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Civil Aviation Authority of Sri Lanka

AIRPORT MAINTENANCE PRACTICES

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AIRPORT MAINTENANCE PRACTICES

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FOREWARD

The effective maintenance of airport infrastructure is a cornerstone of safe, efficient, and sustainable aviation operations. As aviation continues to evolve, airports must adapt to meet the demands of increased traffic, stricter safety standards, and emerging environmental considerations. In this context, **"Airport Maintenance Practices"** serves as a vital resource, drawing upon the guidelines established in the International Civil Aviation Organization's (ICAO) DOC 9137 - Part 9 - Airport Services Manual (Fourth Edition – 2009).

Sri Lanka, with its strategic geographic location and growing role as a regional hub, faces unique challenges and opportunities in airport maintenance. This book provides a comprehensive overview of the maintenance practices implemented across the country's airports, tailored to align with international standards while addressing local operational realities. From airport visual aids maintenance to the pavement maintenance, drainage systems, and airside equipment, this work highlights the importance of a systematic, proactive, and sustainable approach.

By integrating ICAO's established principles with practical insights specific to Sri Lanka's aviation landscape, the book aims to serve multiple stakeholders. It offers airport operators, engineers, regulatory authorities, and policymakers a clear roadmap to enhance operational efficiency and ensure compliance with international safety requirements. Furthermore, it emphasizes the critical role of regular training, technological upgrades, and collaboration among aviation stakeholders in achieving long-term maintenance excellence.

This publication not only celebrates the progress made by Sri Lanka's aviation industry but also underscores the collective responsibility of maintaining safe and reliable airport infrastructure. It is a timely and essential addition to the body of knowledge on airport management, reinforcing the importance of adopting global best practices to meet the dynamic needs of modern aviation.

This document is continually subject to revisions and amendments if required. Suggestions for improvement of the document are appreciated and should be addressed to the undersigned.

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Civil Aviation Authority of Sri Lanka
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Acronyms and Abbreviations

ACN/PCN	Aircraft classification number/pavement classification number
ARM	Aircraft recovery manual
ATC	Air traffic control
CBR	California bearing ratio
HAZ-MAT	Hazardous material
HBV	Hepatitis B virus
IATA	International Air Transport Association
IATP	International Airline Technical Pool
MAC	Mean aerodynamic chord
MEW	Manufacturer's empty weight
MZFW	Manufacturer's zero fuel weight
NLA	New larger aeroplane
NOTAM	Notice to all airmen
NRW	Net recoverable weight
OEW	Operating empty weight
PSI	Pounds per square inch
RAT	Ram air turbine
RC	Reference chord
REW	Recoverable empty weight
VHF	Very high frequency

Chapter 1 General

1.1 AIM OF THE MANUAL

1. 1.1 This publication is for airport authorities responsible for managing airport operations and facilities (except meteorological or electronic navigation aids). It is designed for those ensuring the safety of airport facilities and equipment, as well as smooth ground operations. It refers to ICAO guidelines that outline specific tasks authorities must follow to maintain safety and efficiency in air transport.

1.1.2 This manual covers the maintenance of airport facilities, regardless of the airport's size or purpose. However, it focuses only on facilities that are specific to airports. Like other industrial sites, airports require general maintenance for buildings, equipment, and infrastructure, but this manual does not cover routine maintenance tasks—only those that, if neglected, could affect aircraft safety or passenger operations.

1.2 USE OF THE MANUAL

1.2.1 The manual is intended to give guidance to authorities on planning and conducting maintenance work on an airport. The guidance has been developed from various airport operators' practices and reflects long-term experience in the field or airport operation.

1.3 ORGANIZATION OF THE MANUAL

1.3.1 This manual mainly covers airport maintenance tasks needed to keep aircraft safe during landing, taxiing, and take-off. It also includes some tasks that help improve airport efficiency.

1.3.2 The first part of the manual focuses on safety, including the maintenance of lights, electrical systems, pavements, unpaved areas, and drainage. Having the right equipment is important for maintaining airport facilities, so vehicle and equipment maintenance is also covered. Special equipment for removing aircraft is also included.

1.3.3 Chapter 9 concerns one aspect of the large field of maintenance tasks for the serviceability of handling facilities on an airport, i.e. the maintenance of some of the technical passenger handling facilities in the terminal building.

1.4 PURPOSE OF AIRPORT MAINTENANCE

1.4.1 An airport is a key part of aviation infrastructure and must meet high safety standards. This can only be achieved through proper maintenance of all its components.

1.4.2 Maintenance involves actions to keep or restore functionality and assess the current condition of an element. The main components of maintenance are:

- Inspection: Checking the condition of facilities and equipment.
- Servicing and Overhaul: Performing routine upkeep and major maintenance.

– Repair: Fixing any faults or damage.

1.4.3 Inspection includes all actions to check and assess the condition of equipment, including both spontaneous and scheduled checks. Scheduled checks follow a plan that outlines preparation, the type of check, the report on the results, and the evaluation of those results. Based on the evaluation, the operator decides if additional servicing or repairs are needed.

1.4.4 Servicing and overhaul include actions to keep a facility or device in good working condition or restore it to its required state. These actions should be done according to a plan that outlines the timing, the type of service, and a report confirming that the service was completed.

1.4.5 When inspection or servicing finds problems, repair actions must be planned and completed as soon as possible. Repairs can range from minor tasks to major work, such as runway surface treatment, which may cause traffic disruptions.

1.4.6 Efficient and safe operations can only be expected from facilities that are in good working condition. Proper maintenance, as described above, is necessary to achieve this. Additionally, maintenance reduces wear and tear, helping to significantly extend the lifespan of technical components. In this way, maintenance is also an economic necessity, as it helps keep investment and capital costs for airport infrastructure within acceptable limits.

1.5 ORGANIZATION OF AIRPORT MAINTENANCE

1.5.1 A complete assessment of all airport parts is essential for the maintenance organization. This includes numbering buildings, pavement sections, unpaved areas, machinery, technical equipment, and vehicles. These numbers identify each item, allowing for specific maintenance requirements to be set for each one. These requirements should be documented on cards or stored in computer files for easy reference.

1.5.2 Maintenance programs will be based on experience with the needs of different items or follow the manufacturer's recommendations. For efficiency and fairness in dividing responsibility, it's recommended to break down the work into specific areas (e.g., for a building—roofs, walls, doors and windows, machinery, electrical systems). This allows each team or expert responsible for a specific task to follow a clear, systematic work plan, ensuring the best possible efficiency.

1.5.3 A key task of the maintenance organization is to convert maintenance requirements into man-hours. This evaluation helps determine staffing needs and serves as a tool for decision-making when considering outsourcing maintenance tasks instead of hiring additional personnel.

1.5.4 All maintenance programs should be reviewed once a year. It's important not only to rely on recorded data but also to inspect the condition of major items at that time. Unlike machines, where operating hours can indicate wear, buildings' deterioration is more influenced by factors like weathering, heavy use, hidden construction flaws, or other unpredictable sources of damage.

1.5.5 Updated maintenance programmes will allow:

- appropriate staffing;
- compliance with the recorded maintenance needs; and
- flexibility as to the timing of action when unexpected circumstances have affected the planned work schedule.

When management checks the work against scheduled tasks, it ensures full control over the maintenance progress. Compliance reports provide feedback and should be recorded, along with any observations on reported deficiencies.

1.5.6 Computer assistance can be useful and cost-effective when maintenance volume is high. Computers are especially good at managing preventive maintenance tasks for electrical systems and machines. They can also help evaluate the aging of inventory using specialized programs. However, computers are less effective for managing maintenance of buildings and pavements, where repairs are usually done as needed.

1.5.7 To ensure the operation of technical facilities at an airport, a sufficient number of technicians must be available during operating hours to address any issues immediately. The team should include, as needed, engineers, automotive technicians, air conditioning and heating technicians, and electricians. If there are control or monitoring centers for technical facilities, they should be staffed at all times.

1.5.8 Outside of operating hours, the standard maintenance team can be reduced to focus on keeping essential systems (such as electrical circuits, heating, air conditioning, and telephone systems) functional. Additional technicians can be called in quickly for serious issues. In other cases, the reduced team will handle temporary repairs and report any maintenance needs to the standard team when they start their shift.

1.5.9 The standard team doesn't need to handle all maintenance tasks at the airport. The airport authority can hire contractors for tasks that can be scheduled easily. However, special tasks may arise unexpectedly due to the nature of air transport and its vulnerability to external factors. Reasons for extra maintenance work could include:

- rain, heavy thunderstorm with consequential damage;
- aircraft accidents or incidents; and
- technical or criminal emergencies.

1.5.10 To handle these unexpected work demands and in line with the airport emergency plan, the airport authority must maintain a reserve of skilled craftsmen on staff. This reduces the need for contract maintenance by third-party companies.

1.5.11 To ensure the smooth operation of the entire airport, it’s necessary to have workshops at the airport for both operational and economic reasons. The types of workshops needed depend on factors like the airport's size, traffic volume, ownership of facilities and equipment, and the division of work between airlines and the airport operator. Each workshop solution must consider:

- local maintenance requirements; and
- compliance with the airport emergency plan.

Chapter 2 Maintenance of Visual Aids

2.1 INTRODUCTION

2.1.1 The main purpose of visual aid systems is to ensure the safe operation of aircraft, so their maintenance must meet the highest standards. After installation, the system's effectiveness relies on its serviceability, which depends on how well maintenance is performed. According to IS 30, Chapter 10, a light is considered to have failed when its output drops below 50 per cent of the specified level for a new light. Loss of light output can be caused by contaminants inside and outside the light unit, or by aging of the lamp and optical system. To restore the light to its original condition, it should be cleaned, and any degraded parts or lamps should be replaced. A comprehensive routine maintenance system is essential for ensuring the lights and other equipment meet the specified requirements, as outlined in IS 30, Chapter 10.

2.2 PERSONNEL

2.2.1 Maintaining lighting aids should be assigned to reliable and skilled electricians with experience in high voltage, series circuits, and lighting systems. These electricians should be available or on call during airport operating hours to address any issues that may arise. Training programs should be set up to ensure maintenance personnel stay competent and up-to-date with new developments in the field.

2.3 SPARE PARTS

2.3.1 An adequate stock of spare parts should be kept on hand. The quantity of stock needed will depend on how long it takes to restock an item and its shelf life.

2.4 AS-BUILT DRAWINGS

2.4.1 A set of as-built drawings should be kept readily available. These drawings must be kept up to date and any changes at site should be reflected immediately on these drawings. The completeness and the accuracy of all circuit diagrams, drawings and descriptions should be checked at least annually.

2.5 LIGHT MAINTENANCE SCHEDULE

General

2.5.1 When servicing lights, it’s important to follow the instructions from the equipment manufacturer to ensure the required service standards are met. Service records should be created for each piece of equipment, showing maintenance schedules recommended by the manufacturer or local standards.

These records can be stored in a dated reminder file to ensure regular servicing. The record should include space for observations, measurements, and the initials of the person performing the service. If local conditions suggest a change in the servicing interval, the schedule can be adjusted in consultation with the equipment manufacturer.

2.5.2 The frequency of routine inspections, cleaning, and servicing will depend on the type of equipment, its location, and how often it is used. A maintenance program should be created for each airport based on past experience, with the goal of meeting the required service standards. The provided schedules are intended as guidance for setting up a preventive maintenance program. More frequent checks may be needed for lights on precision approach Category II and III runways. These time schedules should not override the manufacturer's instructions or be applied to similar equipment not mentioned. After each check, any necessary corrective action should be taken.

Basic maintenance programme for approach, runway and taxiway lighting systems

2.5.3 Maintenance for all types of approach, runway and taxiway lights should include checking and, if necessary, taking the indicated corrective action, as follows:

Daily:

– system for burnt-out lamps; replacing burnt-out lamps
– system for gross misalignment (if applicable); adjusting
– control equipment for proper operation on each brightness step (if applicable); correcting or repairing malfunctions
– glass for breakage; replacing broken parts.

Annually:

– fasteners of each light unit; tightening
– lights for corrosion; painting or replacing rusted parts — reflector of each light unit (if applicable); cleaning or replacing
– glass of each light; cleaning or replacing
– lamps of the whole system; replacing of the unserviceable lamps or entire system (see 2.6.18)
– elevation setting (if applicable); adjusting
– horizontal alignment; adjusting
– plug connexions for cleanness and faultless contact
– cleaning or replacing of dirty parts
– light fittings and their supporting structure (if existing) for adequacy of fastening and for corrosion and rust; tightening fasteners; painting or spraying
– general condition of the whole system and recording results.

Unscheduled:

– elevation setting and the horizontal alignment (if applicable) of the light units for obstruction by grass, etc. (not applicable for inset lights); removing any obstacles found.

Additional maintenance programme for special types of lights

2.5.4 In addition to the maintenance programme specified in 2.5,3, the following should be carried out for PAPIs, runway threshold and end lights, and inset lights.

2.5.5 Runway threshold light maintenance should include checking and, if necessary, taking the indicated corrective action as follows:

Twice weekly:

- fasteners of the lights; tightening
- glass of each light for wear and tear; replacing.

2.5.6 Runway end light maintenance should include checking and, if necessary, taking the indicated corrective action as follows:

Twice weekly:

- fasteners of the lights; tightening
- glass of each light for wear and tear; replacing.

2.5.7 Inset lights (runway centre line lights, touchdown zone lights, taxiway centre line lights) maintenance should include checking and, if necessary, taking the indicated corrective action, as follows:

Daily;

- lenses for cleanness; cleaning

Twice weekly (not applicable to taxiway and stop bar lights):

- light output of lights within 900 m from each threshold including measuring and recording the results; cleaning of the lenses
- top parts of lights within 900 m from each threshold; replacing.

Quarterly (not applicable to taxiway and stop bar lights):

- light output of all lights within the system including measuring and recording the results; cleaning of the lenses
- top parts of the lights; replacing.

Semi-annually (not applicable to taxiway and stop bar lights):

- lights for cleanness inside and out; cleaning
- lights for moisture; drying
- electrical connexions of the lights; tightening; spraying with contact agent alignment of lights; adjusting.

Annually:

- prisms and filters; cleaning or replacing

– sealing compound; resealing.

Unscheduled:

– top parts of the lights two to four weeks after replacement•, tightening.

Maintenance programme for other airport lights

2.5.8 Other airport lights, such as airport beacons, obstacle lights, and wind direction indicators, typically require less maintenance than approach, runway, or taxiway lighting systems. Their maintenance should involve checking the lights and, if needed, taking the following corrective actions:

Daily:

– lamps; replacing if necessary
– control equipment for proper operation (not applicable in the case of obstacle lights); correcting or repairing
– fabric of the wind cone; repairing or replacing.

Semi-annually (only for airport beacon):

– power supply (brushes and slip-rings); cleaning or replacing
– electrical connexions; tightening
– rotating parts; fastening.

Annually:

– optical system of the airport beacon
– glasses and the gaskets of obstacle lights; cleaning or replacing
– function of the flashing relays and of the twilight switches of the obstacle lights; cleaning, repairing or replacing
– power supply and the lighting of the wind direction indicator; repairing or replacing
– electrical connexions; tightening; spraying with contact agent fasteners of obstacle lights
– structure and the fasteners of the wind direction indicator; tightening or repairing the structure
– lights for corrosion; painting
– colour of the fabric cone of the wind direction indicator; replacing. Location of obstacle lights for easy access for maintenance; arranging of change of location if required and possible.

Unscheduled:

– wind direction indicator after severe Storms; repairing.

Docking guidance systems

2.5.9 Maintenance programmes for various types of aircraft docking guidance systems are provided at airports and it is very difficult to describe a generally applicable maintenance programme for these very different systems, principal requirements to be checked and maintenance action to be taken, if necessary, include:

Daily:

- system for over-all operation; repairing
- lamps; replacing burnt-out lamps.

Semi-annually:

- alignment of the system; adjusting.

Annually:

- electrical connexions (if provided) for corrosion, wear and tear; cleaning, tightening and replacing
- function of relays (if provided); cleaning or replacing
- structure of the system and the function of all mechanical parts; repairing
- system for cleanness and moisture; cleaning and drying.

2.6 Light maintenance procedures

General hints for maintenance of lights

2.6.1 For efficiency, light maintenance should, whenever possible, be done indoors. This helps avoid outdoor inconveniences like heat, rain, and aircraft noise, and minimizes traffic restrictions or interruptions. The quality of service will also be better in a workshop environment compared to working outdoors. This approach is especially useful when maintenance needs to be performed at night to avoid disrupting traffic flow during the day.

2.6.2 The maintenance procedure commonly used comprises two steps:

- removal of defective lights and immediate replacement by new or repaired ones
- servicing and overhaul of deficient lights in the workshop where all required tools, measuring and adjusting equipment are available.

2.6.3 This approach has proven practical, especially for maintaining inset lights. Having a sufficient stock of spare lights is essential. The number of spare parts needed depends on the overall requirements of the airport and the experience with how easily different types of lights might get damaged. It's also helpful to choose lights that are designed for quick removal and installation, without requiring complex technical equipment.

Furthermore, all mechanical and optical parts of the light should be incorporated in the removable part.

Cleaning procedures för lights

2.6.4 The type and level of contamination on different airport lights vary. Elevated approach and edge lights are typically affected by weather conditions, such as dust carried by wind and rain. However, inset lights, especially on runways, experience more severe contamination. Rubber deposits from tires during landing and exhaust from engine reverse thrust procedures leave stubborn marks on the exterior glass of these lights. The varying levels of contamination should be considered when creating the maintenance schedule for different categories of lights or sections of the runway and taxiway system.

2.6.5 *When cleaning the glassware of lights, it's important to follow the manufacturer's recommendations. Generally, cleaning is done by washing the glass with a mixture of water and a special solvent that won't damage the sealing material or leave a residue on the glass. The solvent should be given enough time to dissolve the deposits. If needed, rubber spots can be scraped off using plastic tools or powder before applying the solvent. Other tools for cleaning may include sponges, cloths, hand brushes, or electric rotating brushes. The cleaning methods and materials should ensure that the glass is not scratched or damaged, and that the sealing material remains intact.*

2.6.6 Dry cleaning of glassware should be avoided. If cleaning is necessary, heat or other abrasive materials should not be used. To prevent the need for special treatment, it's best to follow a maintenance schedule that includes wet cleaning at appropriate intervals.

2.6.7 For cleaning light fittings on-site, special maintenance vehicles equipped with air compressors, vacuum cleaners, and solvent tanks should be used. A low working seat at the rear or front, or an opening in the bottom of the vehicle, makes the work much easier. In some cases, these vehicles can also carry all the necessary tools for various maintenance tasks, including removing old lights and installing new ones.

2.6.8 Thorough cleaning of the interior of lights to remove mud, moisture, or rust should be done in workshops. Only minor contaminants, such as dust, should be removed on-site.

Light measurement

2.6.9 The light output will decrease over time due to lamp aging. Contamination of the reflector and lens will also contribute to a further reduction in light output. According to IS 30, a light is considered to have failed when its output is less than 50 per cent of the required intensity. For practical reasons, it is recommended to replace a light when its output falls below 70 per cent of the specified intensity for a new light.

2.6.10 Light measurements should be conducted regularly to detect early signs of reduced light output. Suitable equipment for both field and bench measurements of light output is available. However, the equipment provided by light manufacturers typically doesn't show absolute intensity values but instead offers ratios between the measured and original light intensities for each specific type of light.

2.6.11 Field measurements are especially important for inset lights, as wheel loads can often cause damage to them. One type of measuring equipment provided by light manufacturers for field use includes a photocell and a microammeter. These devices are placed over the light fitting, and the meter reading is compared with the calibration value. Before performing measurements, the lights should be cleaned and set to the highest available intensity setting.

2.6.12 Light measurements can also be made using a photographic spot meter. This meter is not placed directly on the light casing but is moved vertically and horizontally through the light beam at a fixed distance. The intensity is then checked by comparing the results with a calibration test conducted using a new light.

2.6.13 The measuring procedures described above can be quite time-consuming, with each measurement taking about 2 minutes using the special device. However, experienced personnel can often achieve comparable results much faster through visual observation to identify and report individual lights with unacceptable light output. For visual checks, the brightness level should be set to "low" (3 to 10 percent of maximum).

2.6.14 To adjust the correct angle of the beam, lights are typically equipped with alignment markings. Additionally, light manufacturers provide suitable adjustment equipment for their products. However, if beam misalignment occurs due to displacement of the optical system inside the light, it cannot be corrected by adjusting the casing. In such cases, if misalignment is observed visually, the light should be brought to the workshop for proper adjustment.

2.6.15 To measure light output in the workshop, the measuring equipment provided by the light manufacturer should be used. This equipment typically includes a bench to fix the light and a photocell sensor element. Microammeter readings should be compared with the calibration value. Directional adjustments can be made using the alignment screws to ensure proper light orientation.

2.6.16 When light measurements need to be done without the manufacturer's special equipment, a practical method is to check the isocandela curve on a vertical surface located about 3 meters in front of the light unit. By placing photocells at the vertical and horizontal limit lines of the isocandela curve, you can compare the light output with that of a new light. Before testing, the lights should be set to their maximum brightness level to ensure accurate measurements.

Lamp replacement

2.6.17 The lifespan of lamps can range from 100 to 1,000 hours of operation, depending on factors such as the duration of operation at high brightness levels and the frequency of switching. Dynamic stresses from aircraft wheel loads (for inset lights) and temperature-induced stresses inside the casing also impact lamp life. Once lamps fail, they should be replaced promptly, as the airport's lighting system must meet specific serviceability standards. Refer to IS 30, Chapter 10 for more details on these requirements.

2.6.18 Lamp replacement can be organized in two different ways:

- *Failure-based replacement:* Only replace lamps that have failed or show a significant drop in light output. This method requires frequent checks to identify faulty lamps.

- *Scheduled bulk replacement:* Replace lamps in sections of the lighting system based on a set schedule. The replacement interval should be based on the average lifespan of the lamps, with replacements done when lamps reach 80 per cent of their expected life. This method requires fewer checks but needs accurate records of operating hours for each section.

2.6.19 It is better to replace lamps in the workshop, especially for inset lights. The faulty lamp should be removed and replaced with a working one. For elevated lights, replacement can be done on-site as long as the casing is easy to open and the lamp socket doesn't require realignment after replacing the lamp.

Removal of water

2.6.20 Inset lights can sometimes collect water, which leads to corrosion, damage to electrical parts, and deposits on the lens and lamp, shortening the lamp's lifespan. To prevent this, proper drainage of the opening must be ensured before installing the light into the pavement. However, it is not always possible to fully prevent moisture from entering. Regular inspections are needed to check for water inside the lights. If water is found, the light should be removed and replaced if possible. If not, it should be dried on-site. After drying, the seals should be checked and replaced if necessary. Before resealing the light, it should be turned on for a while to allow any remaining moisture to evaporate due to the heat inside.

2.6.21 Attention should be paid to the presence of water on and in front of the glass of inset lights. Water may bend the light beam, thus misaligning the light direction. If such a situation is observed, the drainage has to be improved.

2.7 SIGNS

2.7.1 Signs give pilots directional information for taxiing and holding. Maintenance should ensure integrity and perfect legibility of the information provided by the signs. The design and construction of signs varies considerably but the following general checks and, if necessary, maintenance action, are recommended for each sign:

Daily:

- lighting; replacing burnt-out lamps
- inscriptions for legibility and absence of obstructions; repairing the signs and removing obstructions.

Annually:

- mounting of both the sign and its lighting if provided; repairing
- structure and its paint; cleaning, repairing or replacing.

Unscheduled:

- after severe storms; re-positioning tumbled Signs and repairing damaged signs.

2.8 MARKINGS

2.8.1 All markings on paved areas should be inspected at least semi-annually. Local conditions will determine when to inspect.

2.8.2 Markings which are faded or discoloured by soil should be repainted. When rubber deposits have been removed from the pavement all defaced markings should be restored as soon as possible.

Chapter 3 Maintenance of Airport Electrical Systems

3.1 GENERAL

3.1.1 The serviceability and operational reliability of air navigation equipment are essential for the safe operation of aircraft in the airport area. This includes not just visual aids, but also electronic landing aids, navigation systems, radar, and meteorological equipment. While guidance on maintaining visual aids is provided in Chapter 2 of this manual, maintenance programs for other equipment, such as radar and meteorological systems, should be developed and managed by the relevant authorities, including Air Traffic Control (ATC) and Meteorological Services. These maintenance programs are crucial to ensuring the proper functioning of all systems that support safe airport operations.

3.1.2 To keep airport equipment running smoothly, it’s important to have a reliable power supply. Regular maintenance is needed for the equipment that distributes both primary and backup power. This includes power cables, transformers, control cables, relay cabinets, and backup power systems. The manual also provides guidance on maintaining floodlighting systems on the apron and lighting systems around passenger terminals (covered in Chapter 9). Proper upkeep of these systems ensures safe and efficient airport operations.

3.2 PERSONNEL

3.2.1 Airport electrical system maintenance should be handled by skilled electricians familiar with the work. Since tasks often involve high-voltage areas, electricians must stay updated on safety measures. All necessary safety devices should be well-maintained to ensure personnel protection.

3.2.2 The maintenance personnel should be present or on call during the operating hours of the airport. it may be advisable to have the same persons take care of maintenance of both electrical systems and visual aids.

3.3 SCHEDULE OF MAINTENANCE

3.3.1 Schedules of routine maintenance of the individual elements of the airport electrical system should be based on manufacturers' recommendations adjusted to the operator's own experience regarding the frequency of malfunctions. Therefore, a record of maintenance work carried out will need to be maintained.

3.3.2 As the frequency of servicing depends on the type of equipment, it is not possible to set up generally applicable maintenance programmes. Therefore, the following schedules provide only general guidance on the setting up of a programme of preventive maintenance.

Power cables and distributors in field

3.3.3 Cables and distributors outside of buildings can only be checked where installed in channels. Preventive maintenance is not possible where power cables are buried in the soil. In such cases, work is restricted to repair when malfunctions have been noticed. Their maintenance should include semi-annual checking and, if necessary, taking the indicated corrective action, as follows:

- distributors located in manholes for cleanness and moisture; cleaning and drying
- plug-in and clamp connections in the distributors for good contact; tightening and spraying
- manholes for condition of the interior; pumping-out, drying up or cleaning
- insulation resistance by measuring the earthing resistance of each circuit; recording readings and taking necessary corrective action.

Transformers and regulators (including standby units)

3.3.4 Maintenance of transformers and regulators should include checking and, if necessary, taking the indicated corrective action, as follows:

Monthly:

- power supply transformers and regulators for cleanness and oil losses; cleaning and replacing oil
- switches at all light intensity positions for malfunctions; restoring
- switch over to standby units for serviceability, restoring.

Annually:

- transformers for noise; investigating reason for any unusual sound and repairing
- over-all condition; repairing — insulators; repairing or replacing
- collector bar system; cleaning
- voltage and amperage at all intensity levels, measuring and recording; adjustment of voltage to nominal level.

Transformer stations for electric power supply

3.3.5 Maintenance of transformer stations for electric power supply should include checking and, if necessary, taking the indicated corrective action, as follows:
Weekly:

- over-all condition visually; restoring
- fuse boxes for completeness of contents; adding missing fuses.

Semi-annually:

- insulators and electrical connexions; cleaning and restoring
- station for dirt and moisture; cleaning and drying
- locks to stations for serviceability; repairing and locking.

Annually:

- protection relay; adjusting
- high voltage cable insulation; recording condition of each cable; taking preventive measures
- earthing and its resistance; cleaning

- electrical supply system for noise and damage; repairing — for rust, corrosion or defective coating; cleaning and painting
- warning signs and safety devices are present and in correct positions; cleaning or replacing
- safety grids for completeness, rust or coating deficiencies; completing, cleaning and painting
- safety grids for stability and earthing; tightening and restoring proper earthing.

Relay and switch cabinets (including switch cabinets in sub-stations)

3.3.6 Maintenance of relay and switch cabinets should include checking and, if necessary, taking the indicated corrective action as follows:

Semi-annually:

- turn and plug-in connexions for cleanness and good electrical contact
- relays for positive closing of contacts; cleaning or replacing
- electrical contacts for corrosion and wear; cleaning and replacing
- cabinet condition including proper weather seal, cleanness and mechanical damage; cleaning and repairing
- monitoring relay of series circuits for proper feedback; repairing
- voltage switch-over — if available — of two circuits for serviceability; repairing.

Annually:

- cabinet outer condition for dirt, moisture, easy access; cleaning and drying
- fuses (if provided) and fuse sockets; cleaning and spraying sockets and replacing fuses
- voltage output for all series circuits; recording results; taking corrective action.

Control cables, monitoring units, control desk

3.3.7 Maintenance of control cables, monitoring units and control desk should include checking and, if necessary, taking the indicated corrective action, as follows:

Daily:

- optical and acoustical signal for feedback; restoring.

Weekly:

- nominal control voltage; charging battery
- voltage and ammeter readings; adjusting
- acid level in batteries; adding distilled water.

Monthly:

- functions of the monitoring unit
- parts for cleanness and condition; cleaning and repairing or replacing.

Quarterly:

- system components for loose connexions; tightening, repairing or replacing
- control desk for over-all operation; investigating any malfunctions; repairing or replacing parts
- mimic panel indications for conformation to field conditions; correcting or adjusting
- mechanical structure of the desk for stability, repairing.

Semi-annually:

- replace lamps in monitoring units,

Annually:

- cables and distributors; cleaning and repairing
- relays for cleanness; cleaning
- control and monitoring units; replacing
- connexions; tightening and spraying.

Unscheduled:

- insulation of cables after each lightning strike, i.e. insulation between wire and wire, and insulation between wire and ground; improving insulation.

Secondary power supplies (generators)

3.3.8 Maintenance of secondary power supplies should include a monthly test run and checking and, if necessary, taking the indicated corrective actions as follows:

- switch-over time from primary to secondary power supply for conformation to the requirement
- voltmeter readings to ensure that the voltage remains within acceptable tolerances
- transfer equipment for excessive heating and malfunctions
- generator for vibrations and excessive heating
- diesel engine for any irregularities and oil leakage
- fuel level in the tank after the test run; refilling with fuel if necessary
- abnormal or undesirable performance; taking corrective action and repairing
- recording the meter readings of the test run and comparing with former records to detect potential deficiencies.

Fixed 400 Hz ground power supplies

3.3.9 Maintenance of ground power supplies should include checking and, if necessary, taking the indicated corrective action, as follows:

Daily:

- plugs, cables and cable holdings; repairing.

Weekly:

- proper functioning
- tightness (oil spillage) and loose connexions; repairing.

Monthly:

- serviceability of control lamps; replacement
- screw connectors at the contact rail for potential temperature rise; improvement of contact
- cleanness of cables; cleaning
- ventilator flaps and orifices for cleanness; cleaning— cone belts, driving the ventilator system; adjustment of belt stress.

Quarterly:

- current-input cables for potential deformation; removal of deficiencies
- connector boxes for:
- mechanical damage
- proper mounting of plug sockets
- condition of contact clips in the plug sockets
- bearings for lubrication.

Semi-annually:

— cables (wires and insulation) for serviceability; repairing or replacing
— main conductor cables for temperature rise under nominal electric power; removal of discovered deficiencies — connectors, plugs and cable holdings; adjusting and tightening
— switches for proper operation; removing of dust and dirt from switch elements
— fixings holding the regulator and switch cabinet housings; tightening of mounting screws or bolts.

Apron floodlighting

3.3.10 Maintenance of apron floodlighting should include checking and, if necessary, taking the indicated corrective action, as follows:

Daily:

- lamp outage; replacing lamps
- switching operation from remote control; repairing.

Annually:

- turn and plug-in connexions for cleanness and good electrical contact
- relays for serviceability; cleaning or replacement
- contacts for corrosion and wear; cleaning or replacement

- relay cabinet condition including proper weather seal, moisture, cleanness, mechanical damage; cleaning. drying and repairing
- fuses and fuse sockets; cleaning and spraying sockets and replacing fuses
- relay cabinet outside condition including free access thereto.

Chapter 4 Maintenance of Pavements

4.1 SURFACE REPAIR

General

4.1.1 Runway surfaces must be kept in good condition to prevent any irregularities or damage that could pose a risk to aircraft operations. This requires constant monitoring of the pavement and timely repairs when needed. Since pavement repairs can be expensive and may disrupt airport traffic, especially for small areas of damage, preventive maintenance plays a crucial role in effective airport pavement management.

Portland cement concrete pavements

4.1.2 Surface damage on Portland cement concrete pavement normally stems from design or construction failures, such as insufficient cement, too high water content in the mixture, improper treatment during hardening. Typical forms of surface damage are:

– porous or disintegrated surface
– separation of thin top surface layer
– extreme smoothing of the surface created by polishing under traffic
– breaking up of pavement where cracks extend into the inner layers.

4.1.3 Where the damaged layer of pavement is very thin and damage is identified as being the result of improper surface treatment during construction, surface scoring or grinding is often sufficient to correct the condition. Where the loss of thickness thereby does not create problems and the concrete below is in good condition, no other treatment is required to restore the concrete pavement section. It should be checked that this kind of repair does not lead to unevenness or formation of puddle areas.

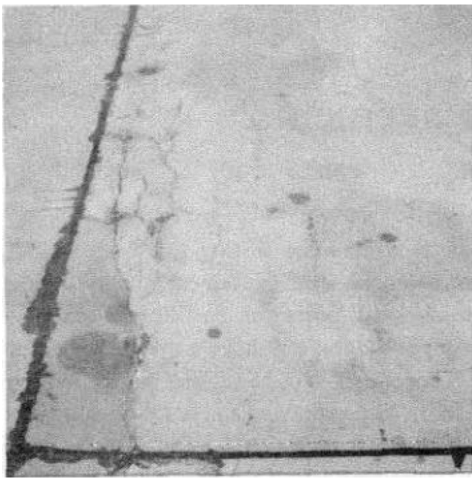
4.1.4 Where the surface has been found to be too porous, but no other pavement quality deficiencies have been observed, pores can be filled by sealing or coating. Epoxy resin solutions have proven to be suitable. The liquid penetrates into the surface material down to a depth of 5 mm. When applying epoxy resin sealings, the forming of closed surface films must be avoided. Such a film would hamper moisture evaporation from Within the concrete causing early destruction of the repaired surface. Furthermore, the surface will become too smooth and slippery when wet.

4.1.5 Where concrete surface material is more severely damaged with deep cracks, (see Figure 4-1), the damaged material has to be ground off until sound concrete material is reached. After grinding, the surface must be fully dry and free of dust before being refilled. The new surface has to be pretreated with a diluted solution of synthetic resin to create good adhesion. Where reinforcement steel is exposed, all rust has to be eliminated, and wires must be covered by a new coating of epoxy resin or equivalent. A layer of epoxy grout is put on top of the pretreated area and levelled at the required thickness. A lean mixture of grout is recommended to permit the patch material to conform to the physical characteristics of the pavement. Similar shrinkage characteristics are most important for the grout to avoid chipping off after hardening. The grout can be made of special quartz sands or ceramic material. To prevent the surface from becoming too smooth, coarse quartz sand can be strewn on the still wet grout. Joints between concrete slabs should not be filled with grout in the course of repair.

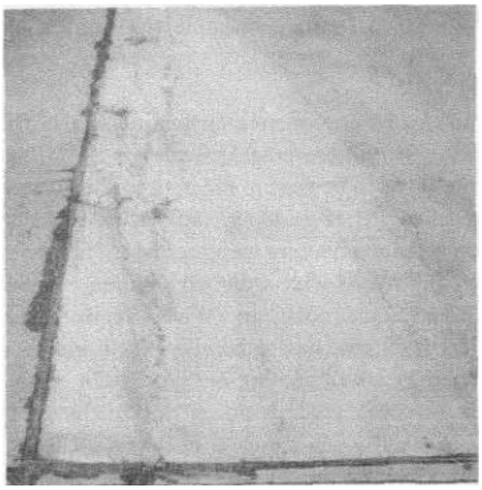
4.1.6 For urgent provisional pavement surface repair special quick-hardening cement products are available which gain high strength within one hour or less. Experience has shown, however, that the durability of such material is rather short.

Bituminous pavements

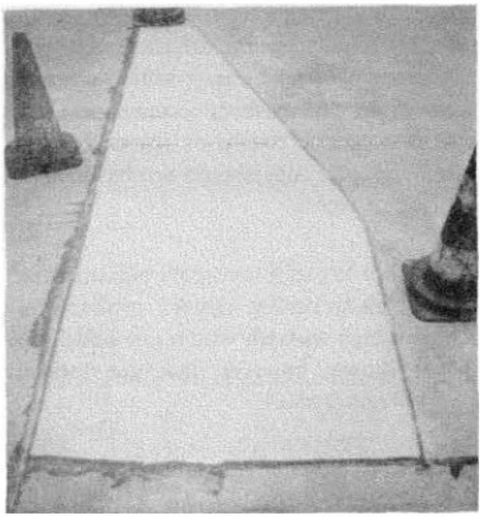
4.1.7 Surface damage on asphalt normally stems from wrong composition of the bituminous mixture, impact of fuel, grease or solvents, extreme spot loading, mechanical wear or destruction by chemicals. Other forms of damage are decay by weathering of the surface structure, softening of the surface and deformation.



a. Surface cracks in a concrete slab



b. State of the damaged area after start of milling



c. Former damaged area after filling with epoxy resin grout

Figure 4-1. Surface repair of concrete pavement showing minor damage

4.1.8 When damage is minor and concerns the surface only, the repair can be carried out by spraying a bituminous seal onto which quartz sand or crushed basalt material is spread and rolled.

4.1.9 Where damage affects more than just the surface, the whole affected layer should be removed by grinding. The minimum grinding depth is 3cm to allow reconstruction of an asphalt layer consistent with sound engineering. The bed for the new layer must be sharply edged to receive a clean seam. After grinding, the strips have to be carefully cleaned from contamination and grinding material (e.g. by road type suction sweepers) before they are sprayed with a bituminous binder. Then the new layer will be brought in, in accordance with road engineering design practice. Compaction (rolling) must be carried out very thoroughly at the edges of the old asphalt in order to close the joints. Covering the joints by spraying with a bituminous seal is recommended.

4.1.10 In cases where damage goes deeper, repair must include the sub-base material. In the course of such maintenance work sub-grade material may have to be replaced and compacted to restore its bearing capacity under the repaired pavement area. The bituminous layer or layers would then be laid according to good engineering practice.

4.2 REPAIR OF JOINTS AND CRACKS

Joints in concrete pavements

4.2.1 Joints are provided in concrete pavements to eliminate stress induced by length variations of the concrete material due to temperature changes. Joints must be closed with a fuel resistant elastic material (bituminous sealant or hose-type plastic sealant) to prevent surface water from penetrating into the sub-base or subgrade and hard debris or stones from being pressed between adjacent concrete slabs. Once a joint becomes permeable the subgrade may be washed out and voids below the slabs may weaken the supporting capability of the base material. This effect result in destruction of the concrete. Basically, it is the sensitivity of the subgrade to water that determines the joint maintenance requirements.

4.2.2 The first sealant of a concrete joint will remain serviceable for a period of four to six years, depending on the mechanical and thermal impact of the pavement. Later on, the sealing material will lose part of its original elasticity and — due to shrinking — it will fail to adhere to the side flanks. Mechanical forces applied to such aged sealant will start the sealant breaking off, and rotary brooms of sweeping will accelerate the process. To protect concrete pavements from severe damage, a renewal of all joint sealants is necessary when the material in the joints is observed to fail and break off.

Concrete joint maintenance

4.2.3 For concrete joint maintenance all old sealing material has to be removed. A so-called "joint plough" may be used to carry out this task. Then the bare slab flanks should be cleaned thoroughly of soil, grease and dust. Where edges are damaged, they should be repaired with a suitable synthetic resin grout. After inserting a new inlay to limit the depth of the sealing material, the joint may be refilled with the liquid sealing material. Attention should be paid not to fill the joint up to the top. A surplus of sealing material in the joint will swell above the top when the pavement expands under thermal stress. This may lead to surface contamination later on, the selected material must be fuel-resistant, particularly in pavement sections where fuel spillage may occur occasionally.

4.2.4 When joints are to be closed by plastic material, such as hollow Neoprene profiles, the same method for joint cleaning and preparation is applicable. To improve the sealing capacity of plastic material, the concrete flanks should be covered with an adhesive before placing the sealing profile into the joint. At joint intersections and ends the plastic material must be welded together to prevent water entering at the insert and it acting as a hose distributing water to the entire joint system.

Joints in bituminous pavements

4.2.5 Recent experience indicates that it -is useful to provide for joints in bituminous pavements. For airport asphalt construction hard types of bituminous material are required. Reaction to temperature changes in such pavements is quite comparable with that in concrete. Unpredictable crack formation is very likely to occur in bituminous pavements, due to thermal stress. Stress reliever joints not wider than 8 mm and not deeper than two thirds of the thickness of the wearing course may be cut into the pavement to control the crack formation. When the pavement shrinks at low temperatures, cracks will only appear under the joints, and these can be sealed to prevent water penetration.

4.2.6 Joints in bituminous pavements should be filled with a hot bituminous sealing material without any synthetic components. The chemical relationship between the pavement and the sealing material, and the almost identical thermoplastic reaction of both, provides a reliable closure of the joint.

4.2.7 Where joints in bituminous pavements are damaged, they normally can be repaired by filling with a hot bituminous sealing material, if the opening is not wider than about 3 cm. The same type of repair should be carried out where the sealing material is observed to have sunk into the joint.

Cracks in concrete pavements

4.2.8 Reasons for cracks in concrete slabs can be:

- incorrect forming of expansion joints which has resulted in a transfer of force between concrete slabs
- delayed cutting of hinged joints (dummy joints) in the construction phase so that shrinkage due to hardening was able to generate random strain cracks
- improper treatment during the initial hardening phase as, for instance, due to strong sun radiation on fresh concrete
- incorrect compacting of sub-base and therefore uneven settlement of subgrade so that slabs are not supported equally
- insufficient dimensioning of concrete slabs in view of the load applied on them.

4.2.9 "Wild" cracks in concrete always go through the full depth of the slab. On the surface the crack will appear in the form of a hair crack or a break, the latter giving the separated parts the freedom to move one against the other. Repair of cracks in concrete can never restore its capability of load transfer. The purpose is only to avoid water penetration from the surface into the subgrade.

4.2.10 Cracks in concrete slabs should be repaired by transforming the breaks into expansion joints. The crack has to be widened by cutting a slot along its length about 1.5 cm wide and 1 cm deep, The widened crack must be filled with a fuel resistant thermoplastic sealing material.

4.2.11 When the subgrade is particularly affected by water, and optimum water tightness is required, a channel about 20 cm wide and 2 cm deep should first be cut along the track of the crack and then the crack widened to a slot as described in the preceding paragraph. The cleaned slot is filled with a flexible dummy insert. Then, after appropriate cleaning and priming the channel is filled with an epoxy resin grout. When the resin has hardened the insert is removed from the widened crack and the resulting void filled with a fuel resistant thermoplastic sealing material (Figure 4-2).

4.2.12 Hair crack repair can be accomplished by sealing the crack zones with epoxy resin solvents. Since the solvent will not penetrate very deeply into the crack, damaged slabs should be inspected regularly and sealing repeated when necessary. A hair crack slab has not lost much of its bearing capacity and thus does not represent a severe deficiency to the operational serviceability of the pavement.

Cracks in bituminous pavements

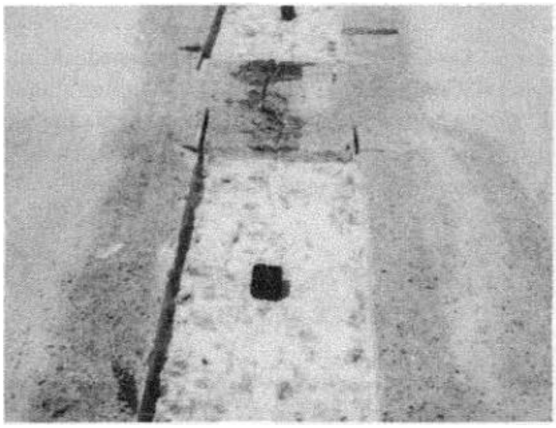
4.2.13 Cracks in bituminous pavements result from thermal stress building up in vast pavement areas when there are no expansion joints. Other reasons can be an insufficient adhesion of construction joints between adjacent lanes or deficiencies of subgrade bearing strength at isolated points due to construction mistakes. Repair of such cracks is essential to avoid penetration of water into the sub-base or subgrade. It is, however, not possible to stick the cracked parts firmly together and to retain the original stability of the pavement.

4.2.14 Cracks in bituminous pavements can be filled with a sealing emulsion without prior grinding. Special emulsions of high fluidity are available that will penetrate deeper into the crack than hot bituminous sealings. The filling can be carried out manually by using cans, or mechanically by using special pouring equipment. With a first run the crack's interior flanks will be covered, with a second run the crack can be filled up. The procedure should be repeated yearly or at longer intervals, depending on local climatic conditions.

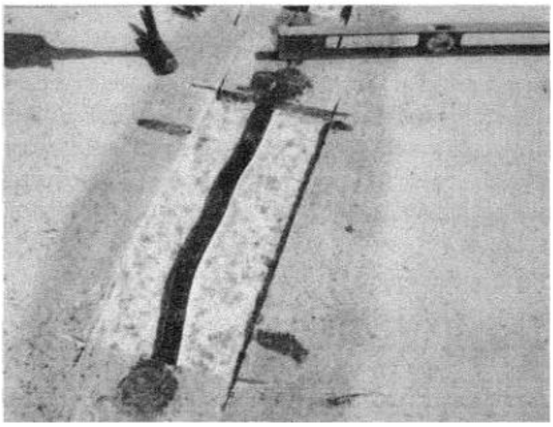
4.3 REPAIR OF PAVEMENT EDGE DAMAGE

General

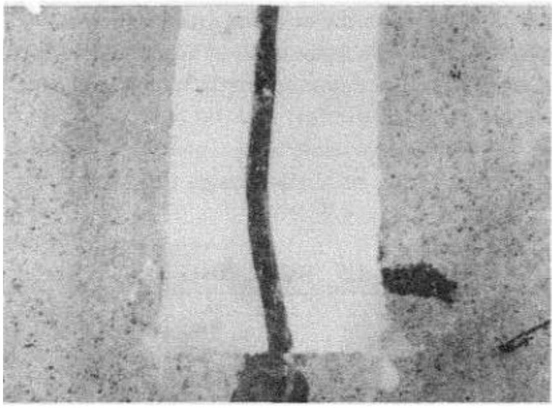
4.3.1 Broken edges occur most frequently at pavement joints. The reason for this type of damage is the undesirable transfer of force across the joint mostly produced by incorrect joint design or stones pressed into the joint. The pavement material above the point of contact is split off due to the induced compressive stress. Another reason can be the application of extreme point loads near to a slab joint or slab edge. Corners are particularly sensitive to overload when for some reasons the slabs are insufficiently supported by the sub-base.



a. Removal of surface material along the crack in channel shape



b. Widened crack filled with a flexible dummy insert or plastic sealant



c. 'Channel" refilled with epoxy resin grout
crack tightly closed by a joint sealant

Figure 4-2. Repair of a deep crack in a concrete pavement

4.3.2 Broken edges produce loose parts of various size which create a substantial risk to aircraft. Furthermore, surface irregularities on pavement are undesirable for aircraft and ground vehicles. Therefore, broken edges should be repaired as soon as possible. At least, imminent danger to aircraft should be minimized by removing all loose material from the pavement surface and closing provisionally deeper openings in the pavement surface,

Edge repair

4.3.3 Part of the maintenance should be to carry out careful investigation of the damaged section to find out the reason for the failure. When making the repair, the treated area should be made big enough to cover all damage. The boundary should be cut to a depth of at least 2 cm and all inside pavement material removed down to such a depth that all loose material is eliminated. Cutting can be done manually or by means of an electric hammer. When the damage is at a joint, the joint sealant must be removed to a length and depth of 5 cm beyond the cut-out section. The joint's flanks have to be cleaned, and dust and debris removed from the opening, preferably by compressed air. After preparing the cut surface with a primer and after putting a form into the emptied joint, the opening can be refilled with a suitable synthetic resin mixture. It is most important that in the course of filling the cut area no bridge is built up between the two neighbouring slabs, since sooner or later it would become the source of a new break in the repaired edge. Compacting should be done layer by layer and when smoothing the surface a chamfer should be provided at the edge. After hardening, the form in the joint can be removed, flanks in the joint cleaned, and the joint filled with a hot sealing material.

4.3.4 A filler material that meets the requirements of the climatic impact on the airport's pavement should be chosen. It is essential to add sufficient aggregate (quartz, glass pearls or other ceramic) to achieve a lean mixture with a small shrinkage ratio. Filler material which obtains its nominal strength no sooner than 24 hours after mixing has proven to be more suitable than quick hardening material.

4.3.5 For provisional repair some special cold asphalt materials have been developed which gain sufficient strength by compacting or hammering. Such material can be used for quick repair of both concrete and bituminous pavement. The costs are comparatively high and duration is limited, particularly on concrete pavement.

Corner repair

4.3.6 Broken corner repair will be carried out in the same way as described for edge repair. Attention should be paid to the slab's need to expand in two directions. Furthermore, the surface of the repaired slab must be level with both neighbouring slab surfaces.

4.4 REPAIR OF OTHER PAVEMENT SURFACE DEFICIENCIES

4.4.1 High quality requirements have been specified for runway pavement surfaces. The surface texture shall provide good friction characteristics, and the runway surface shall be constructed without irregularities that could adversely affect the landing or take-off of an aeroplane.

4.4.2 Where the friction characteristics of the runway surface have been found to be below the level specified by the state in IS 30, remedial action will have to be taken. Repair measures may range from cleaning the surface of contaminants to major repair. According to experience the following three techniques are in use:

- surface dressing;
- grooving of surface;
- scoring of surface.

4.4.3 With time a surface may become uneven without generating cracks. Where the unevenness occurs in spots and is moderate, scoring or milling the surface can help to restore the required surface quality. Where the deficiencies are found to be more severe, corrective action, such as the construction of an overlay, may become necessary. Such work is generally not considered a matter of maintenance but rather a matter of airport design practice.

4.5 SWEEPING

Purpose of sweeping

4.5.1 For safety reasons the surfaces of runways, taxiways and aprons have to be clean of sand, debris, stones or other loose objects. Aircraft engines can easily ingest loose material and suffer severe compressor blade or propeller damage. There is also the risk that propeller or jet engine blast may cause loose objects to be "shot" like bullets against adjacent aircraft, vehicles, buildings or people. Also, the tread on tires of taxiing aircraft or any other moving vehicle may throw up objects and cause damage. Maintenance of movement areas requires constant monitoring and regular sweeping of surfaces.

Surface monitoring

4.5.2 *Runway and taxiway contamination.* Objects to be found on runways and taxiways stem from the following sources:

- debris from damaged pavement
- debris from joint sealings
- rubber debris from aircraft tires

- stones from grass mowing
- metal or plastic parts from aircraft
- sand and soil from heavy storms or engine blast of aircraft
- dead birds or other small animals hit by aircraft.

4.5.3 *Visual checks on runways and taxiways.* Visual checks should be carried out regularly and at least every six hours during operating periods. Immediate checking is necessary upon advice of pilots on the existence of objects or debris. Special attention should be paid to the cleanness of runways and taxiways, when construction work on or near operational surfaces is going on. When construction machines or trucks use surfaces used also by aircraft, more frequent checking than normal is recommended.

Cleaning of surfaces

4.5.4 *Frequency of sweeping*. Surfaces intended to be used by aircraft and ground vehicles have to be swept regularly. The interval between sweepings depends on local needs and experience. Certain areas such as aircraft stands or freight handling zones at busy airports may require sweeping at least once a day.

4.5.5 *Sweeping equipment*. To accomplish the task of regularly sweeping all paved portions of the movement area, the use of truck-type cleaning equipment is practicable. The efficiency of the sweeper required depends on the size and traffic volume of the airport.

4.5.6 Truck-type Street sweepers are the right equipment for sweeping populated apron areas, service roads, access roads, walkways, parking lots and even hangar or shed floors. They are available in many different sizes. They work like vacuum cleaners, suppressing dust generation. To enable them to pick up heavy iron metal parts a magnetic beam can be mounted close to the sucking orifice or to a trailer pulled by the sweeper truck.

4.5.7 *Personnel discipline.* Even with regular sweeping the airport authority cannot fully guarantee the absence of contamination in the areas where work is continually being carried out. Regular training courses for the apron personnel on accident risks and the benefit of discipline are useful to minimize careless attitudes on the movement areas. Sweeping can only keep the foreign object damage low when the whole staff takes notice of the problem and keeps the movement area as clean as possible.

4.5.8 *Apron contamination.* Aprons are more likely to become contaminated than other aircraft movement areas on the airport due to the greater number of users of this area, traffic concentration and the loading process going on there. Objects found on aprons include stones, bottles, cans, stoppers, bottle caps, lost hand tools, personal belongings, nails, screws, bolts, paper, rubber, wire, plastic material, wooden, textile, synthetic and metal parts of all sizes from boxes, cases, pallets, containers and other packing devices. Contamination is worst in freight handling areas and, of course, near construction areas. Another kind of contamination to the pavement surface is by hydraulic oils, fuel and lubricants. Special cleaning measures to be taken are described in 4.6.

4.5.9 *Visual checks on aprons*. Through training programmes and regular reminding, personnel working on the apron can be taught to watch and visually check the condition of the apron and report on cleaning needs. Apron management service or the unit/service responsible for traffic on the apron should take immediate action to clear the apron of any dangerous contamination or debris observed or reported. Furthermore, inspection tours or walks should be carried out — when traffic activities justify — several times a day to ensure that the need to remove objects or any contamination on the apron is recognized in time.

4.6 CLEANING OF CONTAMINANTS

Purpose of cleaning pavements

4.6.1 Paved surfaces on airports can be contaminated by fuel, lubricants, hydraulic oils, marking paint or rubber. Contaminants may cause slipperiness and cover surface markings. Oil and rubber deposits on runways adversely affect the braking action of aircraft particularly when pavements are wet. A clean runway surface therefore is a safety requirement.

Removal of rubber deposits

4.6.2 Aircraft wheels contact the runway surface at high speed on touchdown resulting in a build-up of rubber deposits. Due to the friction-induced high temperature in the wheel contact area the rubber melts and is smeared into the surface texture. The rubber film is sticky and with the passage of time increases in depth. Layers of up to 3 mm thick may build up within 12 months in the touchdown zone of a busy runway. The aim of rubber removal is to restore the original macro roughness of the pavement surface. Such restoration is important to provide good drainage under the wheel in wet conditions.

4.6.3 Three methods are described below for removing rubber:

– chemically
– by mechanical grinding
– by high pressure waterblast.

The three methods are all effective; however, they are different in terms of speed, cost and erosion of surface material.

4.6.4 Rubber should be removed from runways when friction measurements under wet conditions indicate significant loss of braking quality in critical runway sections.

4.6.5 *Chemical method.* The area of pavement to be treated is sprayed with a liquid chemical from a tank vehicle having a spray bar, or by hand with hose and nozzle. The chemical's reaction time ranges from 8 to 15 minutes, depending on the depth of the rubber film. During this time the rubber (and paint) swell up and can be flushed away with high pressure water jets. Sweeper trucks or other equipment must clean the water- flooded area sucking up the loose rubber from the Surface. Special equipment has been developed combining flushing and sucking in one vehicle. The chemicals dissolve not only rubber but also paint markings and bituminous material. When applied to asphalt pavements, sufficient water flushing is important to protect the pavement. The treatment must not be interrupted before treated patches have been flushed thoroughly with water.

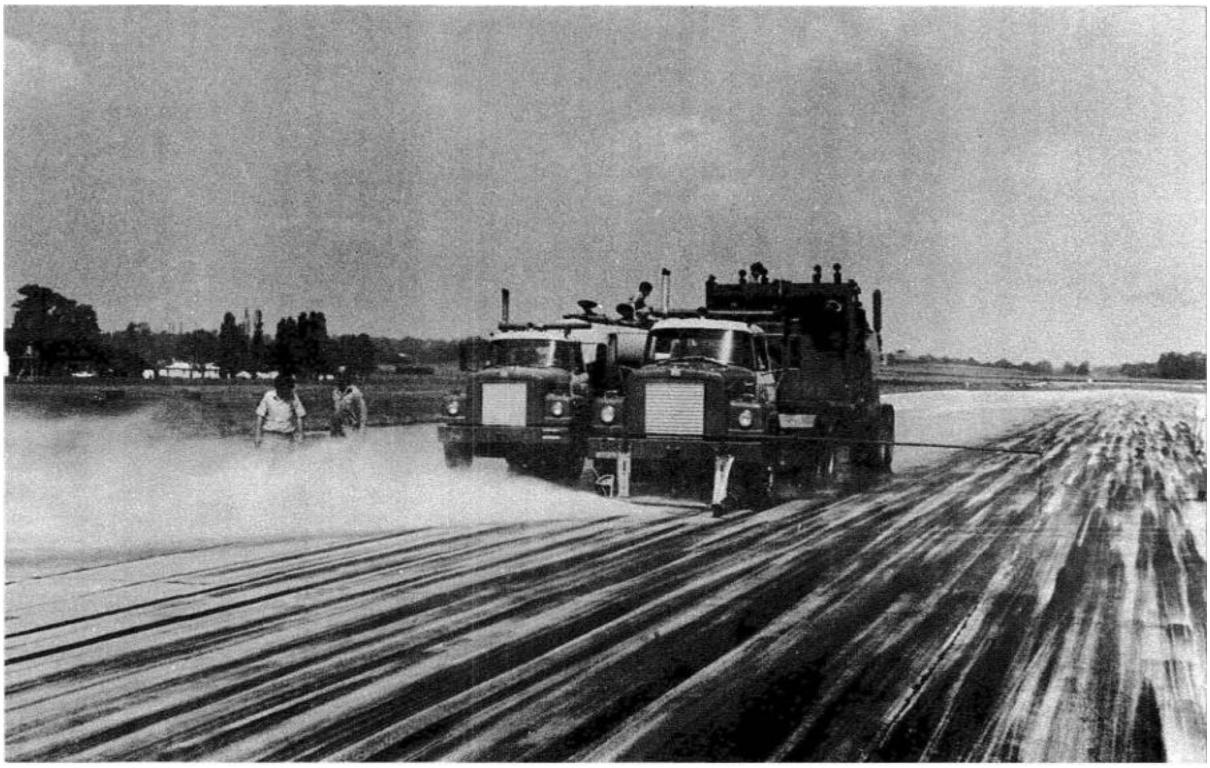


Figure 4-3. Rubber removal by the high-pressure water blast method

4.6.6 *Mechanical grinding method.* There are various methods of grinding pavement surfaces. As runway maintenance should preserve the integrity of the original surface, a milling method has proven to be satisfactory. Milling rollers composed of metal discs on a rotating shaft are passed over the surface. The distance between the shaft and the pavement is controlled so that the discs just hit the pavement, but without much pressure. With three rollers fixed to the vehicle's chassis, a strip of about 1.8 m can be cleaned at one run. Working speed goes up to 500 m^2 per hour if rubber deposits are not too thick. The milling not only removes the rubber layer but, depending on the height control of the roller Shaft, also roughens the pavement surface. While this can effectively improve the surface textures the milled depth should be kept as small as possible. All mechanical methods must be applied very carefully to avoid severely damaging inset lights and joints between slabs. Sweepers must follow the milling vehicle to clean the strip of dust and rubber debris.

4.6.7 *High pressure water blast method.* Rubber removal is accomplished by high pressure water jets directed at oblique angles to the pavement surface (see Figure 4-3). The equipment normally consists of a tank vehicle with motors pumping water at high pressure, e.g. 40 MPa through a nozzle bar guided closely above the pavement surface. Water consumption is high, about 1 000 L per minute. The angle of attack of the water jets can be varied, e.g. by rotation of the nozzle bar. Working speed will range from 250 m^2 to 800 m^2 per hour. Cleaning has to be done by sweepers following the removal truck at some distance. Where water supply is not a problem, the high-pressure waterblast method is most efficient, As opposed to the chemical method, there are no special measures required for environmental protection.

Fuel and oil removal

4.6.8 Contamination by fuels, lubricants and oils can be found on many apron areas, such as aircraft stands and areas used regularly by loading vehicles, Contaminants can be removed by spraying grease solvents followed by water flushing. If necessary, water jet cleaning may follow to achieve optimum results. Where fuel or oils are spilled accidently the spillage must immediately be covered by oil absorbing material, as developed by the oil industry. This material is a powder or granulate which, scattered on the spillage, absorbs the liquid and can be easily removed later by sweeping. However, it does not absorb oils already soaked into the pavement material. Repeated oil soaking of concrete and/or bituminous asphalt may deteriorate the surface material and require surface repair instead or cleaning. Since surface drainage from apron and workshop areas normally runs into the sewage system, national rules on environmental protection have to be borne in mind when cleaning pavements by means of chemicals.

Chapter 5 Drainage

5.1 GENERAL

5.1.1 Drainage of the airport area is necessary:

- to maintain sufficient bearing strength of the soil for the operation of vehicles and/or aircraft at any time during the year
- to minimize the attraction of birds and other animals representing a potential hazard to aircraft.

5.1.2 Surface drainage is required to clear all parts of the movement area of standing water and prevent the formation of ponds or puddles. The quick run-off of water is particularly important on runways to minimize the hazard of aquaplaning.

Layout

5.1.3 For practical reasons an airport should have two drainage systems, one system which drains areas such as runways, taxiways, aprons, service roads, public roads and parking lots, and another system which drains areas more likely to be polluted by oil, grease or chemicals such as hangars, aircraft maintenance areas, workshops and tank farms (see Figure 5-1).

5.1.4 The drainage system intended to serve the "clean" area may be built in a way to sink the drain water (from precipitation) into the adjacent ground. Where the natural ground is not suitable to drain the surface water it must be collected in slot drains or other artificial sinks which are connected with a drain pipe, culvert or canal ducting the water to nearby creeks, rivers, lakes, etc. To protect these natural water courses from pollution, collector basins with oil separators should be installed.

5.1.5 The drainage system intended to serve hangars, workshops, tank farms and other pollutant-generating areas should be connected to a regular sewage system which ducts the water to sewage treatment plants. For pretreatment the collected drain water should pass through fuel separators before entering the sewage culvert.

5.1.6 Generally, the airport operator will have to comply with rules on water treatment issued by the national or local authorities responsible for water conservation, water supply and environmental protection. The layout of airport drainage systems depends on local conditions and so does the maintenance programme.

5.2 CLEANING OF SLOT DRAINS

5.2.1 To facilitate the cleaning of slot drains, openings should be provided at 60 m intervals along the whole line. They must give good access to the bottom of the slot drain and serve as sand traps at the same time. Cleaning of a slot drain can be carried out most effectively by flushing all sections with water at high pressure, forced into the duct at 18 MPa or more. Where necessary, mud and sand deposits must be vacuumed off by special mobile cleaning equipment.

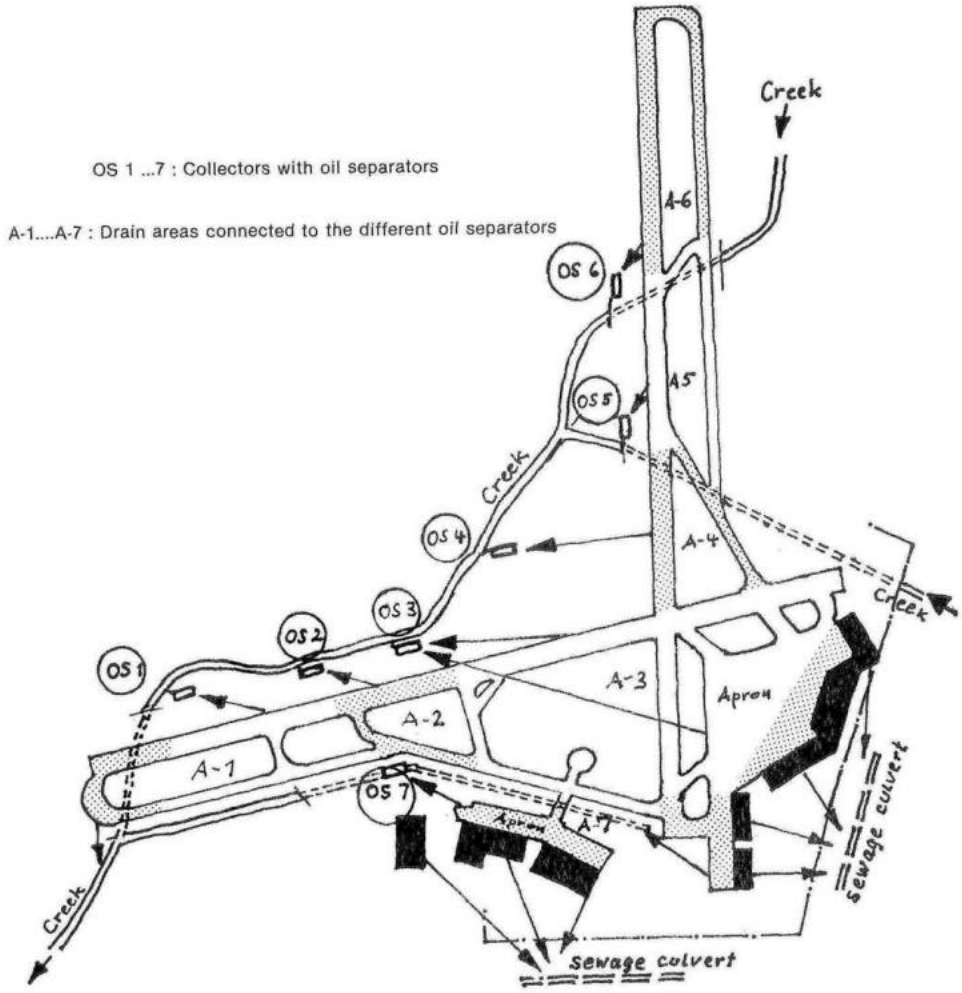


Figure 5-1. Example of an aerodrome drainage system where all drain water from hard surfaces is passed through oil separators

5.2.2 The time intervals for cleaning depend on local experience with drain lines. One cleaning action per year has proved to be the minimum. Regular inspections should be carried out to detect the need for additional cleaning. After heavy rain showers which flood unpaved areas near the slot drain, immediate checking of the drain capacity is highly recommended.

5.3 DRAIN PIPES OR CULVERTS BETWEEN SURFACES AND COLLECTOR BASINS

5.3.1 Drain pipes should have manholes at intervals to allow cleaning the pipe of deposits. Sections between consecutive manholes should not exceed 75 m and manholes should have a cross section of at least 1 m^2. The cleaning can be accomplished by means of flushing with water at high pressure.

5.3.2 Time intervals for cleaning depend on local experience. Cleaning once a year seems to be the operational minimum to ensure good drainage capacity of pipes and culverts collecting surface water from precipitation, where the cross section of the pipes are less than 30 cm, cleaning twice a year may be necessary.

5.4 OIL AND FUEL SEPARATORS

5.4.1 Oil separators are integral parts of water collectors. The number and size of collectors depend on the drained area and quantity of precipitation (see Figure 5-1). The capacity of a separator shall be such that the flow speed will at any time be slow enough to prevent oil passing by the separator wall into the collector basin. The oil layer depth at the surface of the separator must be checked weekly and oil pumped off when necessary (see Figure 5-2).

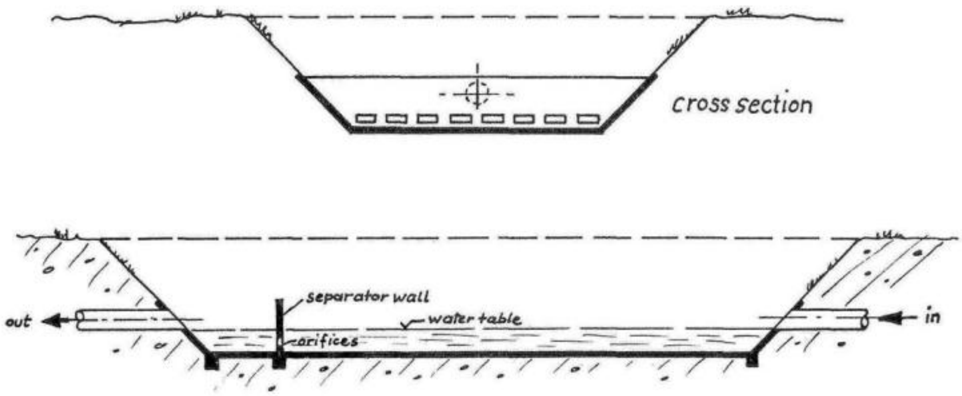


Figure 5-2. Drain water collector with oil separator

5.4.2 The bottom and the banks of the drain water collector basins should be kept clear of plants. Embankments should be mowed regularly. Once a year the bottom should be cleaned.

5.4.3 Fuel separators are components of the drainage system of hangars, workshops and other technical working areas which must be provided with separator installations. Their capacity will be determined by the expected maximum drain water through-put. The amount of trapped oil and/or fuel should be checked in accordance with a maintenance plan for the facility, describing the time intervals of pumping off oils. The intervals must be derived from local experience. They can vary widely. To avoid accidental overflow of the fuel collector, automatic monitoring can be provided. Oil and fuel separated from the drain water must be pumped or carried to a demulsify-cation plant (see Figure 5-3).

5.4.4 For removal of oil and fuel from separators the employment of specialists (under contract) can be practical since special tank vehicles are required, and the deposits have to be removed in accordance with environmental rules on the treatment of waste oil.

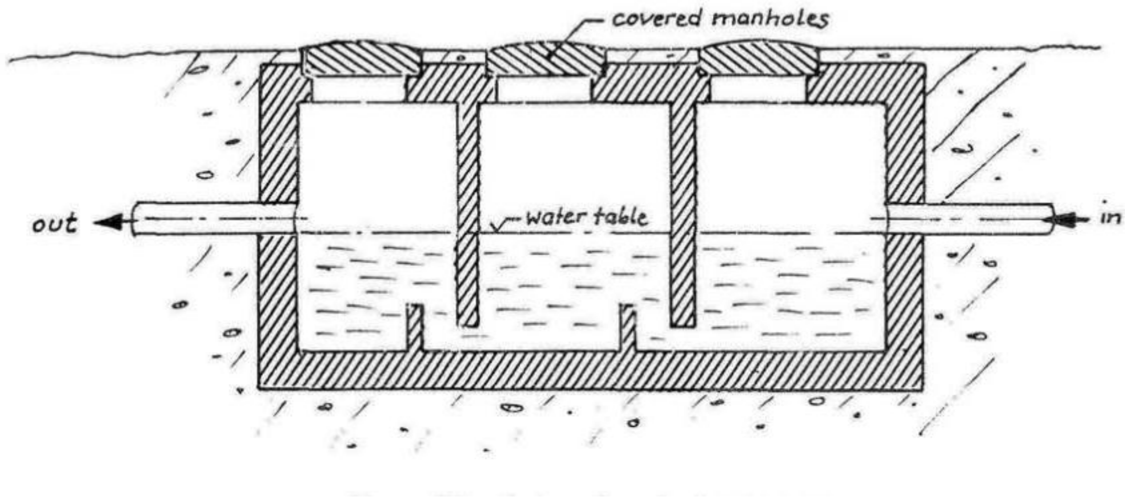


Figure 5-3. Sub-surface fuel separator

5.5 WATER HYDRANTS

5.5.1 The capacity of the airport's water supply system should comply with the requirements of firefighting. All valves and flaps in the pipeline network should undergo functional testing once a year. Additional monitoring by checking the water consumption weekly can be useful to detect undiscovered leakages at an early date.

5.5.2 All fire hydrants including those at buildings must be checked regularly (see 9.12.1). Any subsurface hydrants should be kept clean of soil or mud so that they can be found without delay in cases of emergency.

Chapter 6 Maintenance of Unpaved Areas

6.1 GENERAL

6.1.1 The maintenance of unpaved areas on an airport is essential for the following major reasons:

a) safety of aircraft on operating areas (this concerns runways, taxiways, strips and runway end safety areas);

b) safety of airborne aircraft (this concerns areas on the airport and in its nearby vicinity within the defined flight pattern where trees and bushes may grow); and

c) reducing bird hazards to aircraft (this concerns grass land within the airport's boundaries).

6.1.2 The maintenance of unpaved areas need not necessarily be carried out by the staff of the airport operator. The airport operator may contract with nearby farmers who will take care of the task upon advice. The farmers can use the grass for cattle feed and can provide their own equipment. Work performed by contractors must be monitored by authorized personnel to safeguard air traffic safety requirements.

6.2 MAINTENANCE OF GREEN AREAS WITHIN STRIPS

6.2.1 Requirements as to the quality of surface grading and bearing capacity of strips and shoulders are specified in IS 30, 3.4.8, 3.5.8 and 3.11.4.

6.2.2 After construction work in strip areas, attention should be paid to retain the specified surface conditions. Where the bearing capacity has been reduced it must be improved by soil compaction. Humps and depressions should be eliminated. To protect the surface against blast erosion a sound matting of grass should be provided. On normal soil this condition can be achieved by seeding with grass. Poor soils will need fertilizing. Sometimes this can be accomplished by adding arable soil or humus from composted hay.

6.2.3 In many cases soil replacement will become necessary. A biologically acceptable sealing material may have to be used for fixing the loose soil containing the fresh seed until the grown grass is capable of protecting the soil against blast erosion. Where poor drainage along the edges of pavement increases erosion effects, hard surface shoulders may have to be built to overcome the problem.

6.2.4 Grass in the strips should not exceed 10 cm (4 inch) in height. Regular mowing will be necessary to keep the grass low, the frequency depending on the climate. The cut material should be picked up since otherwise it might be sucked into jet engines, thus creating a potential hazard to aircraft operation. Where applicable, growth retardant can be used to control growth rate. Its application, however, is often limited by national or municipal rules for ground water protection, since some growth retardant chemicals can detrimentally affect the quality of drinking water. As these chemicals may also be expensive, it is useful to consider their cost effectiveness in comparison to more frequent mowing.

6.2.5 Mowing attracts birds as the freshly mowed areas are rich in bird food. To minimize the ever-present risk of bird strikes, mowing should take place preferably before periods of lowest air traffic. In other cases, bird protection measures may have to be increased after mowing to keep the collision risk low.

6.3 MAINTENANCE OF GRASS ON UNPAVED RUNWAYS AND TAXIWAYS

6.3.1 Grass height should be kept as low as practicable on unpaved runways and taxiways a rolling drag increases markedly with grass height. Take-off distances can increase by some 20 per cent when grass on runways is too high. For treatment refer to 6.2.4 and 6.2.5.

6.4 MAINTENANCE OF GREEN AREAS OUTSIDE STRIPS

6.4.1 The major reason for maintenance of green areas of an airport outside the strips is to control animal life within the airport boundary. While generally it is not too difficult to keep wild animals that might create collision risks out of the area, for instance by means of fencing or hunting, the bird population is very difficult to control. The aim of measures concerning grass surface cultivation is to minimize bird population in order to keep the bird strike hazard as low as possible.

6.4.2 Maintenance of grass surfaces should be determined by the individual needs of the site, i.e. the local species of birds and their habits. Most species prefer low grass areas for food searching; conditions for finding food are better and watching out for enemies is facilitated by good visibility in all directions. For keeping large numbers of birds from settling, the optimum grass height has been observed to be around 20 cm (8 in). Only the smallest birds of body mass less than 20 g will prefer such meadows for residence. They are, however, less dangerous for aircraft than heavier birds.

6.4.3 Recent research indicates that dry grass land offers more food to birds than wetland. Draining should therefore be restricted to areas such as unpaved runways, taxiways and strips where good bearing capacity of the soil is necessary in the interest of air safety. In other parts of the airport swampy patches can be tolerated as long as ponds are precluded that would attract aquatic birds.

6.4.4 When the grass height is kept to not less than 20 cm (8 in), as protection against birds the mowing frequency will be low. The grass should be mowed down to a height of about 10 cm and the cut grass should be picked up to prevent detrimental "choking" effects to the grass mats under a probably heavy hay coverage. Consequential composting effects on the mat also produce great numbers of microscopic organisms, insects, worms etc., and again, attract birds to the area. Since immediately after mowing the area attracts birds searching for food, the most favourable period for mowing with regard to local birds' habits should be chosen.

6.4.5 Maintenance work on grass lands should include special methods to diminish the number of mice. Where mice population exceeds a "normal" rate, birds of prey may be attracted which, due to their flight techniques and body mass, create the most severe bird strike hazard. Mice populations will then have to be controlled by using suitable chemicals.

6.4.6 Trees and bushes need no special maintenance except for controlling their height. When trees penetrate an obstacle limitation surface they should be shortened. One technique is to cut the trees or bushes but leave their roots in the ground so that they may sprout again. To discourage birds from settling, all bushes carrying berries should be eliminated from the airport.
Note.- The height of trees in the approach and departure areas outside the airport boundary must be controlled for air traffic safety reasons. To minimize the extent of cutting or shortening of trees, cutting can be done more frequently.

6.5 TREATMENT OF CUT GRASS

6.5.1 Since grass should be removed immediately after mowing as a protection against birds and for other safety reasons, considerable quantities of cut grass will be collected on larger airports. If grass cannot be given away to nearby farmers or ranchers, two options exist:

a) composting at a suitable site and recycling as fertilizer for the airport, or for sale to gardeners or farmers, cut grass needs approximately three months for composting before it is usable;

b) *disposal in a dump.* The dump should be far away from the airport since cut grass will, without proper treatment, decay producing a wet and very polluting waste.

Chapter 7 Maintenance of Equipment and Vehicles

7.1 GENERAL

7.1.1 By preventive maintenance, facilities on an airport can be kept in such a condition as to maintain safety, regularity and expeditious operation of air traffic. This specification covers the following equipment and vehicles:

- rescue and fire fighting vehicles
- pavement surface friction measuring devices
- sweepers for removal of contaminants from aircraft operating areas
- mowers and other vehicles for control of grass height on unpaved areas.

7.1.2 There also may be many other vehicles in operation for aircraft ground handling (fuel, water, electric energy, high and low pressure air), passenger handling, freight handling and transport. All these vehicles require preventive maintenance work in accordance with the manufacturer's advice. Operators of the vehicles have to make appropriate arrangements for keeping their equipment serviceable at any time as part of the airport maintenance task.

7.2 ORGANIZATION OF VEHICLE MAINTENANCE

7.2.1 Airport vehicle maintenance can be organized according to three different principles:

a) maintenance is carried out by the airport in its own workshops;
b) maintenance is carried out by contractors in workshops located on the airport; or
c) maintenance is carried out by contractors outside the airport.

7.2.2 The main reasons for providing workshops at the airport are:

a) the difficulty of moving specialized and very big vehicles, which are not licensed for use on public roads, outside the airport area; and

b) the time and manpower needed to move vehicles from the airport to remote workshops and vice versa.

7.2.3 Reasons for providing airport-owned workshops are:

a) personnel can be supervised by the airport management and their schedule or work adjusted to fit the airport's needs;

b) personnel can be trained to specialize in maintenance tasks for all airport equipment and will gain much experience;

c) personnel can be organized in such a way as to carry out stand-by tasks outside the normal duty hours;

d) personnel can carry out maintenance tasks on installed equipment; and

e) other duties like aircraft removal, assistance in emergencies, etc. can be assigned to workshop personnel upon short notice.

7.2.4 Reasons for contracting with maintenance companies outside the airport are:

a) availability of expert knowledge, plants and tools for standard equipment overhaul and repair (e.g. motors, gear boxes, generators, drive axles of standard automotive design);

b) lack of own personnel or specialists for economic reasons (e.g. number of vehicles too low to warrant workshop installations and manning); and

c) need to overcome peak or bottleneck situations.

7.3 SCHEDULE OF VEHICLE MAINTENANCE

7.3.1 The basis for vehicle maintenance is a schedule of the services required and the intervals between servicing. The schedule can be developed by the maintenance workshop or by the vehicle operating branch. For maintenance of standard vehicles the manufacturer's advice should be considered. In the absence of such recommendations the schedule should be based on experience with maintenance needs.

7.3.2 Inspection schedules for self-driven vehicles can be related to the kilometres driven or operating hours recorded. For ether equipment, fixed time intervals are practical.

7.3.3 Fixed time intervals offer the advantage of a well-balanced workshop utilization. Equipment with a low number of operating hours per year should be inspected regularly. Maintenance to protect from true wear, however, cannot be met by the fixed interval method, since the individual use of equipment is not considered.

7.3.4 Where the hours driven are the basis of the schedule, the user must maintain a record of the hours operated. The equipment user should take care to rotate the use of equipment and check the operating hours record. An easy way of controlling the operating hours can be achieved by marking the limit of the vehicle on a label attached to the driver's panel or screen. Monitoring can also be carried out by fuelling personnel.

7.3.5 The user (or proprietor) of the vehicles will define the maintenance intervals in accordance with experience, manufacturer's recommendation and workshop capacity. No standards can be given.

7.3.6 The maintenance programme is individual for each type of vehicle or equipment and depends on its function, wear and tear characteristics and manufacturer's recommendation. Inspection must be carried out by specialists.

7.3.7 In the interest of safety, operating personnel must be advised to check the functioning of ail essential components, e.g. brakes, control, tires, lights every day before using any vehicle or piece of equipment. Whenever deficiencies or failures are discovered, the unserviceable equipment should be taken out of service and repair should be carried out as soon as practicable.

7.3.8 An important element of the maintenance of airport vehicles is the servicing of installed radiotelecommunication equipment, since, by the very nature of traffic control on an airport, the radiotelephone has to be serviceable at any time.

7.4 WORKSHOPS

7.4.1 Workshops on airports should be concentrated, if possible, to form a workshop centre. The capacity and equipment to be provided depends on the workload which is a function of the size of the airport's equipment fleet. The availability of the following workshops is most useful:

- automotive engine with test bed
- chassis (garage) with paint section
- automotive electric workshop
- mounting platform and car hoist
- brake test bed
- hydraulics
- tinsmith
- washing.

7.4.2 Workshops should be manned by specialists. At intervals the personnel should be sent to equipment manufacturers for training.

Chapter 8 Buildings

8.1 GENERAL

8.1.1 Many airports are sites for various industrial activities generated by aviation or related business. The built-up area of an airport therefore can be covered by a great number of buildings, only part of which house the primary aviation functions. Typical buildings to be found on airports are:

– passenger buildings
– freight handling sheds and cargo stores
– air traffic control buildings
– aircraft hangars
– fire stations
– workshops and aircraft/engine maintenance plants
– vehicle and equipment sheds
– fuel farms and fuel tanks
– depots and silos
– aircraft catering buildings
– administration and office blocks
– hotel/restaurant buildings
– convention centres
– parking garages.

8.1.2 All these buildings require maintenance; however, little of this work is airport-specific. In the context of airport maintenance practices dealt with in this manual, normal building and technical facilities maintenance is not described. Descriptions will be limited to elements, the proper function of which is a prerequisite to efficient passenger or baggage handling, or passenger safety.

8.1.3 The building on an airport that directly affects passenger and baggage handling is the passenger or terminal building. Its purpose is the interchange between ground and air transportation, and transfers between flights. While the safety requirement is the same as for any other public facility, the outstanding requirement is for a speedy flow of passengers and baggage through the facility.

8.1.4 In order to meet this efficiency requirement the following components of the terminal building should not suffer from operational deficiencies during the operating hours:

– lighting system for the passenger terminal buildings and associated landside forecourt and car parking area
– passenger flight information system
– air conditioning system
– mechanical (automatic) doors
– baggage conveyor belts
– baggage delivery equipment in claim areas
– fixed passenger loading devices (nose loaders or loading bridges)
– lifts (elevators)

– escalators
– people movers
– fixed fire protection installations
– emergency exits.

8.1.5 A great deal of the maintenance work described in the following section is particularly appropriate to contract work. Maintenance contracts on servicing and overhaul of such facilities as automatic doors, conveyor belt systems, passenger loading bridges, lifts, escalators and moving walkways have proven to be useful and economical.

8.2 LIGHTING AND ELECTRIC EQUIPMENT

8.2.1 The complete lighting system of the passenger building and forecourt has to be checked daily. Visual monitoring should cover all lamps, illuminated signs and information boards. Any deficiencies that would adversely affect passenger orientation or handling should be corrected quickly. Other reported deficiencies should be noted for repair within the schedule of the maintenance plan.

Daily:

Visual inspection of all lamps for proper operation.

Weekly:

Replacement of fluorescent tubes and their ignition starters in accordance with the replacement schedule that the terminal operator has laid down in the maintenance plan.

Monthly:

– repairs which have been found necessary by inspections according to the maintenance plan for electric installations
– checking of accumulator (battery capacities)
– replacement of light bulbs according to plan.

Quarterly:

– checking of lighting control units
– adjustment of dimmers.

Semi-annually:

– checking of supply lines and cables, switches and distributors
– cleaning of plugs, contacts and terminals in the electric wiring.

Annually (or less frequently):

- cleaning of lamps
- checking of insulation capacity by overload voltage.

8.2.2 *Lighting system for roads and parking lots.* Basically, the maintenance programme is the same as for apron lighting systems, described in 3.3.10. A functional check during daylight, however, is not required, since the serviceability of the total system is maintained in spite of single lamp failures. The unserviceable lights can be identified more easily during regular night inspections. Other possible failures will be noticed by the operator of control desks, particularly where the lighting system is connected to a control centre equipped with appropriate electric monitoring meters.

8.3 COMMUNICATION FACILITIES

8.3.1 Means of communication in passenger terminals can be flight information boards, television monitors, loudspeakers and electric clocks. Normally such installations are self-monitoring, i.e. deficiencies are identified electronically and indicated at the technical control centre. Maintenance should include checking of: Daily: - control unit for flight information board - readability of television monitors - electric clocks' control unit - electric circuit of the loudspeaker system.

Whenever possible, adjustments should be carried out immediately.

Semi-annually: Servicing of all components of:

- flight information boards and television monitors
- amplifiers for the loudspeaker system.

Annually:

Cleaning of information boards, e.g. all drives and flaps of electro- mechanical systems, screens or lights used for giving information visually to passengers.

8.4 AIR CONDITIONING SYSTEM

8.4.1 The operational condition of the system has to be monitored constantly from the control centre so that any failures can be detected early and corrective action taken in time. Maintenance should include checking the following:

Daily:

Inspection of all machinery and air ducts concerning temperature, pressure and leakage including:

- moisture controls
- energy consumption of electric motors
- freezers
- cooling water flow meters
- timer control.

Findings should be recorded and, in case of deficiencies, remedial action taken.

Weekly:

- activated carbon filters; changing when necessary
- other air filters; changing when necessary
- energy consumption of freezers (refrigerators), air supplies, fans, electric motors, flaps, valves, regulators and pumps
- insulation for damage
- cone belts.

Monthly:

- servicing of all air ducts, fans, electric motors, flaps, valves, regulators and pumps
- cleaning of all dirt traps in the pipe network
- energy consumption record.
- air ducts

Semi-annually:

- servicing of refrigerators and switching units
- cleaning of heat exchangers and fans
- output data and adjustment of performance of all components to desired standards
- cleaning of fire protection gates and other closing devices in the system.

Annually:

- chemical and mechanical cleaning of condensers and evaporators
- servicing of fire protection gates.

Unscheduled:

Activated carbon has to be replaced at intervals of between two and three years according to experience with the air conditioning system in use.

8.5 AUTOMATIC DOORS

8.5.1 Automatic doors may be operated electrically, hydraulically or pneumatically. Any observed deficiencies of such doors should be reason for immediate repair or closure of the unserviceable entrance/exit to avoid damage to the door and - even more important - to avoid the risk of injuries to people. Unserviceable automatic doors should be marked by warning signs that at the same time give guidance to people on where to walk. Maintenance should include:

Weekly:

- checking of control mechanism at all automatic doors
- adjustment of the level of sensitivity if necessary
- at pressured air operated doors: checking of compressed checking of: air tanks and pipes for tightness.

Annually:

- full overhaul including cleaning of the door drives and at compressed air operated doors also the overhaul of compressors
- checking on wear at activator rods, chains and guide rails of the driving mechanism
- replacement of worn parts
- checking of serviceability and if necessary adjustment of all safety installations.

8.6 BAGGAGE CONVEYOR BELTS (FIXED INSTALLATIONS)

8.6.1 Baggage conveyor belts are normally installed between baggage check-in areas and sorting or baggage make-up areas as well as between unloading stations for incoming bags and luggage reclaim areas. To ensure uninterrupted operation the condition of all belts has to be monitored continuously. Short cracks at the edges can be eliminated by cutting off the damaged edge material. Maintenance should include:

Weekly:

- visual checking of belts for damage such as cuts and cracks
- checking on smooth movement and low noise; whenever necessary, replacement of noisy or squeaking rollers
- adjustment of loose spring rollers
- adjustment of belt movement and stress.

Monthly:

- cleaning of joints and dirt trapping boxes
- removing of paper and other waste from underneath the belt by vacuuming.

Annually:

- checking and overhaul of drives
- cleaning of driving motors, oil change or refilling of gear boxes
- cleaning and lubrication of driving chains.

8.7 BAGGAGE CLAIM UNITS

8.7.1 Weekly maintenance should include checking for:

- damage and cracks
- smooth movement and low noise, and, when necessary, replacement of noisy rollers.

8.8 PASSENGER BOARDING BRIDGES

8.8.1 Passenger boarding bridges (fixed and apron drive) are exposed to weather impact. Major maintenance work should follow immediately after rain season to counteract corrosion.

Bridge gear and lift device maintenance should include:

- weekly check of tires for surface damage and wear and replacing if necessary
- inspection of wheel brakes
- inspection of electric driving motors and cleaning of drive chains
- inspection of lifting jacks for wear
- checking of lubrication of lifting jacks
- inspection of hydraulic system

Intervals of regular maintenance work depend on experience and/or manufacturer's advice.

Bridge body maintenance should include:

Weekly:

- checking of all bridge movements, i.e. extension, retraction, lowering, raising and steering.

Semi-yearly:

- checking of bearings and their lubrication
- replacement of worn or corrosive rollers
- checking of drive chains and adjustment of chain stress
- checking of floor covers for damage and fixing or replacement of loose parts
- warm water cleaning of outer skin of bridge tunnel
- renewal of paint, if necessary.

8.9 FIRE PROTECTION INSTALLATIONS

8.9 .1 Maintenance of fixed fire protection installations should include checking of:

Weekly:

- fire extinguishers within the whole building for integrity

– emergency exits for access clearance and removal of obstacles.

Quarterly:

– serviceability of all components of the fire warning and fire alarm system in the building.

Semi-annually:

– serviceability of fire doors designed to close automatically in case of fire or smoke
– serviceability of all fire extinguishers in the building.

Annually:

– functioning of smoke doors and flaps
– serviceability of emergency exit locks
– serviceability of pumps and fire hydrants
– hose condition.

Note.- National rules for the provision and maintenance of fire protection installations have to be observed carefully.

-END-