.
FAA Advisory Circular 150/5345-44J, Specification for Runway and Taxiway Signs, issued September 29, 2010.

FAA Advisory Circular 150/5345-46D, Specification for Runway and Taxiway Light Fixtures, issued May 19, 2009.

FAA Advisory Circular 150/5345-51B, Specification for Discharge-Type Flashing Light Equipment, issued September 8, 2010.

FAA Advisory Circular 150/5345-52A, Generic Visual Glideslope Indicators (GVGI), issued September 5, 2007.

FAA Advisory Circular 150/5345-56B, Specification for L-890 Airport Lighting Control and Monitoring System (ALCMS), issued September 29, 2011.

FAA Advisory Circular 150/5360-12F, Airport Signing and Graphics, issued September 26, 2013.

FAA Advisory Circular 150/5370-2F, Operational Safety on Airport During Construction, issued September 29, 2011.

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APPENDIX C

Sample Airport Documents

Not all job position descriptions included herein are required at all airports. These are offered only as examples. Some airports combine many duties.

SAMPLE JOB DESCRIPTION
ANYTOWN MUNICIPAL AIRPORT

POSITION: AIRPORT MAINTENANCE SUPERVISOR

POSITION SUMMARY:

Under the direct supervision of the Assistant Airport Manager, conducts general and specific maintenance activities on all airport grounds, improvements, buildings, and systems; supervises other personnel engaged in maintenance activities; and performs administrative functions relevant to required duties.

DUTIES:

1. Carries out repairs of airport facilities, including grounds, buildings, airfield systems, and equipment.
2. Operates light and heavy equipment, including dump trucks, loaders, and other equipment, while carrying out the normal functions of the position.
3. Maintains airport equipment and carries out repairs and preventive maintenance inspections and service.
4. Operates snow removal equipment during snow events.
5. Recommends or requests the purchase of parts, supplies, and equipment necessary to carry out the normal functions of the position.
6. Remains on call during non-duty hours and responds to emergency maintenance situations when requested.
7. Directly supervises the activities of other personnel engaged in maintenance functions, including establishing work priorities and job assignments.
8. Responsible for tracking maintenance expenditures and controlling maintenance parts and equipment inventory.

APPOINTMENT:

The Airport Maintenance Supervisor is appointed by the Airport Manager or Assistant Airport Manager. The position reports directly to the Assistant Airport Manager.

SUPERVISION:

The person in this position works under the general supervision of the Assistant Airport Manager but routinely works unsupervised while performing most tasks. He/she is responsible for meeting the requirements of the job while operating within specific policy and procedural guidelines. He/she may routinely work without direct supervision and is held responsible for all associated activities, including all maintenance requirements of all airport facilities.

MINIMUM QUALIFICATIONS:

Competent in operating and repairing heavy equipment, including dump trucks, loaders, and snowplows. General understanding of electrical and plumbing fixtures and their repair or replacement. Ability to troubleshoot a variety of problems and render repairs using good judgment and fiscal responsibility. Must possess a valid commercial driver's license (CDL) with an acceptable driving record. Must be availability to work weekends and holidays and be on call for snow or emergency events.

EDUCATION:

High school graduate or equivalent.

EXPERIENCE:

Two years of experience in general maintenance activities and the operation of heavy equipment, with at least one year in a supervisory capacity.

SAMPLE JOB DESCRIPTION
ANYTOWN MUNICIPAL AIRPORT

POSITION: MAINTENANCE TECHNICIAN I

POSITION SUMMARY:

Under the direct supervision of the Maintenance Supervisor, or in his/her absence, the Maintenance Technician II, assists with or conducts general and specific airport maintenance activities on all airport grounds, improvements, buildings, and systems, and carries out custodial and general maintenance activities.

DUTIES:

1. Assists with or carries out repairs of airport facilities, including grounds, buildings, airfield systems, and equipment.
2. Operates light and heavy equipment, including dump trucks, loaders, and mowers, to carry out the normal functions of the position.
3. Operates snow removal equipment during snow events.
4. Mows aeronautical and non-aeronautical areas of the airport using light and heavy equipment designed for same.
5. Conducts general and preventive maintenance on terminal building systems, including electrical and mechanical.
6. Conducts general and preventive maintenance on hangars and other buildings, including hangar aprons and parking lots.
7. Assists with or conducts pavement maintenance and repairs on runways, taxiways, aprons, parking lots, and other areas.

8. Conducts inspections of airfield lighting systems and performs light maintenance and repairs on same.
9. Inspects and assists with repairs on equipment.
10. Purchases or recommends the purchase of parts, supplies, and equipment necessary to carry out the normal functions of the position.
11. Responsible for the overall janitorial upkeep of the airport terminal building.
12. Responsible for the overall upkeep and maintenance of terminal building landscaping.
13. Assigns and supervises the work of community service workers.
14. May be trained to perform duties as Aircraft Rescue Firefighter.

APPOINTMENT:

The Maintenance Technician I is appointed by the Airport Manager or Airport Assistant Manager, with the assistance of the Airport Maintenance Supervisor. The position reports directly to the Airport Maintenance Supervisor.

SUPERVISION:

The person in this position works under the supervision of the Airport Maintenance Supervisor, or, in his/her absence, the Maintenance Technician II, but frequently may work unsupervised while performing many of the required tasks. He/she is responsible for meeting the requirements of the job while operating within specific policy and procedural guidelines. He/she may routinely work without direct supervision and is held responsible for all associated activities.

MINIMUM QUALIFICATIONS:

Ability to operate or learn to operate light and heavy equipment, including mowers, dump trucks, loaders, and snowplows. Competent in routine methods and janitorial practices for commercial buildings and in maintaining landscaped areas and working with associated equipment. Basic knowledge of troubleshooting a variety of problems and rendering repairs using good judgment and fiscal responsibility. Must possess a valid driver's license with an acceptable driving record. Must be available to work weekends and holidays and be on call for snow removal or emergency events.

EDUCATION:

High school graduate or equivalent.

EXPERIENCE:

Two years' experience in general maintenance activities or general custodial or landscape maintenance and the operation of light and heavy equipment, or an acceptable combination thereof.

SAMPLE JOB DESCRIPTION
ANYTOWN MUNICIPAL AIRPORT

POSITION: AIRPORT MAINTENANCE TECHNICIAN II

POSITION SUMMARY:

Under the direct supervision of the Airport Maintenance Supervisor, conducts general and specific maintenance activities on all airport grounds, improvements, buildings, and systems.

DUTIES:

1. Carries out repairs of airport facilities, including grounds, buildings, airfield systems, and equipment.
2. Operates light and heavy equipment, including dump trucks and loaders, while carrying out the normal functions of the position.
3. Maintains airport equipment and carries out repairs and preventive maintenance inspections and service.
4. Operates snow removal equipment during snow events.
5. Recommends or requests the purchase of parts, supplies, and equipment necessary to carry out the normal functions of the position.
6. Remains on call during non-duty hours and responds to emergency maintenance situations when requested.
7. May be trained to perform duties as Aircraft Rescue Firefighter.

APPOINTMENT:

The Maintenance Technician II is appointed by the Airport Manager or Assistant Airport Manager/Operations Supervisor, with the assistance of the Airport Maintenance Supervisor. The position reports directly to the Airport Maintenance Supervisor.

SUPERVISION:

The person in this position works under the supervision of the Airport Maintenance Supervisor but frequently may work unsupervised while performing many of the required tasks. He/she is responsible for meeting the requirements of the job while operating within specific policy and procedural guidelines. He/she may routinely work without direct supervision and is held responsible for all associated activities.

MINIMUM QUALIFICATIONS:

Competent in operating heavy equipment, including dump trucks, loaders, and snowplows. Basic understanding of electrical and plumbing fixtures and their repair or replacement. Ability to troubleshoot a variety of problems and render repairs using good judgment and fiscal responsibility. Must possess or be able to obtain a valid commercial driver's license (CDL) with an acceptable driving record. Must be available to work weekends and holidays and be on call for snow or emergency events.

EDUCATION:

High school graduate or equivalent.

EXPERIENCE:

Two years' experience in general maintenance activities or general custodial or landscape maintenance and the operation of light and heavy equipment, or an acceptable combination thereof.

APPENDIX D

Pavement Treatments

This appendix provides an introduction to treatments that can be used as preventive maintenance of both asphalt- and concrete-surfaced general aviation pavements. Keep in mind, however, that it is not the treatment itself that determines a preventive maintenance application, but rather the condition of the pavement when the treatment is applied.

At the time of publication of this guidebook, a broader ACRP guidebook (from ACRP Project 09-11) about pavement maintenance was in development. Airport officials may also wish to review that document for information about pavement treatments and preventive maintenance when it is published.

For each treatment included in this appendix, a summary table provides the following information:

- Treatment description;
- Applicable FAA specifications and other guidance (abbreviated as "specs");
- Applications/uses;
- Construction considerations; and
- Miscellaneous considerations such as costs, treatment life and pavement life extension, safety issues, risk considerations, and climate or environmental limitations.

There are many more treatments available than are described in this appendix. Some are not included because they are unlikely to be considered as preventive maintenance at general aviation airports. These include various recycling treatments, slab replacement of concrete pavements, and concrete overlays. Others are not included because they are variations of a treatment that is included (such as a double chip seal or double application of microsurfacing, or a cape seal) or because they are proprietary products. The exclusion of any product is not meant to suggest that it might not be cost-effective as a preventive maintenance treatment at a general aviation airport; the airport staff or the airport's consultant is encouraged to identify appropriate treatments both from among those discussed here and using input from other knowledgeable sources. The types of treatment discussed in this appendix are:

Flexible Pavements
Crack sealing and filling
Chip seal
Fog seal/rejuvenator
Sand seal
Slurry seal
Microsurfacing
Thin overlay

Rigid Pavements
Joint resealing and crack sealing
Diamond grinding
Partial-depth repair
Load transfer restoration

<table>
<tr><th colspan="3">CRACK SEALING/FILLING</th></tr>
<tr><td>Treatment Description</td><td colspan="2">Crack sealing and crack filling consist of the placement of an adhesive material into and/or over cracks at the pavement surface. These treatments are primarily intended to prevent moisture from entering into the pavement structure through existing cracks, thereby reducing further crack deterioration, roughness, and rutting.

Crack filling is for cracks that undergo little movement and is characterized by minimal crack preparation and lower-quality materials. Fillers are often found on longitudinal cracks.

Crack sealing addresses working cracks (i.e., those that open and close with temperature changes). Sealing operations typically require good crack preparation and high-quality materials [i.e., thermosetting or thermoplastic (bituminous) materials that soften upon heating and harden upon cooling].</td></tr>
<tr><td rowspan="2">Spec</td><td>Guidance
AC 150/5380-6B, Guidelines and Procedures for Maintenance of Airport Pavements
ACRP Synthesis 22: Common Airport Pavement Maintenance Practices</td><td>Specifications
ASTM D6690 (sealants)
ASTM D5078 (fillers)
ISSA A175</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td rowspan="2">Applications/Uses</td><td>Conditions Addressed
▪ Longitudinal cracking
▪ Transverse cracking
▪ Reflection cracking
▪ Block cracking (low extent)
▪ Alligator cracking (low severity)</td><td>Conditions Not Addressed: Crack sealing may be applied to structural (i.e., fatigue or reflection) cracks early in their development. While sealing provides no structural benefit, keeping moisture out of the pavement structure may slow down the progression of load-related cracking.</td></tr>
<tr><td></td><td>Limitations: Overband applications may increase pavement roughness. Cracks greater than about 0.75-in. wide are better addressed by a repair rather than a crack seal.</td></tr>
<tr><td>Construction Considerations</td><td colspan="2">▪ Material selection requirements to consider: adhesion, softening resistance, flexibility, pot life, weather resistance, and cure time.
▪ In deciding between hot- and cold-applied crack fillers, consider the size and types of cracks: hot-applied crack fillers are better suited to 0.5-in. wide or larger expanding cracks (large longitudinal, transverse, and reflective cracks), while cold crack fillers work better in smaller cracks that are less than 0.5-in. wide.
▪ Cracks should be clean and dry; prior to sealing, cleaning is essential to a good bond and maximum performance.
▪ A variety of placement configurations are used, based on local experience, materials used, snowplow use, and anticipated subsequent treatments.
▪ Sealants and fillers should be allowed to set before being subjected to traffic.
▪ Sealants and fillers require curing before another treatment is applied to the surface, especially if a HMA overlay is to follow. Emulsions usually require several days to cure; hot-applied crack fillers 3 to 4 months.</td></tr>
<tr><td rowspan="2">Miscellaneous Considerations</td><td>Cost ($ to $$$$):
▪ Crack fill: $ ($0.10–$1.20/ft)
▪ Crack seal: $ ($0.75–$1.50/ft)</td><td>Treatment Life (years):
▪ Crack fill: 2 to 4
▪ Crack seal: 3 to 8

Pavement Life Extension (years):
▪ Crack seal: 2 to 4</td></tr>
<tr><td colspan="2">▪ Safety: Extensive crack sealing may require blotting to maintain the pavement’s skid resistance.
▪ Risk: Improper installation can cause sealant or filler material to fail. Overband applications may be susceptible to snowplow damage. Sealant that fails to bond and is pulled out of the crack will be a source of FOD.
▪ Climate: Placement should be during moderate temperatures when the pavement is dry; while the manufacturer’s guidelines should be followed, a good range of ambient temperatures is 45°F to 65°F.</td></tr>
<tr><td>Other Remarks</td><td colspan="2">▪ Tracking of seal or fill material by tire action may obscure pavement markings. Applying a blotter coat of sand can reduce such tracking. There are also commercial products and means available to reduce surface tackiness.
▪ There is a point at which excessive cracking is better addressed by a blanket solution, such as a surface treatment or milling.
▪ Surface bumps may occur at cracks during warm months when sealant or filler material is compressed and bulges out of the crack.</td></tr>
</table>

<table>
<tr><td colspan="3">CHIP SEAL</td></tr>
<tr><td>Treatment Description</td><td colspan="2">A chip seal is a spray application of asphalt (commonly an emulsion, although heated asphalt cement and cutbacks may be used) directly to the pavement surface (0.35 to 0.50 gal/yd^2), followed by application of aggregate chips (15 to 50 lb/yd^2), which are then immediately rolled to achieve 50% to 70% embedment. The treatment is used to seal the pavement surface against weathering, raveling, or oxidation; slow down moisture infiltration into the pavement structure; correct minor roughness or bleeding; and improve friction. Chip seals can be applied in multiple layers (e.g., double chip seal) and in combination with other treatments, such as microsurfacing, which is called a cape seal and reduces concerns associated with loose chips and a rough surface.</td></tr>
<tr><td>Spec</td><td>Guidance
AC 150/5370-10G, Standards for Specifying Construction of Airports
AC 150/5380-6B, Guidelines and Procedures for Maintenance of Airport Pavements
ACRP Synthesis 22: Common Airport Pavement Maintenance Practices</td><td>Specifications
ISSA A165
FAA Item P-609</td></tr>
<tr><td>Applications/Uses</td><td>Conditions Addressed
Longitudinal cracking
Transverse cracking
Block cracking
Friction loss
Bleeding
Roughness
Moisture infiltration</td><td>Conditions Not Addressed: Adds no structural benefit. Because of its flexibility, a chip seal is more effective at sealing low- to medium-severity fatigue cracks in comparison with other treatments.

Limitations: Should not be used where loose chips or FOD are a concern. Steps can be taken to reduce loose chips.</td></tr>
<tr><td>Construction Considerations</td><td colspan="2">Application rates depend on aggregate gradation and maximum size, as well as absorption of existing pavement surface.
Pavement surface must be dry and swept clean of dirt, sand, gravel, and other surface contaminants.
Chip spreader should follow immediately behind asphalt distributor, and rollers close behind spreader.
Traffic may be kept off surface until after curing (typically 2 hours, but depends on ambient conditions).
Avoid prematurely applying pavement markings.
Brooming is often required to remove loose chips; however, brooming before the emulsion has set hard may strip away properly seated aggregate.</td></tr>
<tr><td rowspan="2">Miscellaneous Considerations</td><td>Cost ($ to $$$$):
$$ ($1.50–$2.00/yd^2 single course conventional)
$$$ ($2.00–$4.00/yd^2 single course polymer-modified)</td><td>Treatment Life (years):
Single course: 3 to 7
Double course: 5 to 10
Pavement Life Extension (years):
Single course: 5 to 6
Double course: 8 to 10</td></tr>
<tr><td colspan="2">Safety: Loose aggregates on the pavement surface may increase stopping distance and are a potential source of FOD.
Risk: Primary risk is due to damage from loose aggregate. Steps should be taken to remove loose aggregate before putting traffic back on pavement.
Climate: Performs well in all climatic environments. Placement should occur when temperature in the shade is above 55°F and rising. Avoid placement during cold or wet weather conditions.</td></tr>
<tr><td>Other Remarks</td><td colspan="2">Enhanced performance is obtained from use of a rapid-set emulsion or polymer- or rubber-modified binder in the mix design, application of a smaller-sized “choke” aggregate to lock in larger chips, limiting excess chips to 5% to 10%, or applying a cape seal (slurry or microsurfacing seal) over the chip seal.</td></tr>
<tr><td colspan="3">FOG SEAL/REJUVENATOR SEAL</td></tr>
<tr><td>Treatment Description</td><td colspan="2">Fog Seal—A very light application of a diluted asphalt emulsion to the pavement surface with no aggregate. The application seals the surface, although very lightly.

Rejuvenator Seal—A specialized emulsion that is sprayed on an existing asphalt surface with the intent of softening the existing binder, enriching the weathered pavement, and thereby inhibiting raveling. The specialized emulsion is typically a mixture of asphalt, polymer latex, and other additives. While it is most commonly used in a fog-seal–type application, it can also be used in a sand seal or scrub seal.</td></tr>
<tr><td>Spec</td><td>Guidance
AC 150/5380-6B, Guidelines and Procedures for Maintenance of Airport Pavements
ACRP Synthesis 22: Common Airport Pavement Maintenance Practices</td><td>Specifications
FAA P-608 (fog seals)
FAA P-632 (rejuvenators)</td></tr>
</table>

<table>
<tr><td rowspan="2">Applications/Uses</td><td>Conditions Addressed
▪ Seal/Waterproof Pavement— Prevent or slow the infiltration of moisture into the pavement surface
▪ Rejuvenate Surface/Inhibit Oxidation—Enrich the hardened/oxidized existing surface and inhibit raveling</td><td>Conditions Not Addressed:
This spray-applied treatment does not address cracking; pavements with extensive cracking should be treated in another manner. Similarly, pavements with signs of structural deterioration are best treated in some other manner.</td></tr>
<tr><td colspan="2">Limitations:
The skid number of treated pavements will decrease immediately after application unless steps are taken to apply a skid-resistant surface or other techniques (such as shot blasting and rejuvenators combined) are used. The impact of the loss of skid-resistance on safe operations and the duration of the reduction in friction should be considered prior to the application of either a fog or rejuvenator seal.</td></tr>
<tr><td>Construction Considerations</td><td colspan="2">▪ Varying application rates may be appropriate based on the openness of the surface. Very tight surfaces will require less spray application than very porous surfaces.
▪ Friction immediately following construction may be improved by broadcasting sand, cinders, or other fine-grained mineral products.</td></tr>
<tr><td rowspan="2">Miscellaneous Considerations</td><td>Cost ($ to $$$$): $ ($0.25–$0.50/yd^2)</td><td>Treatment Life (years):
▪ 1 to 2

Pavement Life Extension (years):
▪ 1 to 2</td></tr>
<tr><td colspan="2">▪ Safety: Primary risk factors are associated with the short-term loss of friction immediately following construction.
▪ Risk: The P-632 specification recommends that rejuvenators not be used on airfield pavements.
▪ Climate: These treatments should be applied when ambient temperatures are conducive to the application of sprayed bitumen.</td></tr>
<tr><td>Other Remarks</td><td colspan="2">▪ Neither of these treatments will provide much performance benefit once the pavement exhibits significant cracking or exhibits high-severity weathering.
▪ Note that the repeated application of these treatments does not continue to add life to the pavement.</td></tr>
<tr><td colspan="3">SAND SEAL/SCRUB SEAL</td></tr>
<tr><td>Treatment Description</td><td colspan="2">Sand Seal—A spray application of a rapid-set emulsion with a light covering of sand or screenings that is rolled following application. A sand seal serves a similar function as does a fog seal but provides better surface friction. A sand seal is typically between 0.125 and 0.25 in. thick.

Scrub Seal—Similar to a sand seal but includes the use of brooms to push the emulsion into the surface cracks of the pavement and the fine aggregate into the binder. The seal is also rolled following application. The binder is often polymer modified. The thickness of a scrub seal is typically 0.125 to 0.25 in., but multiple layers are sometimes applied, resulting in thicknesses of between 0.375 and 1.5 in.</td></tr>
<tr><td>Spec</td><td>Guidance
No formal guidance is available from FAA or ACRP documents.</td><td>Specifications
Covered in part by P-608, Emulsified Asphalt Seal Coat</td></tr>
<tr><td rowspan="2">Applications/Uses</td><td rowspan="2">Conditions Addressed
▪ Moisture infiltration through fine surface cracking
▪ Oxidation or aging of the surface, including raveling
▪ Loss of skid resistance through softening</td><td>Conditions Not Addressed:
▪ Cracking greater than hairline width
▪ Extensive cracking</td></tr>
<tr><td>Limitations:
Sand seals and scrub seals will not address high-severity raveling, provide much relief from significant raveling, nor seal extensive surface cracking.</td></tr>
<tr><td>Construction Consideration</td><td colspan="2">▪ Many agencies that apply scrub seals construct their own brooming apparatus.
▪ The fine-grained aggregates that are applied as part of these treatments should be placed immediately after the application of the binder.</td></tr>
</table>

Miscellaneous Considerations	**Cost ($ to $$$$):** ▪ Sand Seal: $$ ($0.65–$0.85/yd^2) ▪ Scrub Seal $$ ($0.80–$1.10/yd^2)	**Treatment Life (years):** ▪ Sand seal: 2 to 3 ▪ Scrub seal: 3 to 4 **Pavement Life Extension (years):** ▪ Sand seal: 1 to 2 ▪ Scrub seal: 2 to 3
	▪ **Safety:** Sand seal may result in loose aggregates on the pavement surface, which may increase stopping distance. ▪ **Climate:** Placement should occur when temperature in the shade is above 55°F and rising. Avoid placement during cold or wet weather conditions.	
Other Remarks	▪ These seals are similar to fog seals and rejuvenators, with the addition of fine-grained aggregate to provide additional skid resistance. ▪ Scrub seals are able to seal hairline cracks better than sand seals.	
SLURRY SEAL		
Treatment Description	A mixture of emulsified asphalt, well-graded aggregate, additives, and water. The mixture is spread over the pavement surface with a spreader box attached to the back of specially equipped mixing trucks. Thickness ranges from approximately 0.25 to 0.375 in., and the material is applied to the pavement surface at a rate between 8 and 16 lb/yd^2.	
Spec	**Guidance** ISSA Publication A-105 AC 150/5380-6B, Guidelines and Procedures for Maintenance of Airport Pavements *ACRP Synthesis 22: Common Airport Pavement Maintenance Practices*	**Specifications** AC 150/5370-10G, Item P-626, Emulsified Asphalt Slurry Seal Surface Treatment
Applications/Uses	**Conditions Addressed** ▪ Longitudinal cracking ▪ Block cracking ▪ Friction loss ▪ Weathering and raveling ▪ Bleeding ▪ Roughness ▪ Moisture infiltration	**Conditions Not Addressed:** Provides no structural benefit. Generally not flexible, so if the pavement has extensive cracking, and especially working cracks, these will all reflect through to the surface. **Limitations:** The FAA suggests that the treatment is limited to airports serving airplanes weighing 12,500 lbs or less, although with FAA approval the engineer may specify this treatment for airports serving airplanes of up to 60,000 lbs. Traffic must be kept off the sealed surface for 4 to 24 hours, depending on ambient conditions.
Construction Considerations	▪ Application rates depend on aggregate gradation and maximum size as well as absorption of existing pavement surface. ▪ Pavement surface must be dry and swept clean of dirt, sand, gravel, and other surface contaminants. ▪ The slurry seal should not be applied if the pavement or air temperature is below 50°F. ▪ Traffic should be kept off the surface for 4 to 24 hours to allow the seal to fully dry. ▪ Avoid prematurely applying pavement markings. ▪ Cracks greater than 0.25-in. wide should be treated prior to construction.	
Miscellaneous Considerations	**Cost ($ to $$$$):** $$ ($0.75–$1.00/yd^2 single course)	**Treatment Life (years):** ▪ 3 to 5 **Pavement Life Extension (years):** ▪ 2 to 5
	▪ **Safety:** Primary safety concern is the loss of bond and the generation of FOD. Loss of friction has also been noted. ▪ **Risk:** Early damage can occur if trafficked before the treatment is set. Treatment may not be durable if placed during inclement weather. ▪ **Climate:** The slurry seal must be applied when the temperature of the air and pavement is above 50°F or above 45°F and rising.	
Other Remarks	▪ Similar to microsurfacing, slurry seals can be modified (e.g., aggregate quality, gradation, polymer) to enhance performance.	
MICROSURFACING		
Treatment Description	A mixture of crushed, well-graded aggregate, mineral filler (Portland cement), and polymer-modified emulsified asphalt spread over the full width of pavement with an augered spreader box attached to a specialty mixing and distribution truck. Microsurfacing is used primarily to inhibit raveling and oxidation. It is also effective at improving surface friction and filling minor irregularities and rutting up to 1.5-in. deep.	

<table>
<tr><td>Spec</td><td>Guidance
AC 150/5380-6B, Guidelines and Procedures for Maintenance of Airport Pavements
ACRP Synthesis 22: Common Airport Pavement Maintenance Practices</td><td colspan="2">Specifications
ISSA A143
FAA P-635</td></tr>
<tr><td rowspan="2">Applications/Uses</td><td rowspan="2">Conditions Addressed
Longitudinal cracking
Transverse cracking
Block cracking
Raveling/weathering
Oxidation
Friction loss
Moisture infiltration
Bleeding
Roughness
Rutting</td><td colspan="2">Conditions Not Addressed: Microsurfacing does not add structural capacity.</td></tr>
<tr><td colspan="2">Limitations: Pavements undergoing high deflections or HMA pavements susceptible to stripping are not good candidates for microsurfacing. Pavements with extensive cracking may not be good candidates for microsurfacing.</td></tr>
<tr><td>Construction Considerations</td><td colspan="3">Most pavement markings need to be removed prior to microsurfacing.
Cracks greater than 0.25-in. wide should be sealed prior to treatment placement.
It is strongly recommended to perform needed patching and crack sealing prior to placement.
Pavement surface must be dry and swept clean of dirt, sand, gravel, and other surface contaminants.
Vegetation should be removed.
Aggregates should be clean, angular/cubical, durable, and uniform, as well as chemically compatible with emulsion systems.
Industry guidelines and recommendations regarding application temperatures and dry conditions should be followed.
Microsurfacing treatments can be applied during nighttime closures (if other temperature requirements are met) because they undergo a chemical set.
Microsurfacing typically can carry traffic after approximately 1 hour.
Allow a minimum of 7 days before applying permanent pavement markings.</td></tr>
<tr><td rowspan="2">Miscellaneous Considerations</td><td colspan="2">Cost ($ to $$$$): $$ (1.50–3.50 $/yd^2 single course)</td><td>Treatment Life (years):
Single course: 3 to 6
Multiple course: 4 to 7
Pavement Life Extension (years):
Single course: 2 to 5
Multiple course: 2 to 6</td></tr>
<tr><td colspan="3">Safety: Primary safety concern is the loss of bond and the generation of FOD. Loss of friction has also been noted.
Risk: Early damage can occur if trafficked before the treatment is set. Treatment may not be durable if placed during inclement weather.
Climate: Placement should occur when temperature is 50°F and rising, and the forecast for the next 24 hours is above 40°F. Placement should avoid rain and hot or freezing temperatures.</td></tr>
<tr><td>Other Remarks</td><td colspan="3">May be applied in either single or double applications.
Finished thickness is between 0.25 and 0.75 in., depending on the top size of the stone and whether the application is single or double.</td></tr>
<tr><td colspan="4">THIN HOT-MIX ASPHALT OVERLAYS</td></tr>
<tr><td>Treatment Description</td><td colspan="3">Thin HMA overlays are composed of asphalt binder and aggregate combined in a central mixing plant and placed with a paving machine in thicknesses of between 0.75 and 1.50 in. Conventional thin HMA overlays can be distinguished by their aggregate gradation:
Dense-graded—a well-graded, relatively impermeable mix, intended for general use.
Open-graded—an open-graded, permeable mix designed using only crushed aggregate and a small percentage of manufactured sand; typically smoother than dense-graded HMA.
Stone matrix asphalt (SMA)—a gap-graded mix designed to maximize rut resistance and durability using stone-on-stone contact.
Additionally, it is recommended to mill the existing pavement surface when surface distresses (e.g., segregation, raveling, or block cracking) are evident; other benefits include improving surface friction, maintaining clearance of overhead structures, and providing an improved bonding surface.</td></tr>
</table>

<table>
<tr><td>Spec</td><td>Guidance
AC 150/5380-6B, Guidelines and Procedures for Maintenance of Airport Pavements
ACRP Synthesis 22: Common Airport Pavement Maintenance Practices</td><td>Specifications
FAA Item P-401</td></tr>
<tr><td rowspan="2">Applications/Uses</td><td rowspan="2">Conditions Addressed
▪ Longitudinal cracking
▪ Transverse cracking
▪ Raveling/weathering
▪ Block cracking
▪ Friction loss
▪ Bleeding
▪ Roughness</td><td>Conditions Not Addressed: While thin HMA overlays should not be used to address structural deficiencies, greater structural benefit in terms of load-carrying capability is possible the thicker the overlay. Rutting can be addressed with a separate rut-fill application before overlay placement.</td></tr>
<tr><td>Limitations: Cold milling provides a smoother riding surface by removing vertical deformations. Ruts should not be filled with a thin overlay.</td></tr>
<tr><td>Construction Considerations</td><td colspan="2">▪ The maximum size of aggregate should not be more than one-half the overlay thickness (note that Superpave mix designs have their own requirements).
▪ If milling is not done in conjunction with overlay application, special consideration should be given to bump grinding prior to treatment placement.
▪ Pavement surface must be dry and swept clean of dirt, sand, gravel, and other surface contaminants; a tack coat applied prior to overlay application is essential to ensure bond to the existing surface.
▪ Because thin HMA overlays dissipate heat rapidly, it is important to specify minimum placement temperatures and to obtain timely compaction.
▪ Treatment can be opened to traffic after approximately 1 to 2 hours.

Recommendations for obtaining a quality milled surface:
▪ Perform pavement patching prior to milling.
▪ Remove pavement castings and cover holes prior to milling.
▪ Use a good working milling machine (12-ft recommended width).
▪ Control milling speed to achieve a smooth, uniform surface (≤30 ft/min).
▪ Use a 30-ft ski and string-line to control grade and longitudinal guidance.</td></tr>
<tr><td rowspan="2">Miscellaneous Considerations</td><td>Cost ($ to $$$$):
▪ $$$ ($2.00–$6.00/yd^2 with no milling)
▪ $$$ ($5.00–$10.00/yd^2 with milling)</td><td>Treatment Life (years):
4 to 12 (with no milling)
5 to 12 (with milling)

Pavement Life Extension (years):
3 to 7</td></tr>
<tr><td colspan="2">▪ Safety: Ensuring that the overlay is well bonded to the existing pavement eliminates the primary safety concerns.
▪ Risk: Though not significantly affected by loading volumes or weights, certain combinations of loadings, environmental conditions, and pavement structure can initiate top-down cracking. Performance will vary according to factors affecting pavement weathering/raveling. Furthermore, treatment can be subject to delamination and reflective cracking. A tack coat prior to overlay placement will help improve bond. Thin overlays cool rapidly, so achieving density within the time available for compaction is especially critical.
▪ Climate: Performs well in all environments.</td></tr>
<tr><td>Other Remarks</td><td colspan="2">▪ Properly constructed thin overlays provide a durable wearing surface. As with other thin treatments, however, the overall pavement performance is likely to be controlled by any underlying structural deficiencies, if present.</td></tr>
<tr><td colspan="3">PCC JOINT RESEALING/CRACK SEALING</td></tr>
<tr><td>Treatment Description</td><td colspan="2">Joint resealing and crack sealing PCC pavements prevent moisture and incompressible materials from infiltrating concrete pavement structures. They help to slow or minimize the development of moisture-related distresses (such as pumping or faulting) and to prevent the occurrence of spalling, blowups, and other pressure-related distresses that might be caused by incompressible materials collecting in the joints. Joint resealing consists of removing and replacing existing deteriorated joint sealant, whereas crack sealing consists of applying adhesive material into or over surface cracks. Effective sealing operations typically require thorough joint or crack preparation and the use of high-quality sealant materials.</td></tr>
<tr><td>Spec</td><td>Guidance
AC 150/5380-6B, Guidelines and Procedures for Maintenance of Airport Pavements
ACRP Synthesis 22: Common Airport Pavement Maintenance Practices</td><td>Specifications
ASTM D6690 (hot-applied sealants)
ASTM D5893 (silicone sealants)
ASTM D3406 (elastomeric sealants)</td></tr>
</table>

<table>
<tr><td rowspan="2">Applications/Uses</td><td>Conditions Addressed
▪ Longitudinal cracking*
▪ Transverse cracking*

*Crack sealing is most effective when cracks do not exhibit faulting or spalling.</td><td>Conditions Not Addressed: Crack sealing may be applied to structural cracks early in their development. While sealing provides no structural benefit, keeping moisture and incompressible materials out of the pavement structure may retard the rate of deterioration.</td></tr>
<tr><td colspan="2">Limitations: Joints or cracks experiencing vertical movement rather than horizontal movement may not remain sealed.</td></tr>
<tr><td>Construction Considerations</td><td colspan="2">▪ Critical material characteristics to consider when selecting a sealant include adhesiveness, cohesiveness, durability, extensibility, resilience, curing time, and shelf/pot life.
▪ Effective cleaning of the joint or crack is essential to achieving a good bond and ultimately to the performance of the sealant. The old sealant material must be removed from each joint/crack face, either by sawing or through mechanical means. After removal of the sealant material, the joint/crack faces should be sandblasted to remove any slurry or laitance.
▪ Sealants should be tack free before being subjected to traffic (typically 1 to 2 hours).
▪ Sealant on the surface may be tracked by traffic or pulled out during snow removal.</td></tr>
<tr><td rowspan="2">Miscellaneous Considerations</td><td>Cost ($ to $$$$):
• Joint resealing: $ ($1.00–$2.50/ft)
• Crack sealing: $ ($0.75–$2.00/ft)</td><td>Treatment Life (years):
▪ Joint resealing: 2 to 8
▪ Crack sealing: 4 to 7
Pavement Life Extension (years):
▪ Joint resealing: 2 to 6
▪ Crack sealing: N/A</td></tr>
<tr><td colspan="2">▪ Risk: Improper installation can cause sealant or filler material to fail. Overband applications should be avoided on heavily trafficked roadways due to high tensile stresses directly above crack edges, resulting in edge separations. Overband applications are also susceptible to snowplow damage.
▪ Climate: Performs well in all climatic environments. Sealants perform best in dry, warm environments without large daily temperature cycles. Placement should take place when the pavement is dry and during moderate temperatures (typically 45°F to 65°F, although the manufacturer's recommendations should be followed).</td></tr>
<tr><td>Other Remarks</td><td colspan="2">▪ Because resealing concrete joints is not a seasonal maintenance activity, periodic inspections should be scheduled to determine when treatment is necessary.</td></tr>
<tr><td colspan="3">DIAMOND GRINDING/GROOVING</td></tr>
<tr><td>Treatment Description</td><td colspan="2">Diamond grinding is the removal of a thin layer of concrete (usually between 0.12 and 0.25 in.) from a concrete pavement surface, using special equipment fitted with a series of closely spaced, diamond saw blades. Diamond grinding removes joint faulting and other surface irregularities, thereby restoring a smooth riding surface while also increasing surface friction.

Diamond grooving consists of cutting narrow, discrete grooves into the pavement surface in order to improve tire–pavement interaction during wet weather landings.</td></tr>
<tr><td rowspan="2">Spec</td><td>Guidance
FAA AC 150/5320-12C, Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces
AC 150/5380-6B, Guidelines and Procedures for Maintenance of Airport Pavements
ACRP Synthesis 22: Common Airport Pavement Maintenance Practices</td><td>Specifications
International Grinding and Grooving Association (IGGA) Guide Specification: Conventional Diamond Grinding for Pavement Preservation</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td rowspan="2">Applications/Uses</td><td rowspan="2">Conditions Addressed
▪ Joint faulting (grinding)
▪ Slab curling/warping (grinding)
▪ Friction loss (grinding/grooving)
▪ Worn away grooves (grooving)</td><td>Conditions Not Addressed: Diamond grinding and diamond grooving do not provide any structural benefit to the existing pavement, nor do they address or correct the mechanisms of the pavement distress.</td></tr>
<tr><td>Limitations: Diamond grinding is the most effective means of restoring desirable surface characteristics to existing concrete pavements. The cause of poor surface characteristics should be identified prior to use.

Diamond grinding should not be used where there is a materials-related distress (such as D-cracking or alkali-silica reactivity that is damaging the pavement).</td></tr>
</table>

Construction Considerations	▪ Aggregate type and hardness influence costs and productivity. ▪ Grinding slurry must be collected on site and disposed of in accordance with local regulations. ▪ Slab stabilization, full-depth repairs, and spall repairs should be completed prior to grinding. Joint resealing should follow grinding to ensure proper sealant depth. ▪ Diamond grooving should be done according to FAA specifications.	
Miscellaneous Considerations	**Cost ($ to $$$$):** ▪ Diamond grinding: $$ ($1.75–$5.50/yd^2) ▪ Diamond grooving: $$ ($1.25–$3.00/yd^2)	**Treatment Life (years):** ▪ Diamond grinding: 8 to 15 ▪ Diamond grooving: 10 to 15 **Pavement Life Extension (years):** ▪ Diamond grinding: N/A ▪ Diamond grooving: N/A
	▪ **Safety:** Safety is improved by restoring pavement surface texture, providing directional stability and increasing skid resistance, and reducing potential for hydroplaning. ▪ **Risk:** If the cause of the need for grinding is not established and corrected, the condition may recur. More frequent grinding may be necessary to maintain surface friction where polishing of the aggregate is a problem, especially if soft aggregate was used. ▪ **Climate:** No significant climate limitations.	
Other Remarks	▪ Usually PCC pavements can be diamond ground at least three times without significantly affecting fatigue life. ▪ Can be accomplished during off-peak hours with short closures.	
PARTIAL-DEPTH REPAIR (PCC Patching)		
Treatment Description	Partial-depth repairs address small, shallow areas of deteriorated PCC. These deteriorated areas are removed and replaced with an approved repair material, thereby maintaining the serviceability of the pavement. Partial-depth repairs should be used to correct joint spalling and other surficial distresses that are limited to the upper third of the slab.	
Spec	**Guidance** AC 150/5380-6B, Guidelines and Procedures for Maintenance of Airport Pavements, Item 564, Repair of Pavement Distresses in Rigid (PCC) Pavements *ACRP Synthesis 22: Common Airport Pavement Maintenance Practices*	**Specifications** N/A
Applications/Uses	**Conditions Addressed** ▪ Joint spalling caused by non-materials–related sources, such as incompressible materials or joint inserts ▪ Corner spalling ▪ Mechanical damage to pavement surface	**Conditions Not Addressed:** Partial-depth repairs restore the structural integrity of localized areas of deteriorated concrete. **Limitations:** Partial-depth repairs may result in increased roughness if not finished properly. Diamond grinding may be used to blend the repaired surface with the surrounding pavement.
Construction Considerations	▪ It is important to properly determine repair boundaries; prepare the patch area; and finish, texture, and cure the repair material according to governing specifications. ▪ Material selection depends on various factors, such as opening requirements, ambient temperature, cost, and size and depth of patch. ▪ Proper and adequate preparation of the area to be patched is critical to ensure treatment success. The patch limits should extend 2 to 6 in. beyond the area of unsound concrete. ▪ Minimum spall repair dimensions are 4 by 12 in. (i.e., 12 in. along a transverse joint and 4 in. away from the transverse joint). ▪ Vertical faces are necessary when patching with most cementitious repair materials. Certain proprietary repair materials may be capable of successfully patching tapered sections. ▪ After concrete removal, the repair area should be prepared by sandblasting or water blasting, and should be air blasted clean immediately prior to the placement of the repair material. ▪ When specified, bonding agents (e.g., Portland cement grout or epoxy resin) should be appropriate for the time available before opening and should be compatible with concrete pavement. ▪ Inserting a compressible bond breaker prevents intrusion of the patch material into the joint, which could result in premature compressive failure of the repair. ▪ If the depth of the repair exceeds 1/3 of the slab thickness, then the placement of a full-depth repair should be considered. ▪ Small milling machines (oriented either parallel or perpendicular to the joint) have been effectively used for concrete removal when spalling exists along the entire length of a joint.	

Miscellaneous Considerations	**Cost ($ to $$$$):** $$$ ($75–$150/yd^2)	**Treatment Life (years):** 5 to 15 **Pavement Life Extension (years**): N/A
	▪ **Safety:** Poorly bonded patches that fail will cause large FOD potential. ▪ **Risk:** Performance failures are often caused by one or more of the following: bond failure, compression failure, variability and improper use of repair material, insufficient consolidation, and differences of the coefficient of thermal expansion between the existing pavement and patch. ▪ **Climate:** PCC patches should not be placed when the air temperature or pavement temperature is below 40°F unless adequately insulated. Furthermore, temperatures below 55°F will usually require a longer cure period. Placement should not proceed if rain is imminent. ▪ The use of all proprietary materials should closely follow the manufacturer's recommendations.	
Other Remarks	▪ Not applicable for spalling caused by dowel-bar misalignment or lockup; cracking caused by improper joint construction; working cracks caused by shrinkage, fatigue, or foundation movement; and spalls caused by materials-related distress (e.g., D-cracking or alkali-silica reactivity). ▪ Full-depth repair is necessary if dowel bars or tie bars are exposed in the patch area. ▪ Where the amount of patching is extensive, other strategies should be considered. ▪ There are many patching materials available, both non-proprietary and proprietary. Selection of the appropriate material should be based on available closure times, operational considerations, desired performance, condition of the pavement, previous experience with materials in the same or similar application, and so on.	
LOAD TRANSFER RESTORATION (DOWEL-BAR RETROFIT)		
Treatment Description	Load transfer restoration is the placement of mechanical load transfer devices (typically dowel bars) across joints or cracks in an existing jointed PCC pavement. These devices increase the load transfer capacity of the joint or crack, thereby reducing deflections and decreasing the potential for the development of pumping, faulting, and corner breaks. Poor load transfer at existing joints or cracks may result from an undoweled jointing situation (in which excessive joint or crack openings lead to reduced aggregate interlock), corrosion of existing load transfer devices, and poor pavement drainage resulting in loss of underlying support.	
Specs	**Guidance** *ACRP Synthesis 22: Common Airport Pavement Maintenance Practices*	**Specifications** International Grinding and Grooving Association (IGGA) Guide Specification: Dowel Bar Retrofit (DBR)
Applications/Uses	**Conditions Addressed** ▪ Joint faulting ▪ Pumping ▪ Corner breaks	**Conditions Not Addressed:** The load transfer efficiency of a joint or crack strongly influences the structural performance of a PCC pavement; poor load transfer can result in pumping, faulting, corner breaks, and spalling. **Limitations:** Unlikely to be effective when placed in a pavement with a materials problem such as D-cracking or alkali-silica reactivity.
Construction Considerations	▪ Careful consideration must be given to selecting patch material and isolating the joint for repair. ▪ Special diamond slot cutters capable of creating multiple cuts in a single operation should be employed for highest productivity. Slots created with milling machines typically cause excessive spalling on the surface and do not create uniform slot widths. ▪ Dowel-bar slots should be sawed to a depth sufficient to place the center of the dowel bar within 1 in. of the mid-depth of the pavement and should be aligned to avoid existing longitudinal cracks. Additionally, slots should be centered over—allowing equal lengths of the dowel to span—the transverse joint or crack and parallel to the pavement centerline. ▪ Transverse joints/cracks should be maintained with a compressible insert. The transverse joint or crack should be caulked sufficiently to prevent any of the patching material from entering the joint/crack. ▪ The dowel bar for chairs should be strong enough to allow full support of the dowel bar, as well as allowing ≥1/2-in. clearance between the bottom of the dowel and the bottom of the slot. ▪ End caps should allow ≥1/4 in. of movement at each end of the dowel bar. ▪ Patching material should be placed in a manner that does not disturb the dowel bar within the slot; thus, patching material should not be dumped into the slots and instead should be placed on the surface adjacent to the slot and shoved into the slot.	

<table>
<tr><td rowspan="2">Miscellaneous Considerations</td><td>Cost ($ to $$$$): $$$ ($25–$35/dowel bar)</td><td>Treatment Life (years): 10 to 15
Pavement Life Extension (years): 5 to 15</td></tr>
<tr><td colspan="2">Safety: The primary safety concerns are associated with failed slot-filling material causing risk of FOD.
▪ Risk: The alignment of dowel-bar slots must be parallel to the pavement centerline; slots perpendicular to skewed joints will cause joint lockup and lead to cracking. Additionally, slots sawed too deeply will contribute to corner cracks under loading.
▪ Climate: The material used to fill the slots should be placed following the appropriate climatic limitations for the material.</td></tr>
<tr><td>Other Remarks</td><td colspan="2">▪ It is most effective to apply treatment as structural distresses (e.g., pumping or corner breaks) are just beginning to appear.
▪ Diamond grinding done in conjunction with load transfer restoration will provide a smooth riding surface.</td></tr>
</table>

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

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