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AIRPORT MAINTENANCE MANUAL

“State Civil Aviation Agency” public legal entity

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AZƏRBAYCAN RESPUBLİKASI
RƏQƏMSAL İNKİŞAF VƏ NƏQLİYYAT NAZİRLİYİ
DÖVLƏT MÜLKİ AVİASİYA AGENTLİYİ
PUBLİK HÜQUQİ ŞƏXS

ƏMR

“Hava limanının texniki xidmətinə dair Təlimat”ın təsdiq edilməsi haqqında

Mülki aviasiya qanunvericiliyinə dair tələblərin uyğunlaşdırılmasının həyata keçirilməsi məqsədilə Azərbaycan Respublikası Prezidentinin 2025-ci il 21 fevral tarixli 341 nömrəli Fərmanı ilə təsdiq edilmiş “Dövlət Mülki Aviasiya Agentliyi” publik hüquqi şəxsin Nizamnaməsi”nin 2.1.3-cü, 2.1.5-ci, 3.1.9-cu və 4.10.6-cı yarımbəndlərini rəhbər tutaraq,

əmr edirəm:

1. “Hava limanının texniki xidmətinə dair Təlimat” (”Airport Maintenance Manual”) adlı sənədin 1-ci nəşri (bundan sonra – Təlimat) təsdiq edilsin.
2. Keyfiyyətə nəzarət sektoru bu Əmrlə birlikdə Təlimatın “Dövlət Mülki Aviasiya Agentliyi” publik hüquqi şəxsinin (bundan sonra – Agentlik) bütün şəxsi heyətinə çatdırılmasını təmin etsin və rəsmi internet informasiya ehtiyatında yerləşdirilməsi üçün İnzibati idarəetmə departamentinə məlumat versin.
3. Aerodrom istismarçılarına nəzarət (AGA) və yerüstü xidmət təminatçılarına nəzarət departamenti bu Əmrlə birlikdə Təlimatın aidiyyəti mülki aviasiya subyektlərinə müşayiət məktubu ilə çatdırılmasını təmin etsin.
4. Bu Əmr qüvvəyə mindiyi tarixdən etibarən Agentliyin 2022-ci il 04 may tarixli 33 nömrəli əmri ilə təsdiq edilmiş “Hava limanlarına texniki xidmət göstərilməsinə dair Təlimat”ın 3-cü nəşrinə edilmiş 1 nömrəli dəyişiklik (G-AGA-003) ləğv edilsin.
5. Əmrin icrasına nəzarət Aerodrom istismarçılarına (AGA) və yerüstü xidmət təminatçılarına nəzarət departamentinin müdiri Aydın Mirzəzadəyə həvalə edilsin.

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İdarə Heyətinin sədri vəzifəsini
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0 Administration and control of the document

0.1 Approval Page

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0.2 Table of content

0 Administration and control of the document 1

0.1 Approval Page 1
0.2 Table of content 2
0.3 List of effective pages 5
0.4 Distribution and control 7
0.5 Records of amendments and revisions 8
0.6 Terms and definitions 9
0.7 Abbreviations 11
0.8 Terms shall, should, may 12
0.9 Administration and control 12

1 Introduction 1

1.1 Purpose of airport maintenance 1
1.2 Organization of airport maintenance 1

2 Maintenance of visual aids 1

2.1 General 1
2.2 Personnel 1
2.3 Spare parts 1
2.4 As-built drawings 1
2.5 Light maintenance schedule 1
2.6 Lights maintenance procedures 5
2.7 Signs 7
2.8 Markings 8

3 Maintenance of airport electrical systems 1

3.1 General 1
3.2 Personnel 1
3.3 Schedule of maintenance 1

4 Maintenance of pavements 1

4.1 Surface repair 1
4.2 Repair of joints and cracks 2
4.3 Repair of pavement edge damage 4
4.4 Repair of other pavement surface deficiencies 5
4.5 Sweeping 5
4.6 Cleaning of contaminants 7

4.7 Removal of snow and ice 8

5 Drainage 1

5.1 General 1

5.2 Cleaning of slot drains 1

5.3 Drain pipes or culverts between surfaces and collector basins 2

5.4 Oil and fuel separators 2

5.5 Water hydrants 2

6 Maintenance of unpaved areas 1

6.1 General 1

6.2 Maintenance of green areas within strips 1

6.3 Maintenance of green areas outside strips 2

6.4 Treatment of cut grass 2

7 Maintenance of equipment and vehicles 1

7.1 General 1

7.2 Organization of vehicle maintenance 1

7.3 Schedule of vehicle maintenance 2

7.4 Workshops 3

8 Buildings 1

8.1 General 1

8.2 Lighting and electric equipment 2

8.3 Communication facilities 3

8.4 Air conditioning system 3

8.5 Automatic Doors 4

8.6 Baggage conveyor belts (fixed installations) 4

8.7 Baggage claim units 5

8.8 Passenger boarding bridges 5

8.9 Fire protection installations 6

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0.3 List of effective pages

	Chapter 0	
Page	**Effective date**	**Revision #**
1	23.09.2026	00
2	23.09.2026	00
3	23.09.2026	00
4	23.09.2026	00
5	23.09.2026	00
6	23.09.2026	00
7	23.09.2026	00
8	23.09.2026	00
9	23.09.2026	00
10	23.09.2026	00
11	23.09.2026	00
12	23.09.2026	00
	Chapter 1	
Page	**Effective date**	**Revision #**
1	23.09.2026	00
2	23.09.2026	00
3	23.09.2026	00
4	23.09.2026	00
	Chapter 2	
Page	**Effective date**	**Revision #**
1	23.09.2026	00
2	23.09.2026	00
3	23.09.2026	00
4	23.09.2026	00
5	23.09.2026	00
6	23.09.2026	00
7	23.09.2026	00
8	23.09.2026	00
	Chapter 3	
Page	**Effective date**	**Revision #**
1	23.09.2026	00
2	23.09.2026	00
3	23.09.2026	00
4	23.09.2026	00
5	23.09.2026	00
6	23.09.2026	00

	Chapter 4	
Page	**Effective date**	**Revision #**
1	23.09.2026	00
2	23.09.2026	00
3	23.09.2026	00
4	23.09.2026	00
5	23.09.2026	00
6	23.09.2026	00
7	23.09.2026	00
8	23.09.2026	00
9	23.09.2026	00
10	23.09.2026	00
11	23.09.2026	00
12	23.09.2026	00
13	23.09.2026	00
14	23.09.2026	00
	Chapter 5	
Page	**Effective date**	**Revision #**
1	23.09.2026	00
2	23.09.2026	00
	Chapter 6	
Page	**Effective date**	**Revision #**
1	23.09.2026	00
2	23.09.2026	00
	Chapter 7	
Page	**Effective date**	**Revision #**
1	23.09.2026	00
2	23.09.2026	00
3	23.09.2026	00
4	23.09.2026	00
	Chapter 8	
Page	**Effective date**	**Revision #**
1	23.09.2026	00
2	23.09.2026	00
3	23.09.2026	00
4	23.09.2026	00
5	23.09.2026	00
6	23.09.2026	00

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0.4 Distribution and control

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Note: *Electronic and hard copies are considered "uncontrolled" if they are printed or not included into this distribution list.*

0.5 Records of amendments and revisions

Edition/Revision number	Effective date	Entered into force by	Reason
Edition 01	23.09.2026	3-27-102/3-2-51/2026	

Edition: - *Release of a document having incorporated all previous revisions until the current version. New edition of a document will not show revised text in blue colour. Current edition of a document shown on each page in footer.*

Revision: *- A change made to a part of document, where it is reflected with blue text or accompanied with a vertical line on right side of a document. Basic information on revisions (number and date) given in the List of effective Pages and indicated in header of affected page and in context itself.*

0.6 Terms and definitions

Aerodrome: A defined area on land or water (including any buildings, installation and equipment) intended to be used, either wholly or in part for the arrival, departure and surface movement of aircraft.

Aircraft stand: A designated area on an apron intended to be used for parking an aircraft.

Apron: A defined area, on a land aerodrome, intended to accommodate aircraft for purposes of loading or unloading passengers, mail or cargo, fueling, parking or maintenance.

Foreign object debris (FOD): An inanimate object within the movement area which has no operational or aeronautical function and which has the potential to be a hazard to aircraft operations.

Manoeuvring area: That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons.

Movement area: That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, consisting of the manoeuvring area and the apron(s).

Runway: A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.

Safety management system (SMS): A systematic approach to managing safety, including the necessary organizational structure, accountabilities, policies and procedures.

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0.7 Abbreviations

AWSP	*Aerodrome Work Safety Planning*
SCAA	*State Civil Aviation Agency*
TLW	*Time-limited work*
RFF	*Rescue and firefighting*
RTAO	*Restrictions to aircraft operations*
SMS	*Safety Management System*
RMP	*Risk Management Plan*
ADO	*Aeronautical data originator*
RTIL	*Runway threshold identification lights*
MAG	*Movement area guidance sign*
AIC	*Aeronautical information circular*
FOD	*Foreign object debris*
LDA	*Landing distance available*
LVP	*Low visibility procedures*
MOWP	*Method of working plan*
RESA	*Runway end safety area*
ASDA	*Accelerated stopping distance*
TODA	*Take-off distance available*
TORA	*Take-off run available*
WIP	*Works in progress*
WSO	*Works safety officer*
STODA	*Supplementary take-off distance available*
SOT	*Start of take-off run available*

0.8 Terms shall, should, may

The following terms shall have the meaning outlined below:

“Shall” - An action verb in the imperative sense means that the application of a rule or procedure or provision is mandatory.

“Should” - Means that the application of a procedure or provision is recommended.

“May” - Means that the application of a procedure or provision is optional.

0.9 Administration and control

The PDF files will be locked and signed to prevent changes.

This document is regularly revised and amended. All personnel must be familiarized with all revisions done.

This document will be Amended and Revised in accordance with requirements of “Documentation and Control” procedure.

1 Introduction

1.1 Purpose of airport maintenance

1.1.1 An airport, being an important part of the aeronautical infrastructure, has to meet high safety standards. The required level of safety can only be achieved by proper maintenance of all the elements composing an airport.

1.1.2 Maintenance includes measures to keep or restore the operational function as well as measures to check and to evaluate the present function of an element. The basic components of maintenance are:

1) inspection;
2) servicing and overhaul; and
3) repair.

1.1.3 Inspection comprises all measures to check and evaluate the operating condition, including both spontaneous and scheduled checks. Scheduled checks are carried out in accordance with a plan specifying the preparation of the check, the type of check, the reporting of results, and their evaluation. Based on these evaluations, the operator decides whether additional servicing or repair is required.

1.1.4 Servicing and overhaul comprise all measures required to maintain or return a facility or device to its required operating condition. These measures should be carried out in accordance with a plan specifying the timing of the service, the nature of the service, and the reporting of compliance.

1.1.5 Whenever inspection or servicing identifies deficiencies, appropriate repair measures shall be planned and implemented as soon as practicable. Such repairs may include minor or major works, for example runway surface treatment, which may result in operational or traffic interruptions.

1.1.6 Efficiency and safety of operations can only be expected from facilities that are in good operational condition. The maintenance of facilities, i.e. the sum of all measures described above, is the prerequisite for such a condition. Furthermore, maintenance minimizes wear and tear, thus controlling and considerably extending the lifespan of technical components. In this respect, maintenance becomes an economic requirement to keep investment and capital costs for aeronautical infrastructure within acceptable limits.

1.2 Organization of airport maintenance

1.2.1 The complete assessment of all parts of the airport is a fundamental requirement of the maintenance organization. Buildings, pavement sections, and unpaved areas in between shall be numbered, as well as all machinery and technical and mechanical assets, including vehicles. These identifiers define the objects for which maintenance requirements can be specified individually. Such requirements should be recorded on cards or within computerized maintenance management systems.

1.2.2 Maintenance programmes should be developed based on experience with the requirements of different assets or in accordance with the manufacturer's recommendations. For economic reasons, and in order to allocate responsibilities effectively, a precise breakdown of the total work by maintenance disciplines is recommended (e.g. for a building: roofs, walls (including doors and windows), machinery

and mechanical systems, and electrical installations). Each team or specialist responsible for a specific task can then operate in accordance with a systematic work programme, thereby achieving optimum efficiency.

1.2.3 A fundamental task of the maintenance organization is to translate maintenance requirements into man-hours and monetary value. This evaluation forms the basis of staffing and budget planning. Furthermore, it serves as a decision-making tool when considering the contracting of third parties for maintenance tasks instead of employing additional personnel.

1.2.4 All maintenance programmes should be reviewed once a year, preferably during the budget planning period. It is useful not only to rely on recorded data but also to inspect the condition of all major assets at that time. In contrast to machinery, where operating hours provide a good indication of wear, the deterioration of buildings is more dependent on weathering, heavy utilization, concealed construction deficiencies, or other unpredictable sources of damage.

1.2.5 Updated maintenance programmes will allow:

1) appropriate staffing;
2) compliance with the recorded maintenance needs; and
3) flexibility in the timing of actions when unexpected circumstances affect the planned work schedule.

1.2.6 When management checks the work carried out against scheduled tasks, it thereby gains full control of maintenance progress and budget. Compliance reports provide feedback and shall be recorded, as well as observations on any reported deficiencies.

1.2.7 Computer assistance can be helpful and economical if the volume of maintenance is high. The computer is particularly capable of controlling preventive maintenance tasks typical of electrical systems and machinery. Furthermore, evaluation of asset ageing and maintenance budget control can be facilitated by suitable computer programs. However, the computer is less effective for maintenance control of buildings and pavements, where repair work on demand will always prevail.

1.2.8 To maintain the operation of technical facilities at an airport, a sufficient number of technicians must be available during airport operating hours so that deficiencies can be addressed immediately. The team available should comprise, as appropriate, engineers, automotive technicians, locksmiths, tinsmiths, air conditioning and heating technicians, electricians, and IT technicians. If control/monitoring centers for technical facilities exist, they should be staffed on a permanent basis.

1.2.9 This standard team can be reduced outside operating hours to such an extent that vital components necessary for the technical functioning of the airport (e.g. electrical circuits, heating or air conditioning, telephone systems, etc.) can be kept serviceable, and additional technicians can be called upon to arrive promptly in cases of serious disturbance. In all other cases, the reduced maintenance team shall carry out provisional repair work and report maintenance needs to the standard team at the beginning of their duty hours.

1.2.10 The standard team need not be capable of performing all of the airport's maintenance tasks. The airport authority may use contractors to carry out those maintenance tasks that can be easily organized according to a time schedule. However, apart from normal

maintenance tasks—which, based on the experience of the airport authority, the maintenance staff can fully handle—special tasks may occur unexpectedly due to the nature of air transport and its sensitivity to external impacts. Reasons for extra maintenance work can be:

1) snowfall or ice formation on operational areas;
2) sandstorms;
3) rain, heavy thunderstorms with consequential damage;
4) aircraft accidents or incidents; and
5) technical or criminal emergencies.

1.2.11 To cope with these inevitable work requirements, and especially in view of the airport emergency plan, the airport authority will need to maintain a certain reserve of skilled craftsmen. This requirement reduces the scope for contracting maintenance tasks to third-party companies.

1.2.12 To ensure the smooth operation of the entire airport, the provision of workshops at the airport is necessary from both an operational and economic standpoint. The selection of the types of workshops depends largely on local conditions, i.e. airport size, traffic volume, ownership of facilities and equipment, and the division of work between airport users (airlines) and the airport operator, etc. *Individual solutions for the provision of workshops have to take into account:

1) local maintenance requirements;
2) compliance with the airport emergency plan; and
3) economic objectives.

1.2.13 The economic objectives may include performing additional business within the airport workshops, for example aircraft maintenance for home-based carriers and/or general aviation. Alternatively, economic considerations may require the use of external workshops or craftsmen for maintenance work and even emergency assistance. A sound balance between the capacity of the airport's basic maintenance workforce and its ability to cope with peak and emergency workloads is important for efficient airport operations.

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2 Maintenance of visual aids

2.1 General

2.1.1 The basic purpose of visual aid systems is to support the safe operation of aircraft. Therefore, the highest standards of maintenance are required. Once a system has been installed, its usefulness depends on its serviceability, which in turn depends on the effectiveness of the maintenance work carried out. Annex 14, Chapter 1 defines a light as failed when its light output falls below 50 per cent of that specified for a new light. The causes of reduced light output may include contaminants on the exterior or interior of the light unit, and degradation of the lamp and optical system due to ageing. The light can and should be restored to its original condition by cleaning or replacing the lamp and any parts that have become degraded. For this purpose, it is essential to establish a comprehensive routine maintenance system for servicing lights and other equipment so that the installation complies with the specified requirements. Reference is made to Annex 14, Chapter 9.

2.2 Personnel

2.2.1 The task of maintaining lighting aids should be entrusted only to reliable and skilled electricians who have experience with high-voltage series circuits and lighting systems. These individuals should be present or on call during airport operating hours to correct any deficiencies that may arise. Training programmes should be established to maintain the competence of maintenance personnel and to keep them up to date with new developments.

2.3 Spare parts

2.3.1 An adequate stock of spare parts should be available. The level of stock will vary depending on the time required to resupply a particular 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 on site should be reflected immediately in them. The completeness and accuracy of all circuit diagrams, drawings, and descriptions should be checked at least annually.

2.5 Light maintenance schedule

2.5.1 When servicing lights, the instructions of the appropriate authority and the recommendations of the equipment manufacturer should be followed to ensure the required service standards. Service records showing maintenance schedules recommended by the manufacturer or local standards should be prepared for each piece of equipment. These may be arranged in a dated reminder file to ensure that all equipment is serviced regularly. The record should include space for observations, measurements, and the initials of the servicing personnel. If local conditions indicate that a change in the servicing interval is desirable, the schedule may be adjusted in consultation with the equipment manufacturer.

2.5.2 The frequency at which routine inspection, cleaning, and servicing are to be performed will vary according to the type of equipment, its location, and usage. A maintenance programme must be drawn up for each individual airport based on past experience, and its aim should be to achieve the required service standard. The following schedules are

presented as guidance material for establishing a preventive maintenance programme. More frequent checks may be necessary for lights serving precision approach Category II and III runways. The time schedules shown should not take precedence over manufacturers' instructions or be applied to similar equipment not mentioned. Each check should be followed by appropriate corrective action.

2.5.3 Maintenance for all types of approach, runway, and taxiway lights should include inspection and, where necessary, implementation of the indicated corrective actions, as follows:

Daily;

1) system for burnt-out lamps; replace burnt-out lamps;
2) system for gross misalignment (if applicable); adjust as necessary;
3) control equipment for proper operation at each brightness step (if applicable); correct or repair malfunctions;
4) glass for breakage; replace broken parts.

Annually:

1) fasteners of each light unit; tighten as necessary;
2) lights for corrosion; paint or replace corroded parts;
3) reflectors of each light unit (if applicable); clean or replace;
4) glass of each light unit; clean or replace;
5) lamps of the whole system; replace unserviceable lamps or, where necessary, components of the system;
6) elevation setting (if applicable); adjust;
7) horizontal alignment; adjust;
8) plug connections for cleanliness and proper contact; clean or replace contaminated parts;
9) light fittings and their supporting structures (if applicable) for proper fastening and corrosion; tighten fasteners; paint or treat against corrosion;
10) general condition of the whole system; record results.

Unscheduled:

1) elevation setting and horizontal alignment (if applicable) of the light units after severe storms and snowfalls; adjust as necessary;
2) light units for obstruction by grass or moss, etc. (not applicable for inset lights); remove any obstructions found.

2.5.4 Visual approach slope indicator maintenance should include inspection and, where necessary, implementation of the indicated corrective actions, as follows:

Twice monthly:

1) elevation setting (vertical angle) of the light units; adjust as necessary;
2) spreader glasses, filters, and lamps for cleanliness; clean as required.

Annually:

1) system inspection from the air, and recording of results; adjust and replace lamps as

necessary;

2) supporting structure and foundation of each unit; repair as required.

2.5.5 Runway threshold and runway end light maintenance should include inspection and, where necessary, implementation of the indicated corrective actions, as follows:

Twice weekly:

1) fasteners of the lights; tighten as necessary;
2) glass of each light for wear and tear; replace as required.

2.5.6 Inset lights (runway centre line lights, touchdown zone lights, taxiway centre line lights, stop bar lights) maintenance should include inspection and, where necessary, implementation of the indicated corrective actions, as follows:

Daily:

1) lenses for cleanliness; clean as required.

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

1) light output of lights within 900 m from each threshold, including measuring and recording the results; clean lenses;
2) top parts of lights within 900 m from each threshold; replace if necessary.

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

1) light output of all lights within the system, including measuring and recording the results; clean lenses;
2) top parts of the lights; replace if necessary.

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

1) lights for cleanliness inside and outside; clean;
2) lights for moisture; dry;
3) electrical connections of the lights; tighten and spray with contact agent;
4) alignment of lights; adjust.

Annually:

1) prisms and filters; clean or replace;
2) sealing compound; reseal as necessary.

Unscheduled:

1) top parts of the lights two to four weeks after replacement; tighten as necessary.

2.5.7 Other airport lights include, for example, airport beacons, obstacle lights, and wind direction indicators. These normally require less maintenance than approach, runway, or taxiway lighting systems. Their maintenance should include inspection and, where necessary, implementation of the indicated corrective actions, as follows:

Daily:

1) lamps; replace if necessary;

2) control equipment for proper operation (not applicable in the case of obstacle lights); correct or repair;

3) fabric of the wind cone; repair or replace.

Semi-annually (only for airport beacon):

1) power supply (brushes and slip-rings); clean or replace;

2) electrical connections; tighten;

3) rotating parts; secure properly.

Annually:

1) optical system of the airport beacon;

2) glasses and gaskets of obstacle lights; clean or replace;

3) function of flashing relays and twilight switches of obstacle lights; clean, repair, or replace;

4) power supply and lighting of the wind direction indicator; repair or replace;

5) electrical connections; tighten and spray with contact agent;

6) fasteners of obstacle lights; tighten as necessary;

7) structure and fasteners of the wind direction indicator; tighten or repair structure;

8) lights for corrosion; paint as required;

9) fabric colour of the wind direction indicator; replace as necessary;

10) location of obstacle lights for ease of maintenance access; adjust location if required and feasible.

Unscheduled:

1) wind direction indicator after severe storms; repair as necessary.

2.5.8 Maintenance programmes for various types of aircraft docking guidance systems are provided at airports, and it is very difficult to designate a generally applicable maintenance programme for these different systems. The principal items to be checked and the maintenance actions to be taken, if necessary, include:

Daily:

1) system for overall operation; repair as necessary;

2) lamps; replace burnt-out lamps.

Semi-annually:

1) alignment of the system; adjust as necessary.

Annually:

1) electrical connections (if provided) for corrosion, wear and tear; clean, tighten, or replace as necessary;

2) function of relays (if provided); clean or replace;

3) structure of the system and function of all mechanical parts; repair as necessary;

4) system for cleanliness and moisture; clean and dry

2.6 Lights maintenance procedures

2.6.1 For reasons of efficiency, the maintenance of lights should, as far as practicable, be carried out indoors. The inconveniences of working outdoors, such as heat, cold, precipitation, and aircraft noise, can thereby be avoided, and traffic restrictions or interruptions will be reduced to a minimum. The quality of service will also be higher in workshops than outdoors. This is particularly applicable when, in the interest of unrestricted traffic flow during daytime hours, the work has to be carried out at night.

2.6.2 The maintenance procedure commonly used comprises two steps:

1) removal of defective lights and immediate replacement with new or repaired units;
2) servicing and overhaul of defective lights in the workshop, where all required tools, measuring, and adjustment equipment are available.

2.6.3 This procedure has proven to be practical, particularly for the maintenance of inset lights. Provision of a sufficient number of stored spare lights is a prerequisite. The number of spare parts depends on the overall requirements of the airport and experience with the susceptibility to damage of the various types of lights at the airport. It is useful to select lights that are designed to permit removal and installation within a short time, without the use of any sophisticated technical equipment.

2.6.4 The type and degree of contamination of various lights at an airport will differ. While elevated approach and edge lights are normally affected only by weather-related contamination (dust carried by wind and rain), more severe contamination can be observed on inset lights, particularly on runways. Rubber deposits from tyres during touchdown and exhaust from engine reverse thrust operations create firmly adhering deposits on the exterior glass surfaces of lights. This varying degree of contamination must be reflected in the maintenance schedule for different categories of lights or sections of the runway/taxiway system.

2.6.5 When cleaning the glassware of lights, the manufacturer's recommendations should be observed. Normally, cleaning is accomplished by washing the glassware with a cleaning mixture of water and a special solvent that will neither affect the sealing material nor produce a residual film on the glass. The solvent must be given sufficient time to dissolve the deposits. If necessary, rubber spots may be scraped off using plastic tools or powder before applying the solvent. Other mechanical aids for cleaning may include sponges, cloths, hand brushes, or electric rotating brushes. The cleaning technique and materials used should not scratch or damage the glass surface nor affect the sealing material.

2.6.6 Dry cleaning of glassware should be avoided. However, if cleaning becomes necessary for some reason, no sand or other abrasive material should be used. In such cases, cleaning can be carried out using ground walnut or pecan shells and dry compressed air. Special treatment can normally be avoided by following a maintenance schedule with wet cleaning at suitable 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 maintenance vehicle, facilitates the work considerably. In some cases, these vehicles can carry the required tools for all types of maintenance work, including the removal of old lights and the installation of new ones.

2.6.8 Thorough cleaning of the interior of the light to remove mud, moisture, or rust should be carried out in workshops. Only minor contamination such as dust should be removed on

site.

2.6.9 The light output will diminish over time due to lamp ageing. Contamination of the reflector and lens will result in further degradation of light output. According to Annex 14, a light is considered failed when its output is less than 50 per cent of the required intensity. For practical reasons, replacement of a light is recommended when its output falls below 70 per cent of that specified for a new light.

2.6.10 Light measurements should be carried out regularly to detect early reduction in light output. Appropriate equipment for both field and bench measurement of light output is available. However, equipment produced by light manufacturers does not indicate absolute intensity values but provides ratios between the measured and original light intensities for each individual type.

2.6.11 Field measurements are particularly necessary for inset lights. Wheel loads on inset lights may frequently cause damage. One type of measuring equipment offered by light manufacturers for field use consists of a photocell and a microammeter. Such measuring devices are placed over the light fitting, and the meter reading is compared with the calibration value. Before measuring, the lights should be cleaned and switched to the highest available intensity setting.

2.6.12 Light measurements can also be made by using a photographic spotmeter, which is not placed directly on the light casing but moved vertically and horizontally through the light beam at a fixed distance. The intensity is checked by comparison with the results of a calibration test using a new light.

2.6.13 The measuring procedures described above are quite time-consuming. With the special device, each measurement will take about two minutes. Often, a much faster visual observation carried out by experienced personnel can achieve comparable results for detecting and reporting single lights with unacceptable light output. For visual checks, the level of brightness must be switched to “low” (3 to 10 per cent of maximum).

2.6.14 For adjustment of the correct beam angle, lights are normally furnished with alignment markings. Furthermore, light manufacturers offer suitable adjustment equipment for their products. Beam misalignment caused by displacement of the optical system inside, however, cannot be corrected by adjusting the casing. When such misalignment is observed visually, the light should be adjusted in the workshop.

2.6.15 For measuring light output in the workshop, the measuring equipment provided by the relevant light manufacturer should be used. The equipment consists of a bench for fixing 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.

2.6.16 Where light measurements have to be carried out without the manufacturer’s special equipment, a useful technique is to check the isocandela curve on a vertical surface located approximately 3 m in front of the light unit. With photocells at the vertical and horizontal limit lines of the isocandela curve, comparison with the light output of a new light will be possible. Lights should be switched to the maximum brightness level before testing.

2.6.17 The lifespan of lamps varies from 100 to 1,000 hours of operation. The lifetime depends on the percentage of operation at high brightness levels and on the number of switchings. In addition, dynamic stresses imposed by aircraft wheel loads (inset lights) and

temperature-induced stresses inside the casing affect lamp life. Lamps that have failed should be replaced as soon as possible, since the lighting system of an airport has to meet specified serviceability requirements. Reference is made to Annex 14, Chapter 9.

2.6.18 Lamp replacement can be organized in two different ways:

1) only lamps that have failed or lamps showing major output reduction are replaced upon inspection; this method requires checks to be carried out at short intervals;

2) bulk replacement of lamps in certain sections of the entire lighting system, in accordance with a fixed time schedule. The intervals between replacements have to be derived from local experience with the average life of lamps in use. Lamps should be replaced when they have been operated for 80 per cent of their average life. For this maintenance method, a reliable record of operating hours for the individual sections of the airport's lighting system is a prerequisite. This method requires less frequent checks.

2.6.19 Lamp replacement in the workshop is preferable, particularly for inset lights. The unserviceable light should be removed from its position and replaced by a serviceable light. Lamp replacement of elevated lights may be carried out on site, provided that the casing can be opened easily and quickly, and the lamp socket does not require realignment afterwards.

2.6.20 Inset lights may sometimes collect water. Water inside the light increases corrosion, causes damage to electrical parts, and creates deposits on the lens and lamp; furthermore, it reduces lamp life. Before installing a light into the pavement, proper drainage of the opening must be ensured. Nevertheless, the penetration of moisture and accumulation of water cannot be completely prevented. Regular inspection is necessary to check lights for the presence of water. Lights found to be wet inside should be removed and replaced, if such a procedure is possible with the type of light. Otherwise, drying must be carried out on site. After drying, the sealing elements should be carefully checked and replaced when necessary. Before closing a dried light, the lamp should be switched on for some time to allow any residual moisture to evaporate due to the temperature increase 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, drainage has to be improved.

2.7 Signs

2.7.1 Signs provide pilots with directional information for taxiing and holding. Maintenance should ensure the integrity and perfect legibility of the information provided by the signs. The design and construction of signs varies considerably; however, the following general checks and, where necessary, maintenance actions are recommended for each sign:

Daily:

1) lighting; replace burnt-out lamps;

2) inscriptions for legibility and absence of obstructions; repair signs and remove obstructions.

Annually:

1) mounting of both the sign and its lighting (if provided); repair as necessary;

2) structure and paintwork; clean, repair, or repaint as necessary.

Unscheduled:

1) after snowfall, check for legibility; remove obstructions;
2) after severe storms, re-position displaced signs and repair damaged signs

2.8 Markings

2.8.1 All markings on paved areas should be inspected at least semi-annually. Local conditions will determine the exact timing of inspections. In general, a spring and autumn inspection will suffice to detect deterioration due to winter and summer weather extremes. Defaced markings should be removed from the pavement.

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

3 Maintenance of airport electrical systems

3.1 General

3.1.1 The serviceability and operational reliability of air navigation equipment and installations are requirements for the safe operation of aircraft in the airport area. Apart from visual aids, air navigation equipment and installations include electronic landing aids, navigation equipment, radar, and meteorological service equipment. Maintenance programmes for other equipment and installations are to be established by the appropriate authorities (ATC, Meteorological Services).

3.1.2 The required serviceability of installations and equipment will only be achieved as long as a constant power supply is maintained. To this end, regular maintenance work is required for airport equipment and installations distributing primary power and equipment supplying secondary power in the event of a circuit breakdown. The following paragraphs contain guidance on establishing maintenance programmes for the individual elements of the power supply systems, such as power cables, control cables, transformers, transformer stations, regulators, relay and switch cabinets, and secondary power supply equipment. Furthermore, guidance is given on the regular maintenance of floodlighting systems for aprons.

3.2 Personnel

3.2.1 Maintenance work on airport electrical systems should be assigned to skilled electricians who are fully acquainted with the work to be performed. As work is often required in high-voltage areas, they should be well informed and kept up to date on safety measures. To protect personnel, the required safety devices should always be maintained in good condition.

3.2.2 Maintenance personnel should be present or on call during the operating hours of the airport. It may be advisable for the same personnel to be responsible for the maintenance of both electrical systems and visual aids.

3.3 Schedule of maintenance

3.3.1 Schedules for 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 all maintenance work carried out should be maintained.

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

3.3.3 Cables and distributors outside buildings can only be checked where they are installed in channels. Preventive maintenance is not possible where power cables are buried in the soil. In such cases, maintenance is limited to repair after malfunctions have been detected. Their maintenance should include semi-annual inspections and, where necessary, implementation of the indicated corrective actions, as follows:

1) distributors located in manholes for cleanliness and moisture; clean and dry;
2) plug-in and clamp connections in the distributors for proper contact; tighten and spray with

contact agent;

3) manholes for internal condition; pump out water, dry, or clean as necessary;

4) insulation resistance by measuring the earthing resistance of each circuit; record readings and take necessary corrective action.

3.3.4 Maintenance of transformers and regulators should include inspection and, where necessary, implementation of the indicated corrective actions, as follows:

Monthly:

1) power supply transformers and regulators for cleanliness and oil leakage; clean and replenish oil as necessary;

2) switches at all light intensity positions for malfunctions; restore proper operation;

3) switch-over to standby units for serviceability; restore as necessary.

Annually:

1) transformers for abnormal noise; investigate the cause of any unusual sound and repair as necessary;

2) overall condition; repair as required;

3) insulators; repair or replace as necessary;

4) collector bar system; clean;

5) voltage and amperage at all intensity levels; measure and record; adjust voltage to the nominal level.

3.3.5 Maintenance of transformer stations for electric power supply should include inspection and, where necessary, implementation of the indicated corrective actions, as follows:

Weekly:

1) overall condition (visual); restore as necessary;

2) fuse boxes for completeness; replace missing fuses.

Semi-annually:

1) insulators and electrical connections; clean and restore;

2) station for dirt and moisture; clean and dry;

3) locks to stations for serviceability; repair and secure.

Annually:

1) protection relays; adjust;

2) high-voltage cable insulation; assess and record condition of each cable; take preventive measures as necessary;

3) earthing system and its resistance; clean and ensure proper function;

4) electrical supply system for noise and damage; repair as necessary;

5) structures for rust, corrosion, or defective coating; clean and repaint;

6) warning signs and safety devices for presence and correct positioning; clean or replace;

7) safety grids for completeness, rust, or coating deficiencies; complete, clean, and repaint;

8) safety grids for stability and proper earthing; tighten and restore earthing as required.

3.3.6 Maintenance of relay and switch cabinets should include inspection and, where necessary, implementation of the indicated corrective actions, as follows:

Semi-annually:

1) turn and plug-in connections for cleanliness and good electrical contact;
2) relays for proper closing of contacts; clean or replace as necessary;
3) electrical contacts for corrosion and wear; clean or replace;
4) cabinet condition, including proper weather sealing, cleanliness, and mechanical damage; clean and repair as necessary;
5) monitoring relay of series circuits for proper feedback; repair as necessary;
6) voltage changeover (if available) between two circuits for serviceability; repair as necessary.

Annually:

1) cabinet outer condition for dirt, moisture, and accessibility; clean and dry;
2) fuses (if provided) and fuse sockets; clean, treat sockets, and replace fuses as necessary;
3) voltage output for all series circuits; record results and take corrective action as necessary.

3.3.7 Maintenance of control cables, monitoring units, and control desks should include inspection and, where necessary, implementation of the indicated corrective actions, as follows:

Daily:

1) optical and acoustical signal for feedback; restore as necessary.

Weekly:

1) nominal control voltage; charge battery as necessary;
2) voltage and ammeter readings; adjust as required;
3) acid level in batteries; add distilled water as necessary.

Monthly:

1) functions of the monitoring unit;
2) components for cleanliness and condition; clean, repair, or replace as necessary.

Quarterly:

1) system components for loose connections; tighten, repair, or replace as necessary;
2) control desk for overall operation; investigate any malfunctions and repair or replace parts as necessary;
3) mimic panel indications for conformity with field conditions; correct or adjust as necessary;
4) mechanical structure of the desk for stability; repair as necessary.

Semi-annually:

1) Replace lamps in monitoring units.

Annually:

1) cables and distributors; clean and repair as necessary;
2) relays for cleanliness; clean as necessary;
3) control and monitoring units; replace as necessary;
4) connections; tighten and spray with contact agent.

Unscheduled:

1) insulation of cables after each lightning strike, i.e. insulation between wire and wire and between wire and ground; improve insulation as necessary.

3.3.8 Maintenance of secondary power supplies should include a monthly test run and inspection and, where necessary, implementation of the indicated corrective actions, as follows:

1) switch-over time from primary to secondary power supply for conformity with requirements;
2) voltmeter readings to ensure that the voltage remains within acceptable tolerances;
3) transfer equipment for excessive heating and malfunctions;
4) generator for vibrations and excessive heating;
5) diesel engine for any irregularities and oil leakage;
6) fuel level in the tank after the test run; refill with fuel if necessary;
7) abnormal or undesirable performance; take corrective action and repair as necessary;
8) record meter readings from the test run and compare with previous records to detect potential deficiencies.

3.3.9 Maintenance of ground power supplies should include inspection and, where necessary, implementation of the indicated corrective actions, as follows:

Daily:

1) plugs, cables, and cable support; repair as necessary.

Weekly:

1) proper functioning;
2) tightness (oil leakage) and loose connections; repair as necessary.

Monthly:

1) serviceability of control lamps; replace as necessary;
2) screw connectors at the contact rail for potential temperature rise; improve contact;
3) cleanliness of cables; clean;
4) ventilator flaps and openings for cleanliness; clean;
5) drive belts of the ventilator system; adjust belt tension.

Quarterly:

1) current input cables for potential deformation; remove deficiencies as necessary;
2) connector boxes for:

3) mechanical damage
4) proper mounting of plug sockets
5) condition of contact clips in plug sockets
6) bearings for lubrication.

Semi-annually:

1) cables (wires and insulation) for serviceability; repair or replace as necessary;
2) main conductor cables for temperature rise under nominal electrical load; remove detected deficiencies;
3) connectors, plugs, and cable support; adjust and tighten;
4) switches for proper operation; remove dust and dirt from switch elements;
5) fixings holding the regulator and switch cabinet housings; tighten mounting screws or bolts.

3.3.10 Maintenance of apron floodlighting should include inspection and, where necessary, implementation of the indicated corrective actions, as follows:

Daily:

1) lamp outages; replace lamps;
2) switching operation from remote control; repair as necessary.

Annually:

1) turn and plug-in connections for cleanliness and good electrical contact;
2) relays for serviceability; clean or replace as necessary;
3) contacts for corrosion and wear; clean or replace;
4) relay cabinet condition, including proper weather sealing, moisture, cleanliness, and mechanical damage; clean, dry, and repair as necessary;
5) fuses and fuse sockets; clean, spray sockets, and replace fuses as necessary;
6) relay cabinet external condition, including ensuring free access.

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4 Maintenance of pavements

4.1 Surface repair

4.1.1 The surface of a runway should be maintained in a condition that precludes harmful irregularities or the breaking off of pieces that would constitute a hazard to aircraft operations. Reference is made to Annex 14; This requirement calls for continuous monitoring of pavement condition and repair when necessary. Pavement repair is costly and often imposes restrictions on airport traffic, even when damaged areas are small. Preventive maintenance is therefore of high importance in airport pavement management.

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, frost reaction in unsuitable aggregates, or penetration of chemical de-icing fluids into microcracks or pores. Typical forms of surface damage are:

1) porous or disintegrated surface;
2) separation of the thin top surface layer;
3) excessive smoothing of the surface caused by polishing under traffic;
4) breakup of pavement where cracks extend into the inner layers.

4.1.3 Where the damaged layer of pavement is very thin and the damage is identified as resulting from improper surface treatment during construction, surface scoring or grinding is often sufficient to correct the condition. Where the resulting loss of thickness 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 ensured that this type of repair does not lead to unevenness or the formation of ponding 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 to a depth of up to 5 mm. When applying epoxy resin sealings, the formation of a continuous surface film must be avoided. Such a film would hamper moisture evaporation from within the concrete, causing early deterioration of the repaired surface. Furthermore, the surface may become too smooth and slippery when wet.

4.1.5 Where the 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 ensure good adhesion. Where reinforcement steel is exposed, all rust has to be removed and the reinforcement must be covered with a new coating of epoxy resin or an equivalent material. A layer of epoxy grout is then applied to the pretreated area and levelled to the required thickness. A lean grout mixture is recommended to allow the patch material to conform to the physical characteristics of the pavement. Similar shrinkage characteristics are essential to prevent the grout from chipping off after hardening. The grout can be made of special quartz sand or ceramic material. To prevent the surface from becoming too smooth, coarse quartz sand can be spread onto the still-wet grout. Joints between concrete slabs should not be filled with grout during the repair process.

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

4.1.7 Surface damage on asphalt normally stems from incorrect composition of the bituminous mixture, impact of fuel, grease, or solvents, extreme spot loading, mechanical wear, or chemical attack. In addition, frequent freezing and thawing may cause damage when de-icing fluid penetrates into deeper layers. Other forms of damage include deterioration due to weathering of the surface structure, softening of the surface, and deformation.

4.1.8 When damage is minor and concerns only the surface, 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 3 cm to allow reconstruction of an asphalt layer consistent with sound engineering practice. The bed for the new layer must be sharply edged to ensure a clean joint. After grinding, the area must be carefully cleaned of contamination and grinding material (e.g. by road-type suction sweepers) before being sprayed with a bituminous binder. The new layer is then applied in accordance with road engineering design practice. Compaction (rolling) must be carried out very thoroughly at the edges of the existing asphalt in order to close the joints. Sealing the joints by spraying with a bituminous seal is recommended.

4.1.10 In cases where damage extends 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 are then laid in accordance with good engineering practice.

4.2 Repair of joints and cracks

4.2.1 Joints are provided in concrete pavements to eliminate stresses induced by length variations of the concrete material due to temperature changes. Joints must be sealed 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 to prevent 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 capacity of the base material. Where there is no frost-resistant, well-drained subgrade under the pavement, it will be susceptible to frost effects. Both effects may result in deterioration or 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 on the pavement. Later, the sealing material will lose part of its original elasticity and, due to shrinkage, it will fail to adhere to the side flanks. Mechanical forces applied to such aged sealant will cause it to break off, and rotary brooms of sweeping or snow-clearing machines will accelerate this process. To protect concrete pavements from severe damage, renewal of all joint sealants is necessar 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 exposed slab faces should be thoroughly cleaned of soil, grease, and dust. Where edges are damaged, they should be repaired with a suitable synthetic resin grout.

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 exposed slab faces should be thoroughly cleaned of soil, grease, and dust. Where edges are damaged, they should be repaired with a suitable synthetic resin grout. After inserting a new insert 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. Excess sealing material in the joint will rise above the surface when the pavement expands under thermal stress. This may later lead to surface contamination. 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 sealed with plastic materials, such as hollow neoprene profiles, the same method of joint cleaning and preparation is applicable. To improve the sealing capacity of the plastic material, the concrete faces should be coated 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 ingress at the joint and to avoid it acting as a conduit distributing water throughout the entire joint system.

4.2.5 Recent experience indicates that it is useful to provide joints in bituminous pavements. For airport asphalt construction, hard types of bituminous material are required. The 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-relief joints not wider than 5 mm and not deeper than two thirds of the thickness of the wearing course may be cut into the pavement to control 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 compatibility between the pavement and the sealing material, and the almost identical thermoplastic behavior of both, provides a reliable sealing of the joint.

4.2.7 Where joints in bituminous pavements are damaged, they can normally be repaired by filling with a hot bituminous sealing material, provided 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

4.2.8 Reasons for cracks in concrete slabs can be:

1) incorrect formation of expansion joints, resulting in transfer of forces between concrete slabs;
2) delayed cutting of hinged joints (dummy joints) during the construction phase, allowing shrinkage during hardening to generate random cracking;
3) improper treatment during the initial hardening phase, for example due to strong solar radiation on fresh concrete;
4) improper compaction of the sub-base, leading to uneven settlement of the subgrade so that slabs are not uniformly supported;
5) insufficient dimensioning of concrete slabs in relation to the applied loads.

4.2.9 "Wild" cracks in concrete always extend through the full depth of the slab. On the surface, the crack will appear in the form of a hairline crack or a break, the latter allowing the separated parts to move relative to each other. Repair of cracks in concrete can never restore its load-bearing capability. The purpose is only to prevent water penetration from the surface into the subgrade.

4.2.10 Cracks in concrete slabs should be repaired by converting 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 watertightness is required, a channel about 20 cm wide and 2 cm deep should first be cut along the line 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 is filled with a fuel-resistant thermoplastic sealing material.

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

4.2.13 Cracks in bituminous pavements result from thermal stress building up in large pavement areas when there are no expansion joints. Other reasons may include insufficient adhesion of construction joints between adjacent lanes or deficiencies in subgrade bearing strength at isolated points due to construction errors. Repair of such cracks is essential to prevent penetration of water or de-icing agents into the sub-base or subgrade. However, it is not possible to bond the cracked parts firmly together and restore 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 sealants. The filling can be carried out manually using cans or mechanically using special pouring equipment. In a first application, the internal faces of the crack will be coated; in a second application, the crack can be filled. The procedure should be repeated annually or at longer intervals, depending on local climatic conditions.

4.3 Repair of pavement edge damage

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 caused by incorrect joint design or stones pressed into the joint. The pavement material above the point of contact is split off due to induced compressive stress. Another reason can be the application of extreme point loads near a slab joint or slab edge, as is sometimes caused by snow removal equipment. Corners are particularly sensitive to overload when, for some reason, the slabs are insufficiently supported by the sub-base.

4.3.2 Broken edges produce loose parts of various sizes which create a substantial risk to aircraft. Furthermore, surface irregularities on pavements 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 provisionally closing deeper openings in the pavement surface. Part of the maintenance should be to carry out a careful investigation of the damaged section to determine the reason for the failure. When making the repair, the treated area should be made large enough to cover all damage. The boundary should be cut to a depth of at least 2 cm, and all internal pavement material removed 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 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 placing 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, no bridge is formed between the two neighboring slabs, since sooner or later it would become the source of a new break in the repaired edge. Compaction should be carried out 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, the joint flanks cleaned, and the joint filled with a hot sealing material.

4.3.3 A filler material that meets the requirements of the climatic conditions at the airport should be chosen. It is essential to add sufficient aggregate (quartz, glass beads, or other ceramic material) to achieve a lean mixture with a low shrinkage ratio. Filler material that reaches its nominal strength no sooner than 24 hours after mixing has proven to be more suitable than quick-hardening materials.

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

4.3.5 Broken corner repair should 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 the surfaces of both neighboring slabs.

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. Reference is made to Annex 14, Attachment A, Section 5, and the Aerodrome Design Manual, Part 3.

4.4.2 Where the friction characteristics of the runway surface have been found to be below the level specified by the State, 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:

1) surface dressing;
2) grooving of the surface;
3) scoring of the 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 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

4.5.1 For safety reasons, the surfaces of runways, taxiways, and aprons have to be free of sand,

debris, stones, or other loose objects. Reference is made to Annex 14, 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. In addition, the tread on tires of taxiing aircraft or other moving vehicles may throw up objects and cause damage. Maintenance of movement areas requires constant monitoring and regular sweeping of surfaces.

4.5.2 Runway and taxiway contamination: objects found on runways and taxiways originate from the following sources:

1) debris from damaged pavement;
2) debris from joint sealants;
3) rubber deposits from aircraft tires;
4) stones from grass mowing;
5) metal or plastic parts from aircraft;
6) sand and soil from heavy storms or aircraft engine blast;
7) dead birds or other small animals struck by aircraft.

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

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.

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

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.

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:

1) Chemically;
2) by mechanical grinding;
3) 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.

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 m2 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. 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 1000 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 m2 to 800 m2 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.

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.

4.7 Removal of snow and ice

4.7.1 Winter service at many airports means removal of snow and ice from:

1) aircraft movement areas;
2) service roads;
3) public roads and parking lots;

to restore conditions as close to normal as possible. The number of service trucks and special equipment vehicles required depends on:

1) climatic conditions;
2) the extent of the area to be cleared; and
3) the time required for clearing.

4.7.2 Industry has developed highly efficient equipment and vehicles for winter services, capable of rapid snow removal from level, straight surfaces. Aprons, however, have more complex geometry and are, furthermore, occupied by aircraft and ramp handling equipment. The most efficient snow removal equipment used for clearing runways and

taxiways can hardly be operated on aprons, since strong snow blowers on an apron would cause damage to vehicles, parked aircraft, and buildings. Other removal techniques are therefore applied there. Procedures for removal of snow and ice from airport pavement surfaces are described in the paragraphs below. Additional material on methods and equipment used for snow removal and ice control is given in the Airport Services Manual, Part 2 – Pavement Surface Conditions.

4.7.3 A snow plan has to be developed before the beginning of the winter season. The snow plan contains information on:

1) responsibilities for winter services;
2) rules on air traffic interruptions for snow and ice removal operations;
3) rules on communication and information regarding the performance of winter services;
4) priorities for snow and ice clearing of aircraft movement areas;
5) availability of vehicles and equipment for snow and ice removal and performance of winter service;
6) methods of friction measurement on aircraft movement areas.

4.7.4 At airports used by airline operators, the snow plan should be agreed with local airlines and the authority responsible for air traffic control.

4.7.5 To ensure good cooperation, all practical matters of winter service should be discussed on a regular basis among competent representatives of the airport operator, ATS, MET, and airlines. To achieve this cooperation, the formation of a snow committee can be helpful. The aim is to establish a suitable system for rapidly communicating actions caused by weather changes, such as runway closures and re-opening, and priorities for take-off clearances for waiting aircraft. Moreover, the authority responsible for snow and ice removal should lay down in the plan priorities for clearing areas other than the movement area and inform or seek agreement with the parties concerned, e.g. airlines, fueling companies, police departments, freight forwarders, catering companies, and other concessionaires.

4.7.6 The airport operator is responsible for maintaining the aircraft movement area in a safe condition. The airport operator is responsible for clearing snow and ice from runways, taxiways, and aprons, and reporting the resulting condition of the cleared surfaces to ATS via telephone or radio. Reported data on runway conditions should be published in the airport's SNOWTAM.

4.7.7 The operations officer takes decisions on closing a runway when snow or ice removal becomes necessary. Temporary traffic interruptions for winter services on runways should be communicated to the airlines concerned. Close contact with ATS has to be maintained, and information on the time and duration of runway closures has to be provided to ATS so that aircraft heading for the airport can be informed. The same information has to be provided to airlines at the airport affected by the closure. In the case of long interruptions of runway use, a NOTAM has to be issued.

4.7.8 Priorities for clearing the movement area. The order of priority for the snow and ice clearing process is governed by air safety requirements (reference Annex 14,):

1) runway in use;
2) taxiways serving the runway in use;

3) apron taxiways;

4) aircraft stands and stand taxilanes;

5) other operational areas.

4.7.9 Control of vehicle trains. A basic safety requirement is in-depth training of snow removal equipment crews. Only drivers fully familiar with the vehicles and equipment, the local conditions (i.e. the layout of the airport), and holding certificates for radiotelephone operations will be capable of fulfilling this rather difficult task, especially during night and/or low visibility conditions. When snow clearing is performed by more than two vehicles, a senior officer should accompany the removal crew in an additional vehicle to direct the operation via radio. He maintains radio contact with the aerodrome control tower and supervises the vehicle train until it returns to its shed or parking area. He also reports on the progress of work and the resulting surface conditions in the movement area.

4.7.10 Task organization principles. When proceeding to the runway, snow-clearing vehicles should move along the main taxiway serving that runway so that access to the runway will be available when the runway is cleared. At airports with large apron areas and a great number of aircraft stands, snow clearing should be performed simultaneously on the runway and on the apron. This procedure helps minimize the time during which the airport must be closed. In such cases, the fleet of vehicles and personnel must be divided to form two trains working simultaneously. After clearing the movement area, a train of vehicles should start clearing other operational areas in accordance with the priority plan, i.e. major connecting roads, secondary roads, loading bays, parking lots, etc.

4.7.11 Snow removal from runways and taxiways. Snow clearing should start as soon as possible after the beginning of snowfall, since vehicles can work very efficiently as long as the snow cover is still thin. When the wind is calm or in the absence of strong crosswinds, snow removal is performed strip-wise from the center to the edge of the paved surface. With strong crosswinds, removal starts from the windward side of the surface and moves toward the leeward side.

4.7.12 The full complement of snow-clearing equipment required for rapid removal of snow from paved areas consists of snow ploughs, snow sweepers, and snow blowers. These should work together in a staggered formation, with a group of ploughs ahead running along the length of the surface, followed by a group of sweepers. The vehicles turn around at the end of the surface and work on their way back to avoid idle runs. Ploughs will complete their work in about half the time required by sweepers, thus becoming free to continue snow removal on other runways or taxiways.

4.7.13 Another procedure is the operation of vehicles combining a plough and a sweeper in one piece of equipment. A train of such vehicles can remove snow from runways and taxiways in the same way as described above, but the time required to clear the runway/taxiway system of snow will be longer since progress is determined by the working speed of the rotary brooms on the sweepers. This slower procedure, however, requires fewer trailing vehicles and therefore fewer personnel than the faster procedure described in the preceding paragraph.

4.7.14 For snow layers of less than 1.5 cm, snow removal can be accomplished by sweepers and blowers without ploughs.

4.7.15 The number of vehicles required for snow removal depends on the width of the runway, the width of ploughs and brooms, and the time frame allocated for the operation according to the prevailing winter climate and traffic demand.

4.7.16 For the protection of the runway edge lighting system, snow ploughs and sweepers should not remove snow close to the lights. One method to keep the fast-moving plough formation away from the edge lights is to run a single plough along the edge and move one strip of snow toward the inner part of the paved surface (see Figure 4-6). The following train of ploughs will then have good guidance on where to pile the snow, without covering or even cutting off the lights.

4.7.17 The snow banks on one or both sides of the cleared surface have to be removed by throwing all compacted snow far beyond the edge of the surface by means of snow blowers. Snow blowers operate at the end of a snow removal train. If the traffic and air traffic situation permit, this strip can be further cleaned by another sweeper running over it after the blower has completed its work. The aim of snow removal is to achieve safe friction coefficients for landing aircraft and low wheel drag for take-off. After completion of the removal, the responsible operations officer carries out friction measurements with a measuring vehicle. Reference is made to Annex 14, 9.2.8. Additional de-icing measures will have to be taken when friction measurement results so require. Results of the final measurement should be reported to ATC and, if conditions appear to remain stable, published in the next SNOWTAM.

4.7.18 Snow removal from aprons. While snow removal from aprons has lower priority than snow removal from runways and taxiways, clearing of apron surfaces should nevertheless start as early as possible to avoid frozen precipitation and slippery surfaces. Loose snow, when compacted by wheels, is difficult to remove even with mechanical equipment and creates a considerable risk for drivers of ground handling equipment.

4.7.19 Snow and ice removal on aprons starts with apron taxiways and stand taxi lines to make markings and/or center line lights clear and visible to flight crew members and marshallers. Special areas on the apron have to be assigned for snow disposal or, if this is not possible, all snow has to be loaded onto trucks and transported to a remote and well-drained site. Loading can be accomplished most efficiently by the use of special loader blowers. Snow blowers can also be used to remove snow banks created by the ploughs.

4.7.20 Sweeper-blowers can also be used to help clear an apron. In narrower areas, however, and especially near parked aircraft, smaller sweeping vehicles have to be used. No heavy equipment should operate closer than 5 m to an aircraft to avoid damage due to loss of control on slippery surfaces.

4.7.21 There may be special areas on aprons, e.g. the movement areas of passenger boarding bridges, which have to be kept clear of all kinds of slippery precipitation. The use of chemical or thermal de-icing measures for these areas may be necessary.

4.7.22 Snow removal from other operational areas. Service roads will be cleared in the same way as public roads are cleared by municipalities. The availability of special snow blowers suitable for loading snow onto trucks can significantly facilitate this task. All removal work should be carried out in accordance with a plan.

4.7.23 Snow bank heights. The permissible height of snow banks at the side of runways and taxiways is limited (see Airport Services Manual, Part 2 – Pavement Surface Conditions, Figure 7-1). Where the winter climate results in deep frost, the unpaved ground normally gains good load-bearing capacity and can support heavy vehicles, thus enabling them to drive on it and reduce snow bank heights outside the paved surfaces. In other climatic regions, wider paved shoulders are required to allow high-efficiency snow blowers to disperse the snow piled up beyond the normal paved edges.

4.7.24 Protection of radio aids. Radio navigation aids, especially the glide slope part of ILS, are susceptible to accumulation of snow. The effective transmitter antenna heights of the glide slope are reduced by the snow layer, and glide slope angles may change. Electrical coupling to ground elements will also increase, thus affecting the antenna impedance. Snow heights in the sensitive area of the antenna should be kept below 0.9 m.

4.7.25 Snow fences. For protecting important electronic devices (antennas, etc.) from snow drifts, non-magnetic snow fences should be provided on the windward side of such facilities.

4.7.26 Ice conditions on paved surfaces can be improved by:

1) thermal de-icing;
2) chemical de-icing;
3) sanding.

4.7.27 Thermal de-icing. Pavement heating by electrical methods or a warm-water pipe system has limited application, since energy costs are rather high. Where such systems are installed, they serve pavement surface sections of aprons, e.g. aircraft stands served by passenger boarding bridges, or ramps and bridges in the airport's taxiway or road network.

4.7.28 Thermal de-icing is also done by means of flame throwers. The flame nozzle is directed towards the ground and moved slowly over the iced surface to allow the ice film to melt. The working speed has to be carefully adjusted to the particular situation to avoid damaging the pavement due to high thermal stress, which may cause cracking of the surface material. Flame melting has proven to be a slow procedure. Like all thermal de-icing methods, energy consumption is considerable. Another problem is that flame melting is not a preventive measure against subsequent refreezing.

4.7.29 Chemical de-icing. Chemical de-icing material must be non-corrosive, non-toxic, non-flammable, and should comply with local environmental protection regulations. It should also not be harmful to the pavement material or have a detrimental effect on the friction characteristics of the surface. Dry and liquid materials have proven to be effective for rapid ice melting. Most important is their ability to prevent refreezing, thus keeping the movement area clear after treatment. The efficiency of chemical de-icing materials depends largely on climatic conditions, i.e. prevailing temperature ranges. At very low temperatures, chemicals have no melting effect at all. For efficient dispersal, spreading or spraying equipment should be used to treat large surface areas in a short time.

4.7.30 Sanding. Slippery surfaces at very low temperatures have to be sanded. This task is carried out by spreader vehicles in the same way as on public roads. The material can be fine gravel or fine grains of crushed stone. For details, see the Airport Services Manual, Part 2 – Pavement Surface Conditions.

4.7.31 Combined de-icing methods. Many airports have developed their own methods of combining different de-icing techniques. Well-known combinations are:

1) dry chemicals with sand;
2) liquid chemicals with sand;
3) dry and liquid chemicals.

No general rules can be given on their application. Experience must determine the efficiency under the various characteristic conditions encountered at an airport during the winter season. Also, the cost of purchasing chemicals can influence the authority's preference for certain

combinations.

4.7.32 Freezing rain or rain on frozen ground will create the most severe surface icing, since the droplets adhere perfectly to the pavement surface. Whenever the weather forecast predicts the possibility of freezing rain or rain during periods of frost, the surfaces should be treated with chemical anti-icers or de-icers in advance of the rain.

4.7.33 Personnel controlling winter service vehicles should be trained carefully. The training course has to cover the following items:

1) Radiotelephone: Personnel must know the correct use of radio equipment and phraseology so that any misunderstandings are avoided.
2) Removal procedures: Personnel must be fully familiar with both normal and exceptional procedures for snow removal, anti-icing, and de-icing.
3) Operation of equipment: Personnel must be fully familiar with winter service equipment so that they can operate it efficiently.
4) Airport: Personnel must be familiar with those parts of the airport where they will be required to operate the vehicles.

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5 Drainage

5.1 General

5.1.1 Drainage of the airport area is necessary:

1) to maintain sufficient bearing strength of the soil for the operation of vehicles and/or aircraft at any time during the year;
2) 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.

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.

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.

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 m2. 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.

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.

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.

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. Any subsurface hydrants should be kept clean of soil or mud so that they can be found without delay in cases of emergency.

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:

1) safety of aircraft on operating areas (this concerns runways, taxiways, strips and runway end safety areas);
2) 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
3) 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 Annex 14.

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 green areas outside strips

6.3.1 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.

6.3.2 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.

6.3.3 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.

6.3.4 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.

6.3.5 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.

6.3.6 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. 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

6.4 Treatment of cut grass

6.4.1 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:

1) 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;
2) 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.

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:

1) Rescue and fire fighting vehicles;
2) Devices for snow and ice removal;
3) Devices for applying sand and de-icing agents;
4) Pavement surface friction measuring devices;
5) Sweepers for removal of contaminants from aircraft operating areas;
6) 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:

1) maintenance is carried out by the airport in its own workshops;
2) maintenance is carried out by contractors in workshops located on the airport; or
3) maintenance is carried out by contractors outside the airport.

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

1) the difficulty of moving specialized and very big vehicles, which are not licensed for use on public roads, outside the airport area; and
2) 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:

1) personnel can be supervised by the airport management and their schedule or work adjusted to fit the airport's needs;
2) personnel can be trained to specialize in maintenance tasks for all airport equipment and will gain much experience;
3) personnel can be organized in such a way as to carry out stand-by tasks outside the normal duty hours;
4) personnel can carry out maintenance tasks on installed equipment; and
5) 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:

1) 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);
2) b) lack of own personnel or specialists for economic reasons (e.g. number of vehicles too low to warrant workshop installations and manning); and
3) 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 kilometers 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 fueling 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 center. 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:

1) automotive engine with test bed;
2) chassis (garage) with paint section;
3) automotive electric workshop;
4) mounting platform and car hoist;
5) brake test bed;
6) hydraulics;
7) tinsmith;
8) washing.

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

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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:

1) passenger buildings;
2) freight handling sheds and cargo stores;
3) air traffic control buildings;
4) aircraft hangars;
5) fire stations;
6) workshops and aircraft/engine maintenance plants;
7) vehicle and equipment sheds;
8) fuel farms and fuel tanks;
9) depots and silos;
10) aircraft catering buildings;
11) administration and office blocks;
12) hotel/restaurant buildings;
13) convention centres;
14) 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:

1) lighting system for the passenger terminal buildings and associated landside forecourt and car parking area;
2) passenger flight information system;
3) air conditioning system;
4) mechanical (automatic) doors;
5) baggage conveyor belts;

6) baggage delivery equipment in claim areas;
7) fixed passenger loading devices (nose loaders or loading bridges);
8) lifts (elevators);
9) escalators;
10) people movers;
11) fixed fire protection installations;
12) 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:

Weekly:

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

Monthly:

1) Repairs identified as necessary through inspections according to the maintenance plan for electrical installations;
2) Checking of accumulator (battery) capacity;
3) Replacement of light bulbs according to the plan.

Quarterly:

1) Checking of lighting control units;
2) Adjustment of dimmers.

Semi-annually:

1) Checking of supply lines and cables, switches, and distributors;
2) Cleaning of plugs, contacts, and terminals in the electrical wiring.

Annually (or less frequently):

1) Cleaning of lamps;
2) Checking of insulation resistance by overvoltage testing.

8.2.2 Lighting system for roads and parking lots. Basically, the maintenance programme is the same as for apron lighting systems. 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 center 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.

8.3.2 Whenever possible, adjustments should be carried out immediately.

Semi-annually: Servicing of all components of:

1) flight information boards and television monitors
2) 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:

1) Control unit for flight information board;
2) Readability of television monitors;
3) Electric clocks control unit;
4) Electric circuit of the loudspeaker system.

Weekly:

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

Monthly:

1) servicing of all air ducts, fans, electric motors, flaps, valves, regulators and pumps;
2) cleaning of all dirt traps in the pipe network;
3) energy consumption record;
4) air ducts.

Semi-annually:

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

Annually:

1) chemical and mechanical cleaning of condensers and evaporators;
2) servicing of fire protection gates.

Unscheduled:

1) 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:

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

Annually:

1) full overhaul including cleaning of the door drives and at compressed air operated doors also the overhaul of compressors;
2) checking on wear at activator rods, chains and guide rails of the driving mechanism;
3) replacement of worn parts;
4) 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:

1) visual checking of belts for damage such as cuts and cracks;
2) checking on smooth movement and low noise; whenever necessary, replacement of noisy or squeaking rollers;

3) adjustment of loose spring rollers;
4) adjustment of belt movement and stress.

Monthly:

1) cleaning of joints and dirt trapping boxes;
2) removing of paper and other waste from underneath the belt by vacuuming.

Annually:

1) checking and overhaul of drives;
2) cleaning of driving motors, oil change or refilling of gear boxes;
3) cleaning and lubrication of driving chains.

8.7 Baggage claim units

8.7.1 Weekly maintenance should include checking for:

1) damage and cracks;
2) 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:

1) weekly check of tires for surface damage and wear and replacing if necessary;
2) inspection of wheel brakes;
3) inspection of electric driving motors and cleaning of drive chains;
4) inspection of lifting jacks for wear;
5) checking of lubrication of lifting jacks;
6) inspection of hydraulic system.

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

Bridge body maintenance should include:

Weekly:

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

Semi-yearly:

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

8.9 Fire protection installations

8.9.1 Maintenance of fixed fire protection installations should include checking of:

Weekly:

1) fire extinguishers within the whole building for integrity
2) emergency exits for access clearance and removal of obstacles.

Quarterly:

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

Semi-annually:

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

Annually:

1) functioning of smoke doors and flaps
2) serviceability of emergency exit locks
3) serviceability of pumps and fire hydrants
4) hose condition.

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