



GM 14-44

CIVIL AVIATION AUTHORITY OF BANGLADESH

Guidance Manual

Aerodrome Maintenance Manual



Version 2.0
21 August 2024

AERODROME STANDARD DIVISION

GM 14-44



CIVIL AVIATION AUTHORITY OF BANGLADESH

**Guidance Manual
on
Aerodrome Maintenance Manual**

Version: 2.0

21 August 2024

Aerodrome Standard Division

RECORD OF REVISIONS

Revision Number	Pages affected	Date Entered	Entered by

REVISION HISTORY

Revision / Version	Date	Chapter / Section	Details
1.0	2010	All	AC: Guidance Material on Aerodrome Maintenance manual
2.0	2024	All	Guidance Material on Aerodrome Maintenance manual

TABLE OF CONTENTS

Chapter 1. General		
	RECORD OF REVISIONS	02
	REVISION HISTORY	03
	Table of Contents	04
	Forward	09
	Chapter. 1 General	10
1.1	Intention of the manual	10
1.2	Organization of the manual	10
1.3	Organization of the maintenance	10
1.4	Categories of maintenance	11
	1.4.1 Regular / Corrective maintenance	11
	1.4.2 Preventive maintenance	11
Chapter 2. Maintenance of Visual Aids		
2.1	Introduction	12
2.2	Different types of visual aids	12
2.3	Performance Level Objectives for Visual Aids	12
2.4	Personnel	13
2.5	Spare parts	14
2.6	As-built drawings	14
2.7	Preventive maintenance of Visual aids	14
2.8	Basic components of maintenance	15
	2.8.1 Regular maintenance and Inspection	15
	2.8.2 Recording of Inspection and Maintenance reports	15
	2.8.3 Daily IOU Reports	15
	2.8.4 Inspection and Maintenance Team	16
2.9	General procedures of Maintenance	16
2.10	Frequency of checks	16
	2.10.1 Daily Checks	17
	2.10.2 Monthly Checks	17
	2.10.3 Half-yearly / Yearly Checks	17
	2.10.4 Non-schedule Checks	18
2.11	Light Maintenance Procedures	18
	2.11.1 General hints for Maintenance of lights	18
	2.11.2 Steps of Maintenance Procedure	19
2.12	Cleaning procedures of lights	19
2.13	Water inside lamps	20
	2.13.1 Remedial actions against water inside the lamp	20
2.14	Lamp Replacement	20
	2.14.1 Lamp replacement Procedures	21
2.15	Light Measurements and Output Standards	21
2.16	Maintenance of Signs and Markings	22
Chapter 3. Maintenance of Electrical System		
3.1	Introduction	23
3.2	Purpose	23

3.3	Different elements of Electrical Installations and Equipment	23
3.4	Maintenance personnel	23
3.5	As-built wiring / circuit diagram and Manufacturer's Manual	24
3.6	Spare parts	24
3.7	General procedures for Maintenance	24
	3.7.1 Regular / Corrective maintenance	25
	3.7.2 Preventive maintenance	25
3.8	Grouping of the electric items for Maintenance	25
	3.8.1 Regular maintenance and Inspection	25
	3.8.2 Recording of Inspection and Maintenance reports	26
	3.8.3 Inspection and Maintenance Team	26
	3.8.4 Grouping of the electric items for Maintenance	26
3.9	Maintenance schedule and Frequency of Maintenance	26
	3.9.1 Daily Checks	26
	3.9.2 Weekly Checks	27
	3.9.3 Monthly Checks	28
	3.9.4 Quarterly Checks	29
	3.9.5 Half-yearly Checks	30
	3.9.6 Annual Checks	31
	3.9.7 Non-schedule Checks	33
Chapter 4. Maintenance of Paved areas of the Airport		
4.1	Introduction	34
4.2	Different Paved areas of the Airport	34
4.3	Maintenance Personnel	34
4.4	As-built drawing	34
4.5	Basic Components of Maintenance	34
	4.5.1 Pavement Management Program	35
4.6	Inspection and Maintenance team	35
	4.6.1 Responsibility of inspection	35
	4.6.2 Responsibility of maintenance	36
	4.6.3 Recording of Inspection and Maintenance reports	36
4.7	Joints in Cement Concrete	36
	4.7.1 Necessity of joints between concrete slabs	36
	4.7.2 Closing (sealing) of joints in concrete slabs	36
	4.7.3 Why joints between concrete slabs are required to be closed	36
	4.7.4 Damage of joint sealing in concrete slabs	36
	4.7.5 Effect of joints in concrete slabs being permeable	37
	4.7.6 Protection of Concrete pavements from severe damage	37
	4.7.7 Concrete joint maintenance	37
4.8	Cracks and damage of Cement concrete	38
	4.8.1 Cause of cracks in cement concrete	38
	4.8.2 Repair of cracks in cement concrete	38
	4.8.3 Types of damage of Cement concrete	38

4.8.4	Cause of damage of cement concrete	39
4.8.5	Repair of damage of cement concrete	39
4.9	Joints in Bituminous Pavements	40
4.9.1	Necessity of Joints in Bituminous Pavements	40
4.9.2	How to provide joints in Bituminous Pavements	40
4.10	Cracks in Bituminous pavements	40
4.10.1	Cause of Cracks in bituminous pavements	40
4.10.2	Repair of cracks in bituminous pavements	40
4.11	Damage of Bituminous pavements	41
4.11.1	Types of damage of bituminous pavements	41
4.11.2	Cause of damage of bituminous pavements	41
4.11.3	Repair of damage of bituminous pavements	41
4.12	Pavement edge damage	42
4.12.1	Cause of Pavement edge damage	42
4.12.2	Risks of Pavement edge damage	42
4.12.3	Repair of Pavement edge damage	42
4.12.4	Repair of broken corners	43
4.13	Preventative Maintenance of Asphalt Pavements	43
4.13.1	Components of pavement preservation system	43
4.13.2	Effect of Preventative Maintenance of Asphalt Pavements	43
4.13.3	Study result on Preventative Maintenance of Asphalt Pavements	43
4.14	Repair of Deficiencies of Pavement surfaces	43
4.14.1	Quality requirements of the movement areas	43
4.14.2	Maintaining the friction characteristics of runway pavement Surfaces	44
4.15	Unevenness of surface with aging	44
4.16	Contamination of the Movement area and remedial actions	44
4.16.1	Objects contaminating the Apron area	44
4.16.2	Sources of contamination	44
4.16.3	Effects of contamination	45
4.16.4	Removal of contamination	45
4.16.5	Cleaning equipment	46
4.16.6	Personal discipline	46
4.17	Rubber deposits on the Runway	46
4.17.1	Source of rubber deposits	46
4.17.2	Effect of rubber deposits	46
4.17.3	Aim of removal of rubber deposits	46
4.17.4	Methods of removal of rubber deposits	46
4.17.5	When shall the rubber deposits be removed	47
4.17.8	Runway Surface Friction Assessments	47
4.18	Runway pavement bearing strength measurement procedure & duration	52

Chapter 5. Drainage of the Airport

5.1	General	54
5.2	Lay out	54
	5.2.1 Two drainage system	54
	5.2.2 Drainage for the clean areas	54
	5.2.3 Drainage for the areas likely to be polluted	54
	5.2.4 Compliance with national or local regulations	54
	5.2.5 Cleaning of slot drains	55
	5.2.6 Time intervals for cleaning slot drains	55
	5.2.7 Drain pipes or culverts between surfaces and collector basins	55
	5.2.8 Time intervals for cleaning drain pipes or culverts	55
	5.2.9 Oil and fuel separators	55
	5.2.10 Cleaning the oil and fuel separators	56
	5.2.11 Cleaning the bottom and banks of the drain water collector Basins	56
	5.2.12 Removal of oil and fuel from separators	56
5.3	Water Hydrants	56
	5.3.1 Airport's water supply system	56
	5.3.2 Airport Fire hydrants	56
Chapter 6. Maintenance of Unpaved areas of the Airport		
6.1	General	57
6.2	Reasons for maintenance of Green Areas on an Airport	57
6.3	Who can do the job	57
6.4	Maintenance of Green Areas within strips	57
	6.4.1 Target of maintenance of Green Areas within strips	57
	6.4.2 Procedures for maintenance of Green Areas within strips	58
6.5	Maintenance of Green Areas outside strips	58
	6.5.1 Target of maintenance of Green Areas outside strips	58
	6.5.2 Procedures for maintenance of Green Areas outside strips	58
6.6	Equipment for Maintenance of Grass	59
	6.6.1 Spindle mowers	59
	6.6.2 Cutter bar mowers	59
	6.6.3 Rotary mowers	59
	6.6.4 Flail mowers	60
Chapter 7. Disabled Aircraft Removing Equipment		
7.1	Removal Plan	61
	7.1.1 Removal Procedure	61
7.2	Personnel Training	61
	7.2.1 Training programme	61
7.3	Storage of Equipment	62
	7.3.1 Where to store	62
	7.3.2 How to store	62

7.4	Transportation plan of equipment	63
7.5	Inspection of equipment	63
7.6	Maintenance of removal equipment	63
	7.6.1 Monthly checks	63
	7.6.2 Half-yearly checks	64
	7.6.3 Yearly checks	65
7.7	Test run of the equipment	66
Chapter 8. Maintenance of Equipment and Vehicles		
8.1	General	67
	8.1.1 RFF Operation vehicles	67
	8.1.2 Passenger, Freight and Ground handling vehicles	69
8.2	Principles of organization of maintenance of vehicles	69
	8.2.1 Reasons for providing workshops at the airport	69
	8.2.2 Reasons for providing airport-owned workshops	70
	8.2.3 Reasons for contracting with maintenance companies outside the airport	70
8.3	Schedule of Vehicle Maintenance	70
	8.3.1 Basis of preparing the Vehicle Maintenance Schedule	70
	8.3.1.1 Schedule on the basis of kms run	71
	8.3.1.2 Schedule on the basis of hours operated	71
	8.3.1.3 Fixed Interval or Time based schedule i.e. schedule on the basis of Months or year	71
	8.3.2 Categorization of Vehicle for Maintenance purpose	71
	8.3.3 Advantages of Fixed Interval or Time based schedules	71
	8.3.4 Defining the maintenance intervals	72
	8.3.5 Determining factors of maintenance schedules	72
	8.3.6 Servicing of radio-telecommunication equipment	72
	8.3.7 Inspections and maintenance	72

Foreword

This Guidance Material on Aerodrome Maintenance manual is the version 2.0 which has been prepared by the Directorate of Aerodrome Standard Division for the use and guideline for issue of Aerodrome Certificate in the performances of their duties. All matters pertaining to aerodrome operator duties, responsibilities and procedures have been covered to the extent possible in this Guide.

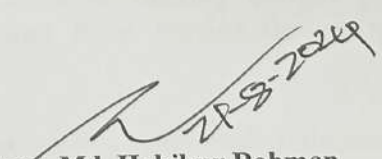
Aerodrome Operators are expected to use good judgment in dealing with matters with where specific guidance is unavailable or be aware of changes in aviation technology, legislation and developments within the industry that may necessitate changes to requirements and the relevant procedures followed by CAAB.

The guidance contains the Standards, Policies & Procedures that pertain to Aerodrome Operator. The contents of the Guidance Material on Aerodrome Maintenance manual shall not be deemed to supersede any instructions contained in the following documents: Aerodrome manual; CARs; ANOs; Rules & Regulations; AIP; AICs; Aerodrome Handbook; Standard Circulars; Aerodrome maintenance manual; Aerodrome emergency manual.

All the Aerodrome Operators are required to be fully conversant with the relevant contents of this book. The content of this guide are mainly extracted from Annexes, Documents, Aerodrome manuals, ; CARs; ANOs; Rules & Regulations; AIP; AICs; Aerodrome Handbook; Standard Circulars; Aerodrome maintenance manual; Aerodrome emergency manual.

The undersigned certifies that this aerodrome operator Guidance Material on Aerodrome Maintenance manual satisfies all the regulatory requirements. The responsibility to publish, make revisions and amendments and to control of the guidance shall be vested in and done according to the instructions and procedures described.

This guideline for Aerodrome Maintenance manual will be updated from time to time in relation to the changes in rules, regulations and or based on received suggestive ideas. Comments and recommendations are welcome and should be forwarded to the undersigned.


Engr. Md. Habibur Rahman
(Superintending Engineer)
Director (Aerodrome Standard)
Aerodrome Standard Division
Civil Aviation Authority of Bangladesh

Chapter 1: General

1.1 Intention of the Manual:

Efficiency and safety of operation at an airport can only be expected from facilities that are in good operational condition. Proper maintenance is the only key to keep the installations and facilities of an airport in good condition. Maintenance also minimizes wear and tear, thus controlling and extending considerably the life span of technical components. In this respect maintenance becomes an economic requirement to keep investment and capital costs for the aeronautical infrastructure within acceptable limits.

1.2 Organization of the Manual:

1.2.1 This manual is organized in such a way as to cover primarily the AIRPORT maintenance tasks required for maintaining safe aircraft operation during the landing, taxi and take-off phases. In addition, some of the maintenance tasks supporting the airport efficiency have been included.

1.2.2 The requirements for safety reasons dominate the first part of the manual's contents, wherein the maintenance of visual aids, of electrical infrastructure, of pavements, of unpaved areas and of the drainage system is dealt with. Availability of suitable equipment is the tool for complying with the maintenance requirements of fixed facilities. Aircraft removal equipment represents a very special type of airport equipment. The material in this manual is complementary to the *Airport Services Manual*, Part 5, which deals with removal procedures.

1.3 Organization of the Maintenance:

1.3.1 Inspection is very vital part of maintenance. It comprises all measures to check and evaluate the operating condition including spontaneous and scheduled checks. Scheduled checks are carried out in accordance with a plan specifying the preparation of the check, the sort of check, the report on the result and the evaluation of the results. From the evaluations the operator decides whether or not extra servicing or even repair has to be undertaken.

1.3.2 A fundamental task of the organization is to translate the maintenance requirements into man/hours and monetary value. This evaluation is the basis of staffing budget planning. It is, furthermore, a tool for decision-making when contracting third parties for maintenance tasks instead of employing extra personnel.

1.3.3 Management should check the work carried out against scheduled maintenance tasks and thereby achieve the full control of the progress of maintenance and budget. Compliance reports are the feedback and have to be recorded, as well as observations on any reported deficiencies.

1.3.4 Updated maintenance programmes will allow:

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

1.3.5 All maintenance programmes should be "screened" once a year, preferably at the time of budget planning. It is useful not only to rely on recorded data but to inspect the condition of all major objects at that time. In contrast to machines, whose operating hours give a good measure of wear, the deterioration of buildings is more dependent on weathering, utilization under heavy load, concealed construction deficiencies or other unpredictable sources of damage.

1.4 Categories of maintenance:

There are two categories of maintenance, namely-

- a) Corrective / Regular Maintenance,
- b) Preventive Maintenance.

1.4.1 Regular / Corrective maintenance:

Corrective maintenance can be defined as the maintenance which is required to bring an item back to working order when it has failed or worn out. Corrective maintenance shall be carried out on items where-

- a) the consequences of failure or wearing out are not very significant, and
- b) the cost of corrective maintenance is not greater than preventive maintenance

Corrective Maintenance activity will consist of repair, restoration or replacement of equipment/ item. This activity will be the result of a regular inspection, which identifies the failure in time for corrective maintenance to be planned, scheduled and effected.

1.4.2 Preventive maintenance:

Preventative maintenance is the maintenance which is carried out to prevent an item failing or wearing out. Preventive maintenance shall be implemented by providing systematic inspection, detection and prevention of incipient failure. Preventive maintenance shall be carried out on items where-

- a) the consequences of failure or wearing out are significant, and
- b) the cost of corrective maintenance is greater than preventive maintenance.

The items falling under preventive maintenance would be e.g. lift, fire alarms, monitoring lamps for important equipment, electricity supply etc.

Chapter 2: Maintenance Of Visual Aids

2.1 Introduction:

The basic purpose of visual aid systems is to aid in the safe operation of aircraft. Therefore, the highest standards of maintenance are required. Once a system has been installed, its usefulness is dependent on its service-ability which in turn depends upon the effectiveness of the maintenance work carried out. Annex 14, Chapter 1 defines a light to have failed when its light output falls below 50 per cent of that specified for a new light. The loss of in light output can be due to the following two causes: -

- a. Contaminants outside and inside the light unit, and
- b. Degradation of the lamp and optical system due to aging.

The light can and should be restored to its original condition by cleaning or replacing the lamp and any parts which have apparently 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 Different types of Visual Aids:

Different types of visual aids used at AIRPORT are as follows:

- a. Runway edge lights, threshold lights, stop bar lights, runway end lights etc.
- b. Taxiway edge lights.
- c. High intensity approach lights, PAPI etc.
- d. Aerodrome beacon, wind direction indicators, obstruction lights etc.
- e. Markings and signs etc.

2.3 Performance level objectives for Visual Aids:

The Performance level objectives for visual aids shall be as follows. This performance level shall be maintained through scheduled, unscheduled and preventive maintenance.

Visual Aids' Performance Level Objective Table

SN	Light category	Minimum acceptable light output (% of specified value)	Minimum acceptable % of serviceable light		Consecutive lights, more than that shall not remain unserviceable
1	Rwy edge lights	50 %	a) For Cat-1 operation	85 %	2
2	Rwy end lights	50 %	a) For Cat-1 operation	85 %	2
3	Rwy THR lights	50 %	85 %		-
4	Approach lights	50 %	a) For Cat-1 operation, Portable Airfield Lighting System (PALS)	85 %	-
			b) For Cat-1 operation, Smart Airfield Lighting System (SALS)	85 %	

Note: With respect to barrettes, crossbars and runway edge lights, lights are considered to be adjacent if located consecutively and:

- ¾ laterally: in the same barrette or crossbar; or
- ¾ longitudinally: in the same row of edge lights or barrettes.

2.4 Personnel:

Electricians to be entrusted with the task of maintenance of lighting aids shall have the following qualifications / qualities:

- a. Be experienced with high voltage series circuits and lighting;
- b. Be fully acquainted with the work to be done;
- c. Be present or available on call during the operating hours of the airport to correct any deficiencies that might develop;
- d. Be provided with appropriate training to maintain their competence and to keep them abreast of new developments.

2.5 Spare parts:

An adequate stock of spare parts should be available. The required level of stock will depend on the following criteria: -

- a. Rate of consumption of the items;
- b. Time required to get the resupply of the items;
- c. Shelf life of the items.

2.6 As-built drawing:

A set of as-built drawings shall be kept readily available in the Maintenance unit. The as-built drawings shall be kept in the following manner: -

- a. Drawings shall be kept in the Maintenance unit and in the Assistant Engineer's (E/M) office;
- b. Drawings must be kept up to date and any changes at site shall be reflected immediately on these drawings.
- c. The completeness and the accuracy of all circuit diagrams, drawings and descriptions shall be checked at least annually.

2.7 Preventive maintenance of Visual aids:

A system of preventive maintenance of visual aids shall be employed to ensure lighting and marking system reliability. Procedures of preventive maintenance shall be as follows: -

- a. Light bulbs shall be considered unserviceable and be replaced when their brightness falls below 50% of normal value.
- b. The specifications from the Manufacturers regarding the normal life time of all the items of visual aids, shall be made available with the maintenance personnel, and light bulbs shall be replaced after 90% of the manufacturer's prescribed life time has elapsed.
- c. In case when manufacturer's specification is not available, light bulbs shall be replaced after 90% of the average life time of the bulbs has elapsed.
- d. Light fittings, fasteners and their supporting structures which may be damaged by rust shall be painted annually. Preferable period for such work shall be between January and April each year.
- e. Cable lives of all concerned sections of visual aids shall be verified and cables shall be replaced whenever there is any threat to the system to be hampered for damage of cables due to aging.

- f. Functions of all other items shall be closely monitored and shall be replaced whenever there is any threat to the system to be hampered due to aging of those items.

2.8 Basic components of maintenance:

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:

- a. Inspection/ Monitoring;
(The unserviceable lights can be identified more easily during night inspections, and of course, possible failures can be noticed by the operator at the Control desk if appropriate electric monitoring system is there.)
- b. Servicing and overhaul; and
- c. Repair.

2.8.1 Regular maintenance and Inspection:

Inspection is a vital part of maintenance. An inspection programme shall be prepared and be strictly followed. As the frequency of inspection will vary according to the hours of operation of the airport, inspection programme shall be prepared keeping pace with the hours of operation of the airport and flight schedule. Assistant Engineer (E/M) or his representative shall regularly inspect the visual aids to assess the requirement of maintenance, and maintenance work shall be done immediately. For expediting the job, Assistant Engineer (E/M) shall be included in the inspection team to do the maintenance job instantaneously.

2.8.2 Recording of Inspection and Maintenance reports:

- a. Daily report of the maintenance work done during the last 24 hours shall be raised by the Sub-Assistant Engineer (E/M) and shall be sent to the Assistant Engineer's office. The Engineer shall verify the genuinity of the report and preserve in his office as record.
- b. Copy of the report shall be sent by Assistant Engineer to the Director (AIRPORT) (Attention: SATO). Director (AIRPORT) / SATO shall verify the maintenance report against the Daily IOU report and shall send it to Aerodrome Standard Division, FSR, CAAB for further necessary action. Significant discrepancies shall be consulted with the concerned engineers. Reports shall be preserved as record.

2.8.3 Daily IOU Reports:

- a. Daily report of the serviceability status (IOU report) shall be raised by the Sub-Assistant Engineer (E/M) and shall be sent to the Assistant Engineer's office. The Engineer shall verify the report against the daily maintenance reports and preserve in his office as record.
- b. Copy of the report shall be sent by the Assistant Engineer to the Director (AIRPORT) (Attention: SATO). Director (AIRPORT) / SATO shall verify the maintenance report against the Daily maintenance report and take necessary action. Significant discrepancies shall be consulted with the concerned engineers. Reports shall be preserved as record.
- c. Director (AIRPORT)/APM shall send the report to CAAB HQ [Attention: Director (ATM) and Director (Aerodrome Standard), through the best available means.

2.8.4 Inspection and Maintenance Team:

A team for the inspection and maintenance of visual aids shall be formed with at least three members out of the following five persons, where No. a, or No. b, and No. e, shall be included:

- a. Sub Divisional Engineer, E/M
- b. Sub-assistant Engineer, E/M
- c. E/M Foreman,
- d. Electrician,
- e. One Security personnel.

2.9 General procedures of Maintenance:

At the time of maintenance of the lights the following general procedures shall be followed:

- a. The instructions of the Director (AIRPORT)/APM, based on the recommendations of the manufacturer shall be followed.
- b. Maintenance schedule shall be prepared and records of maintenance of each piece of equipment shall be maintained.
- c. This can be arranged in a dated reminder file to make sure that each equipment is serviced regularly.
- d. This record should have space to enter observations, action taken and signature of the Technicians.
- e. If situation demands, a change in the schedule may be effected with the approval of appropriate authority and in consultation with the equipment manufacturer, if applicable.

2.10 Frequency of checks:

- a. Frequency of inspection and servicing will vary according to the type of equipment, its location and usage.

- b. A maintenance programme shall be prepared for AIRPORT based on its past experience and with the objective of achieving required service standard.
- c. The following schedules are presented as guidance material in establishing a preventive maintenance programme.
- d. More frequent checks may required for higher categories of lights.
- e. Each check shall be followed by appropriate corrective action.

2.10.1 Daily Checks:

(1) Runway, Taxiway, Approach, Threshold, PAPI and other Lights:

- a. Burnt-out lamps shall be replaced.
- b. Glass of each light to be cleaned and shall be replaced, as required.
- c. Loose fasteners of light units shall be tightened.
- d. Rusted and corroded light parts and reflectors shall be painted and replaced, if required.
- e. Horizontal alignment of the light units shall be adjusted, as applicable.

(2) Other Airport lights: Airport beacon, obstacle lights, signs markers etc.:

- a. Burnt-out lamps shall be replaced.
- b. Control equipment shall be corrected or repaired, as required for proper operation.
- c. Fabric of wind cone shall be replaced, as required.
- d. Inscriptions legibility shall be ensured by repairing the signs and removing the obstructions, as required.

2.10.2 Monthly checks:

(1) Runway, Taxiway, Approach, Threshold, PAPI and other Lights:

- a. Spreader glasses, filters and lamps shall be cleaned.
- b. Light output of all lights within the system shall be measured and results shall be recorded; lenses shall be cleaned.
- c. Elevation setting of the light units shall be adjusted, as required.
- d. Control equipment shall be checked for proper operation at each brightness step; malfunctions shall be corrected and repaired, as required.

2.10.3 Half-yearly / Yearly Checks:

(1) Runway, Taxiway, Approach, Threshold, PAPI and other Lights:

- a. Lamps of the whole system shall be checked; unserviceable lamps or, if required, lamps of the entire system shall be replaced.
- b. Rusted and corroded light parts and reflectors shall be painted and replaced, if required.

- c. Reflector of each light unit (if applicable), shall be cleaned, and replaced, if required.
- d. Loose fasteners of light units shall be tightened.
- e. Plug connections shall be checked and faultless connection shall be ensured by cleaning the dirty parts; if required, faulty plugs shall be replaced.
- f. Elevation setting of the light units shall be checked and elevation shall be adjusted, as applicable.
- g. Horizontal alignment of the light units shall be checked and alignment shall be adjusted, as applicable.
- h. Supporting structure and the foundation of the units shall be repaired and painted, as required.

(3) Other Airport lights: Airport beacon, obstacle lights, signs markers etc.:

- a. Power supply brushes and slip-rings of aerodrome beacon shall be cleaned; or replaced, if required.
- b. Electrical connections of the lights shall be tightened.
- c. Rotating parts shall be fastened.
- d. Optical system of the beacon shall be checked and required remedial action shall be taken.
- e. Glasses and gaskets of obstacle lights shall be cleaned; or replaced, if required.
- f. Function of the Flashing lights and twilight switches shall be cleaned, repaired or replaced, if required.
- g. Power supply and lighting of the wind direction indicator shall be repaired or replaced, if required.
- h. Fastener of the wind direction indicator shall be tightened and structure shall be repaired, if required.
- i. Supporting structure and the foundation of different units shall be repaired, as required.
- j. Loose fasteners of obstruction lights shall be tightened.
- k. Easy access to locations of obstruction lights, for maintenance, shall be arranged; if required and possible, location shall be changed.
- l. Structure and mounting of both signs and their lighting shall be cleaned, repaired and replaced, as required; shall be repainted wherever applicable.
- m. All markings on paved areas shall be inspected at least semi-annually; markings which are faded or discolored by soil shall be repainted.

2.10.4 Non-schedule checks:

In addition to carrying out all the above mentioned scheduled maintenances, situations like some natural calamity, accidents, sabotage etc. may give rise to such situation when some out- of-schedule maintenance work will become essential.

2.11 Light Maintenance Procedures:

2.11.1 General hints for Maintenance of lights

Maintenance work can be done in two ways-

- a. Indoor
- b. Outdoor.

As far as practicable, maintenance work shall be carried out indoor. Outdoor maintenance has the following inconveniences: -

- a. Heat, cold, precipitation etc.
- b. Aircraft noise.
- c. Traffic restrictions, interruptions etc.

2.11.2 Steps of Maintenance procedures

There are two steps in the commonly used maintenance procedure-

- a. Removal of defective lights and replacement by new or repaired once;
- b. Servicing and overhauling of deficiencies in the workshop where required tools and equipment are available.

The prerequisites to run the above system of maintenance are as follows: -

- a. Provision of sufficient number of spares;
- b. Requirements of spare parts will be determined by the past experience of rate of damage / consumption of the individual items;
- c. Lights which are easy to install and repair should be used;

2.12 Cleaning procedures of lights

The type and degree of contamination of the various lights on an airport will be different. While elevated approach and edge lights are normally contaminated by dust carried by wind and rain, more severe contamination can be observed on inset lights, particularly on runways. Rubber deposits from tires on touchdown and exhaust from engine reverse thrust procedures create firmly sticking deposits on the exterior glassware of lights. The very different degree of contamination must be reflected in the maintenance schedule of different categories of lights or sections in the runway/taxiway system.

2.12.1 When cleaning the glassware of lights, the manufacturer's recommendations should be observed. Normally, cleaning is accomplished by washing the glassware with a cleansing 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 by using plastic tools or powder before using the solvent. Other mechanical aids for cleaning may be sponges, cloths, hand brushes or electric rotating brushes. The cleaning

technique and the materials used should not scratch or groove the glass surface nor damage the sealing material.

2.12.2 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 done by using clean ground-up 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.

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

2.13 Water inside lamps

Lights may sometime collect water. Water inside the lights causes the following problems:-

- a. Increase corrosion;
- b. Damage to electrical parts;
- c. Deposits on lenses and lamps;
- d. Reduces the life of the lamp.

2.13.1 Remedial actions against water inside the lamps:

2.13.1.1 Preventive and remedial actions against water inside lamp shall be follows:

- a. Before inserting a light into the pavement, good drainage of the opening must be ensured.
- b. Regular inspection shall be made to check lights for presence of water, penetration of moisture and accumulation of water can not be prevented completely.

2.13.1.2 Lights found to be wet inside should be removed and replaced, if such a procedure is possible with the type of light. Other wise, drying must be carried out on the spot.

- a. After drying, the sealing should be checked carefully and replaced when required.
- b. Before closing a dried light, the lamp should be switched on for some time to permit any residual moisture to evaporate due to the temperature increase inside.

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

2.14 Lamp Replacement

The life span of lamps varies from 100 to some 1 000 hours of operation. The life time depends on the percentage of operation at high brightness levels and on the number of switching, dynamic stresses imposed by aircraft wheel loads (inset lights) and temperature-induced stresses inside the casing affect the lamp life. Lamps which have failed shall be replaced as soon as possible so that

the lighting system of the airport meets the required maintenance level objectives stated in para 4.15 of this Manual. (Ref: Annex 14, Chapter 9).

2.14.1 Lamp replacement Procedures:

The following procedures shall be followed to replace the unserviceable lamps:

- a. Only lamps which have failed or lamps showing major output reduction are replaced upon checking; this method requires checks to be carried out at short intervals;
- b. Bulk changing of lamps in certain sections of the entire lighting system in accordance with a fixed time schedule.
- c. The intervals between replacements have to be derived from local experience with the average life of lamps in use.
- d. Lamps should be changed when they have been operated for 80 per cent of their average life.
- e. For this maintenance method a reliable record of operating hours for the individual sections of the airport's lighting system is a required.
- f. This method requires less frequent checks.

2.14.2 Lamp replacement in the workshop is preferable, particularly with inset lights. The unserviceable light shall 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 socket of the lamp needs no realignment afterwards.

2.15 Light Measurements and Output Standards:

2.15.1 The light output will diminish with the lapse of time due to lamp aging. Contamination of reflector and lens will result in a further degradation of light output. **A light shall be considered to have failed when its output is less than 50% of the required intensity.** For practical reasons a light will be replaced when its output falls below 70 per cent of that specified for a new light. [Ref: ANO (AD) 14-1, Para 10.4.1].

2.15.2 Light measurements shall be carried out regularly to detect early light output reduction. Appropriate equipment for both field and bench measurement of light output will be made available. The equipment produced by light manufacturers does not, however, indicate the absolute intensity values but provide ratios between measured and original light intensities of each individual type.

2.15.3 Field measurements are particularly necessary for inset lights. Wheel loads on Inset lights may frequently cause damage. Before measuring, the lights shall be cleaned and switched to the highest available intensity setting.

2.15.4 Light measurements shall be made by using the measuring equipment supplied by the light manufacturers or procured time to time, as required. The intensity is checked by comparison with the results of a calibration test with a new light.

2.15.5 Often a much faster visual observation carried out by experienced personnel will achieve comparable results for discovering 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).

2.15.6 For adjustment of the correct angle of the beam, lights are normally furnished with alignment markings. Beam misalignment caused by displacement of the optical system inside, which cannot be corrected by adjusting the casing, shall be adjusted in the workshop.

2.15.7 For measuring light output in the workshop micrometer readings shall be compared with the calibration value. Directional adjustments shall be made using the alignment screws.

2.16 Maintenance of Signs and Markings:

Signs and Markings give pilots directional information for taxiing and holding. Maintenance should ensure integrity and perfect legibility of the information provided by them. The design and construction of signs varies considerably and maintenance system may also vary; but the general checks and maintenance, as given in articles 4.10 shall be followed and, if required, additional system may be adopted with the approval of Director (AIRPORT)/APM.

2.17 Frangible Connection:

2.17.1 Requirements.

2.17.1.1 Equipment located in airfield safety areas (such as RSAs or TSAs), is mounted on frangible supports to ensure the structure will break, distort, or yield in the event of an impact by an aircraft. Select materials that preclude any tendency for the components, including the electrical conductors, etc., to "wrap around" the aircraft.

2.17.1.2 Frangible structures include effective failure or breakaway mechanisms, such as those containing a limited number of parts, brittle or low-toughness members and connections, and/or low-mass members. Various design concepts exist, each with its own advantages and disadvantages.

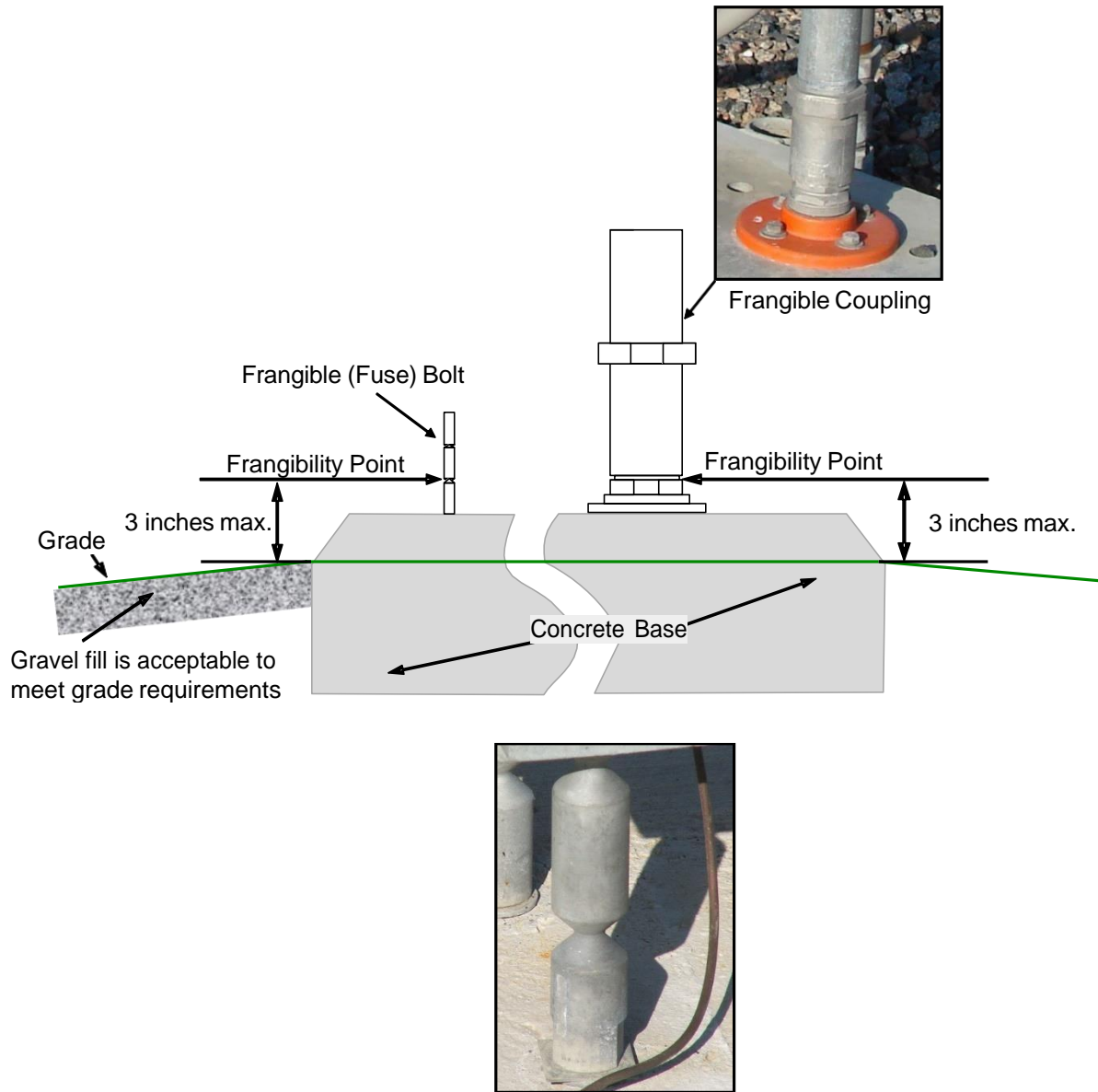


Figure 2-1. Typical Frangible Connections

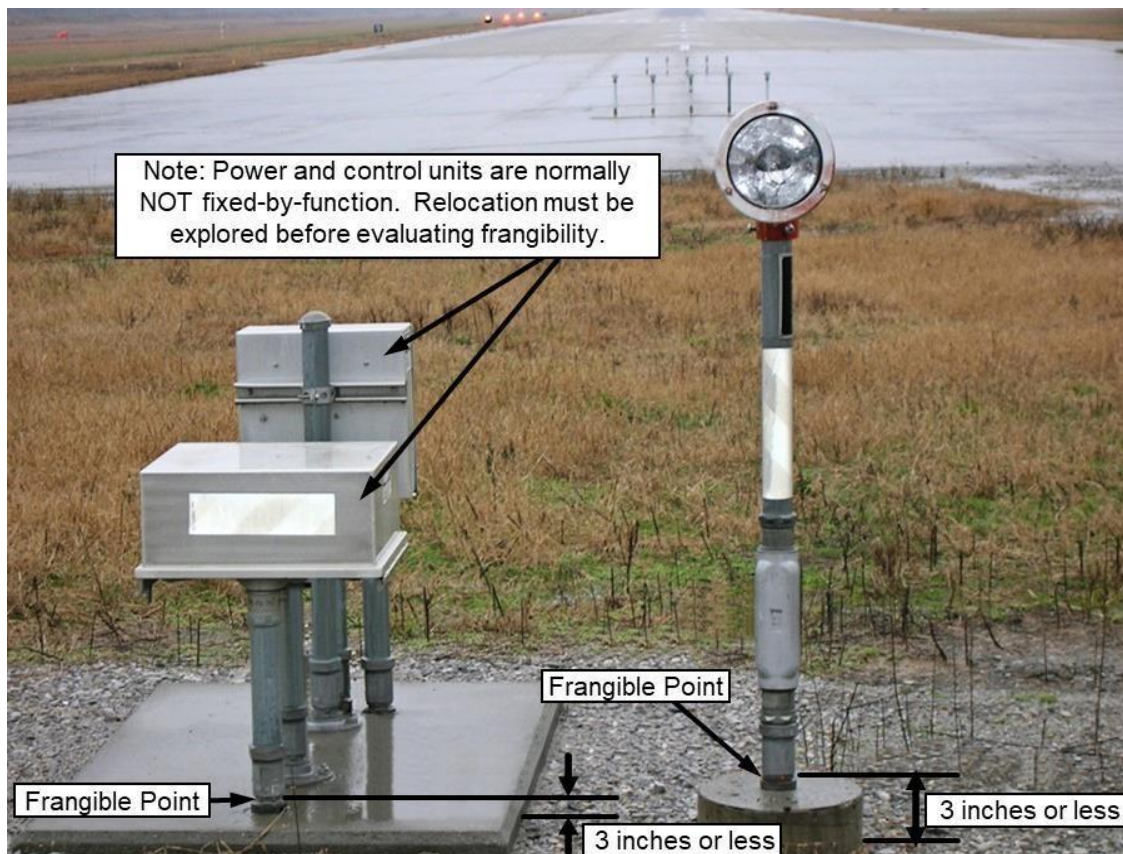





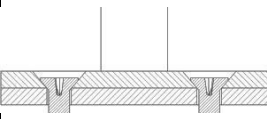
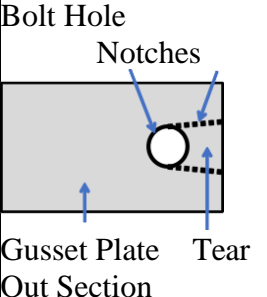
Figure 2-2. Field Measurability of Frangibility

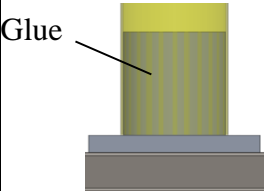
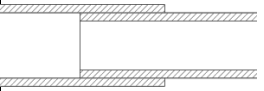

2.17.2 Maintenance Equipment Design.

2.17.2.1 A frangible structure no longer meets requirements if the structure itself is used as a climbing frame or by the addition of a fixed ladder. Maintain the total structure either by using equipment that can be easily moved into position or by lowering the structure to the ground.

2.17.2.2 Portable maintenance stands are recommended to maintain airfield lighting structures. (It may be possible to convert a permanent stand into a portable stand by installing a threaded can into the foundation, which allows for the stand to be temporarily screwed into place whenever needed.)

Table 2-1. Types of Frangible Connections

Frangible Connection	Illustration	Description
Fuse Bolt / Neck-Down Bolts		Bolts designed to break at a specific tensile load by reducing the diameter at a point on the bolt shank. These connections are typically located between the structure and the foundation.
Special Material Bolts		Bolts engineered with specific materials to fail at a given load. Must have a certificate to guarantee compliance of physical properties.
Frangible Couplings		Cylindrical couplings with a reduced circumference or cross-sectional area in a specific area to reduce strength at that point. Typically located between structure and foundation.
Tear Through Fasteners		Fasteners, such as countersunk rivets, designed to tear through the base material when dynamically loaded. Can be used with slip joints.
Tear-Out Sections		Gusset plates designed with notches that will tear out during a dynamic impact. Fasteners do not fail but are used to pull out a section of the gusset plate.

Frangible Connection	Illustration	Description
Glued Joints	 <p>Glue</p>	Type of slip joint where adhesive is added to provide extra strength during normal use. Can be used at base of structure or throughout the structure.
Friction Joints		Friction joints can supply high strength normal to sliding surface but slip when force is applied parallel to surface.
Swing-away or Frangible Support Members		Support members incorporated into a structure providing stability. During an impact, these members will break or swing free, leaving it unstable.

Chapter 3: Maintenance Of Airport Electro-Mechanical(E/M) System

3.1 Introduction:

The serviceability and reliability of air navigation equipment and installations are requirements for safe operation of aircraft in airport area. Apart from visual aids, the air navigation equipment and installations include electronic landing aids, navigation equipment, radar and meteorological equipment. The required serviceability of installations and equipment will only be achieved as long as a constant power supply is maintained. To this end, a regular maintenance for airport equipment and installations distributing primary power and equipment supplying the secondary power when there is a circuit break down. This circular will provide a general guideline to the Aerodrome operators in making a maintenance programme for individual elements of the Power Supply System.

3.2 Purpose:

The purpose this manual is to establish a mechanism to assist the aerodrome operators to prepare their maintenance programme for AIRPORT Electrical System and that they effectively implement the aerodrome maintenance programme including preventive maintenance programme to ensure highest level of performance of all kinds of electrical installations and appliances

3.3 Different elements of Electro-Mechanical Installations and Equipments:

The individual elements of Electrical Installations and Equipment are as follows: -

- a. Power Distribution System (HT, LT Switchgears, Transformers, PFI panel, AVR, Control circuits)
- b. Air conditioning system (Central-Chiller units, AHU, FCU/Split, package)
- c. AGL system (Runway lighting, Approach lighting, Taxiway, Apron lighting), CCR
- d. Boarding bridges
- e. Conveyor belts, Check-in counters, weighting scale
- f. Lifts, Escalators
- g. Generators
- h. Water supply system
- h. Power cables, Control cables
- d. Street lights, Terminal lights etc.

3.4 Maintenance Personnel:

Electricians to be entrusted with the task of maintenance of Airport Electrical System shall have the following qualifications / qualities. They shall-

- a. be skilled electricians,
- b. be well informed and acquainted with the safety measures while working in high voltage areas,
- c. be fully acquainted with the work to be done, and

- d. be present or on call during the operating hours of the airport to correct any deficiencies that might develop. Wherever possible, the same personnel can be utilized for maintenance of both Electrical systems and Visual aids.

Note: *To protect personnel the required safety devices should always be kept in good condition.*

3.5 As-built wiring / circuit diagram and Manufacturer's Manual:

A set of wiring / circuit diagram is required to be available in the maintenance unit. The wiring /circuit diagram shall be kept in the following manner: -

- a. A set of wiring / circuit diagram of important and complex electrifications shall be kept readily available.
- b. These wiring / circuit diagram must be kept up to date and any changes at site shall be reflected immediately on these drawings.
- c. The completeness and the accuracy of all circuit diagrams, drawings and descriptions shall be checked at least annually.
- d. Manufacturer's Operation and Maintenance Manual shall be preserved in the office of the concerned maintenance engineering division.

3.6 Spare Parts:

An adequate stock of spare parts should be available. The required level of stock of spare parts will depend on the following criteria: -

- a) Rate of consumption of the item;
- b) Time required to re-supply the item, and
- c) Shelf life of the item.

3.7 General procedures for Maintenance:

At the time of servicing the electrical installations, the following general procedures shall be followed: -

- a. The instructions of the Director (AIRPORT)/APM, based on the recommendations of the manufacturer shall be followed.
- b. Maintenance schedule shall be prepared and records of maintenance of each piece of equipment shall be maintained.
- c. These can be arranged in a dated reminder file to make sure that all equipment is serviced regularly.
- d. This record should have space to enter observations, measurements and initials of the servicing individual.
- e. If situation demands, a change in the schedule may be effected with the approval of Director (AIRPORT)/APM and in consultation with the equipment manufacturer, if applicable.

3.7.1 Regular / Corrective maintenance:

Corrective maintenance can be defined as the maintenance which is required to bring an item back to working order when it has failed or worn out. Corrective maintenance shall be carried out on items where-

- a) the consequences of failure or wearing out are not very significant, and
- b) the cost of corrective maintenance is not greater than preventive maintenance.

Corrective Maintenance activity will consist of repair, restoration or replacement of equipment/ item. This activity will be the result of a regular inspection, which identifies the failure in time for corrective maintenance to be planned, scheduled and effected.

3.7.2 Preventive maintenance:

Preventative maintenance is the maintenance which is carried out to prevent an item failing or wearing out. Preventive maintenance shall be implemented by providing systematic inspection, detection and prevention of incipient failure. Preventive maintenance shall be carried out on items where-

- a) the consequences of failure or wearing out are significant, and
- b) the cost of corrective maintenance is greater than preventive maintenance.

The items falling under preventive maintenance would be e.g. Lift, fire alarms, monitoring lamps for important equipment, electricity supply etc.

3.8 Basic components of maintenance:

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:

- a. Inspection/ Monitoring;
(The unserviceable lights can be identified more easily during night inspections, and of course, possible failures can be noticed by the operator at the Control desk, if appropriate electric monitoring system is there.)
- b. Servicing/overhauling/repairing;
- c. Replacement.

3.8.1 Regular maintenance and Inspection:

Inspection is a vital part of maintenance. An inspection programme shall be prepared and be strictly followed. Sub Divisional Engineer (E/M)/ Assistant Engineer (E/M) or his representatives of supervisor category shall regularly inspect the electro-mechanical installations and equipment to assess the requirement of maintenance, and maintenance work shall be done immediately. For expediting the job, Sub Divisional Engineer (E/M)/ Assistant Engineer (E/M) shall be included in the inspection team to do the maintenance job instantaneously.

3.8.2 Recording of Inspection and Maintenance reports:

- a. Daily report of the maintenance work during the last 24 hours shall be raised by the S u b - Assistant Engineer (E/M) and shall be sent to the Assistant Engineer's office and ASD, FSR office. The Engineer shall verify the authenticity of the report and preserve in his office as record.
- b. Copy of the report shall be sent by the Engineer to the Director (AIRPORT)/APM (Attention: SATO). Director (AIRPORT) / SATO shall verify the maintenance report and take necessary action. Significant discrepancies shall be consulted with the concerned engineers. Reports shall be preserved as record.

3.8.3 Inspection and Maintenance Team:

Regular inspections of the Electrical items shall be done with a team consisting of at least 3 (three) members out of the following persons, where No. a, or No. b shall be included:

- a. Sub Divisional Engineer (E/M)/Assistant Engineer (E/M)
- b. Sub-assistant Engineer, E/M
- c. Foreman (E/M)
- d. Electrician/Mechanic

3.8.4 Grouping of the electric items for Maintenance:

For the purpose of efficient maintenance and easy supervision all the electrical items may be divided into some groups and maintenance task of particular group of items may be assigned to separate group of personnel. Such grouping may done in two ways: -

- a. group of equipment/ installations which are identical in nature, or
- b. group of equipment/ installations which are located in one or adjacent areas.

3.9 Maintenance schedule and frequency of maintenance:

The following schedules shall be followed for AIRPORT in establishing a corrective and, at the same time, a preventive maintenance programme.

- a. Each check shall be followed by appropriate corrective action.
- b. All malfunctions and corrective actions are to be recorded after taking the action.

3.9.1 Daily Checks:

(1) Lighting and Electric equipment, lighting system of the terminal building and forecourt, Apron Flood lighting, lighting system for Roads and Parking lots:

- a. Burnt-out lamps shall be replaced.

- b. Unserviceable switches, including remote control switches, shall be repaired or replaced as required.

(2) Control cables, monitoring units, control desk:

- a. Optical and acoustical signals shall be checked for feedback and restored.
- b. Unserviceable and burnt-out lamps of monitoring units shall be replaced.

3.9.2 Weekly Checks:

(1) Lighting and Electric equipment, lighting system of the terminal building and forecourt, lighting system for Roads and Parking lots:

- a. Proper functioning shall be checked and ensured.
- b. Fluorescent tubes and ignition starters shall be replaced, as required.

(2) Airport sub-stations:

- a. Over-all condition of the Sub-stations shall be checked visually and restored.
- b. All switchgear panels shall be checked for completeness of contents and missing elements shall be added.

(3) Control cables, monitoring units, control desk:

- a. Nominal control voltage shall be maintained by charging the batteries,
- b. Voltage and ammeter readings shall be adjusted.
- c. Acid level in batteries shall be maintained by adding distilled water.

(4) Baggage check-in counters, weighing scales and Conveyor Belts:

- a. Visual checks shall be carried out for check-in counters, weighing scales and for cuts and cracks of the belts. Short cracks at the edges can be eliminated by cutting off the damaged edge material.
- b. Smooth movement and low noise shall be ensured by proper servicing. Noisy and squeaking parts shall be repaired or replaced.
- c. Loose spring rollers shall be adjusted.
- d. Stress on belt movements shall be adjusted to normal.
- e. Control box and monitoring units of the check-in counters and weighing scales shall be checked and repair or replacement shall be done, as required.

(5) Passenger Boarding Bridge:

- a. Tires shall be checked for surface damage and wear.

- b. Wheel brakes shall be checked.
- c. Electric driving motors shall be checked and drive chains shall be cleaned, as required.
- d. Lifting jacks shall be checked for normal operations; lubrication shall be done as required.
- e. Hydraulic system shall be checked and normal operation shall be ensured.
- f. Bridge movements, i.e. extension, retraction, lowering, raising and steering shall be checked and normal operation shall be ensured.

3.9.3 Monthly Checks:

(1) Lighting and Electric equipment:

- a. Accumulators (battery capacities) shall be checked.
- b. Repair work, as found necessary through inspections, shall be done according to maintenance plan.
- c. Light bulbs shall be replaced according to maintenance plan.

(2) Transformers and regulators, including stand by units:

- a. Shall be cleaned and oil shall be replaced.
- b. Regulator switches at all light intensity positions shall be checked and restored.
- c. Switch over to standby units shall be checked for serviceability, and restored.

(3) Control cables, monitoring units, control desk:

- a. Functions of the monitoring units shall be checked.
- b. Parts shall be cleaned, repaired and replaced as required.

(4) Baggage Conveyor Belts:

- a. Joints and dirt trapping boxes shall be cleaned.
- b. Papers and other wastes shall be removed from underneath the belts.

(6) Secondary Power Supplies (*Generators*):

- a. Switch-over time from primary to secondary power supply shall be checked for conformation to the requirement.
- b. Voltmeter readings shall be checked to ensure that the voltage remains within acceptable tolerances.
- c. Transfer equipment shall be checked for excessive heating and malfunctions.
- d. Diesel engine shall be checked for any irregularities and oil leakage.

- e. After the test run, fuel level in the tank shall be checked and refilled with fuel, if required.
- f. Corrective repairing action shall be taken for any abnormal or undesirable performance.
- g. All the meter readings of the test run shall be recorded and compared with former records to detect potential deficiencies; if required, corrective action shall be taken.

3.9.4 Quarterly Checks:

(1) Control cables, monitoring units, control desk:

- a. System components shall be tightened, repaired or replaced, for good connections.
- b. Over-all operation of control desk shall be investigated and parts shall be repaired or replaced against malfunctions.
- c. Indications of the mimic panel shall be corrected or adjusted for field conditions
- d. Mechanical structure of the desk shall be repaired for stability.

(2) Lighting and Electric equipment:

- a. Lighting control units shall be checked.
- b. Dimmers shall be adjusted.

3.9.5 Half-yearly Checks:

(1) Underground Power cables and Control cables:

- a. Output level shall be measured, and shall be repaired, as required.
- b. Distributors located in manholes shall be cleaned and dried.
- c. Plug-in and clamp connections in the distributors shall be tightened and sprayed for good contact.
- d. Manholes, for condition of the interior, shall be pumped-out, dried up and cleaned.
- e. Insulation resistance shall be measured by measuring the earthing resistance of each circuit, and the readings shall be recorded and necessary corrective actions shall be taken.

(2) Transformer stations for electric power supply:

- a. Insulators and electrical connections shall be cleaned and restored.
- b. Stations shall be cleaned and dried against dirt and moisture.
- c. Locks to stations shall be repaired for serviceability and locking.

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

- a. Turn and plug-in connections shall be cleaned to maintain good electrical contact.
- b. Relays shall be cleaned to maintain positive closing of contact.
- c. Corroded and wearied electrical contacts shall be cleaned, and replaced as required.
- d. Cabinet shall be cleaned and dried, weather seals be kept serviceable, and mechanical damages shall be repaired.
- e. Relays of series circuits shall be monitored for proper feedback, and repaired as required.
- f. Voltage switch-over of two circuits shall be repaired for serviceability, if required.

(4) Secondary power supplies (generators):

- a. Switch over time from primary to secondary power supply shall be checked and conformation to the requirement shall be ensured.
- b. Voltmeter readings shall be checked and voltage within the acceptable tolerance shall be ensured.
- c. Excessive heating and malfunction of Transfer equipment shall be repaired, as required.
- d. Any irregularity or oil leakage of diesel engine shall be removed.
- e. Fuel level shall be checked after the test run and refueling shall be done, as required.
- f. Corrective action shall be taken for any other abnormal or undesirable performance.
- g. Meter readings of the test runs shall be recorded compared with former records and corrective actions shall be taken for any potential differences.

(6) Passenger Boarding Bridges:

- a. Bearings and their lubrication shall be checked and restored.
- b. Rollers shall be checked for wear and corrosion, and shall be greased, repaired and replaced as required.
- c. Drive chains shall be checked for stress and shall be adjusted, as required.
- d. Floor covers shall be checked for damage and be fixed as required.
- e. The outer skin of the tunnel shall be cleaned.
- f. Paints shall be renewed.

(7) Lighting and Electric equipment:

- a. Supply lines, cables, switches and distributors shall be checked.
- b. Plugs, contacts and terminals of the electric wiring shall be cleaned.

3.9.6 Annual Checks:

(1) Lighting and Electric equipment:

- a. Lamps shall be cleaned.
- b. Insulation capacity shall be checked by overload voltage.

(2) Transformer stations for electric power supply:

- a. Relays shall be adjusted.
- b. Insulation of high voltage cables shall be recorded and necessary preventive action shall be taken.
- c. Earthing and its resistance shall be checked and cleaning / necessary corrective action shall be taken.
- d. Noisy and damaged electric supply system shall be repaired.
- e. Rusted, corroded and defective coatings shall be cleaned and painted.
- f. Warning signs and safety devices shall be cleaned and replaced in correct positions.
- g. Safety grids shall be cleaned; coating deficiencies shall be removed and painted against rust.
- h. Safety grids shall be tightened for stability and proper earthing shall be restored.

(3) Transformers and Regulators, including stand by units:

- a. If noisy, reason shall be found out and repairing action shall be taken.
- b. Over-all condition shall be checked and repairing action shall be taken, as required.
- c. Insulators shall be repaired and replaced as required.
- d. Collector bar system shall be cleaned.
- e. Voltage and amperage shall be measured and recorded at all intensity levels, and shall be adjusted to nominal level.

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

- a. Cabinets outer conditions shall be well maintained for easy access by cleaning and drying.
- b. Fuses and fuse sockets shall be cleaned, sprayed or replaced, if required.
- c. Voltage out-put of all series circuits shall be recorded and necessary corrective actions shall be taken.

(5) Control cables, monitoring units, control desk:

- a. Cables and distributors shall be cleaned and repaired.
- b. Relays shall be cleaned.
- c. Control and monitoring units shall be replaced, as required.
- d. Connections shall be tightened and sprayed for good contact.

(6) Baggage Conveyor Belts:

- a. Drives shall be checked and overhauled, as required.
- b. Driving motors shall be cleaned.
- c. Gear box oil shall be changed and refilled.
- d. Driving chains shall be cleaned and lubricated.

(7) Apron Flood lighting:

- a. Turn and plug-in connections shall be cleaned for good electric contact.
- b. Relays shall be maintained serviceable by cleaning, repair or replacement.
- c. Corroded and wearied contacts shall be cleaned, repaired or replaced.
- d. Cabinet shall be cleaned and dried, weather seals be kept serviceable, and mechanical damages shall be repaired.
- e. Fuses and fuse sockets shall be cleaned, sprayed or replaced, if required.
- f. Cabinets outer conditions shall be well maintained for easy access by cleaning and drying.

3.9.7 Non-schedule Checks:

In addition to carrying out all the above mentioned scheduled maintenances, situations like some natural calamity, accidents, sabotage etc. may give rise to the necessity of some out-of- schedule maintenance. Some instances of such non-schedule maintenance are as follows:

(1) Underground Power cables and Control cables:

Underground Power cables and Control cables, whenever malfunction is observed, shall be repaired.

(2) Control cables, monitoring units, control desk:

After each lightning strike, the insulation between wire & wire and between wire & ground shall be checked and necessary improvement shall be effected.

(3) Control cables, monitoring units, control desk:

After each lightning strike, the insulation between wire & wire.

Chapter 4. Maintenance Of Paved Areas Of The Airport

4.1 Introduction

For safe operation of aircraft in an airport, a safe runway is an essential requirement. The surface of a runway should be maintained in a condition that precludes harmful irregularities or breaking off of pieces that would be a hazard to aircraft operation. At the same time the pavement areas of an airport is to maintained free from slipperiness so that the braking action of aircraft is not affected. This Manual requires continuous monitoring of pavement condition, and repair servicing whenever necessary. Repair of pavements is costly and often imposes restrictions on the airport traffic even when damaged areas are small. Preventive maintenance is therefore of high importance for airport pavement management.

4.2 Different Paved areas of the Airport:

Different Paved areas of the airport are as follows: -

- a. Runways,
- b. Taxiways,
- c. Apron,
- d. Cargo handling areas,
- e. Shoulders etc.

4.3 Maintenance Personnel:

Personnel to be entrusted with the task of maintenance of Airport paved areas are the following qualifications / qualities: -

They are-

- a. Experienced in concrete and bitumen pavements;
- b. Fully acquainted with the work to be done;
- c. Present or available on call whenever required;

4.4 As-built drawing:

A set of 'as-built drawing' is required to be available in the maintenance unit, Assistant Engineer's (civil) office and AGA section.

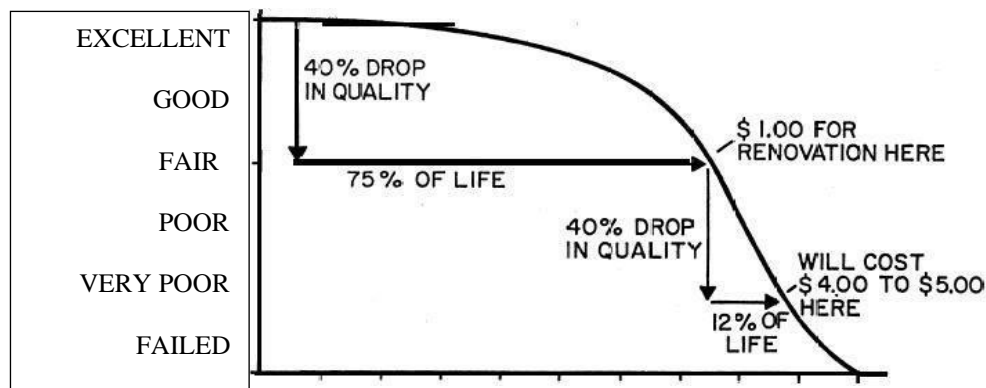
4.5 Basic Components of Maintenance:

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:

- a. Inspection;
- b. Servicing / repair and
- c. Replacement.
- d. Maintenance report

4.5.1 Pavement Management Program (PMP):

A PMP provides one method of establishing an effective maintenance and repair system. A PMP is a systematic and consistent procedure for scheduling maintenance and rehabilitation based on maximizing benefits and minimizing costs. A PMP not only evaluates the present condition of a pavement, but also can be used to forecast its future condition. By projecting the rate of deterioration, a PMP can facilitate a life-cycle cost analysis for pavement maintenance/repair procedures and help determine the best alternative. The primary component of any PMP is the ability to track a pavement's deterioration and determine the cause of the deterioration. This requires an evaluation procedure that is objective, systematic, and repeatable. One such procedure is the Pavement Condition Index (PCI). The PCI is a rating of the surface condition of a pavement and indicates functional performance. A PCI evaluation may also provide an indication of the pavement's structural performance. Periodic PCI determinations on the same pavement will show the change in performance level over time. Airports can use the pavement condition survey to develop pavement performance data. Distress intensity recorded over time helps determine how the pavement is performing. The rate at which the distress intensity increases is a good indicator of the pavement performance. The PCI is determined in accordance with procedures contained in ASTM D5340, Standard Test Method for Airport Pavement Condition Index Surveys.



4.6 Inspection and Maintenance team:

Inspection is a vital part of maintenance. An inspection programme is prepared and be strictly followed. As the frequency of inspection is varied according to the hours of operation of the airport, inspection programme is prepared keeping pace with the hours of operation of the airport and flight schedule. Assistant Engineer (civil) or his representative is regularly inspecting the paved areas to assess the requirement of maintenance, and maintenance work is done immediately.

4.6.1 Responsibility of inspection:

The responsibility of inspection of pavement areas of the airport is given to a committee formed with at least two members out of the following three:

- Assistant Engineer, Civil,
- Sub-assistant Engineer, Civil,
- Foreman.

4.6.2 Responsibility of maintenance:

The responsibility of maintenance lies on the Civil Engineering divisions and AGA section observe the maintenance.

4.6.3 Recording of Inspection and Maintenance reports:

- a. Reports of the maintenance work during the last 24 hours have been raised by the Sub-Assistant Engineer (civil) and are sent to the Assistant Engineer's office and AGA team. The Engineer and AGA team verifies/verify the authenticity of the report and preserve in his/their office as record.
- b. Copy of the report is sent by the Engineer to the Director (AIRPORT) (Attention: SATO). Director (AIRPORT) / SATO verify the maintenance report and take necessary action. Significant discrepancies are consulted with the concerned engineers. Reports are preserved as record.

4.7 Joints in Cement Concrete:

4.7.1 Necessity of Joints in Cement Concrete:

Joints are provided in concrete pavements to eliminate stress induced by length variation of the concrete materials due to temperature changes.

4.7.2 Closing (sealing) of joints in concrete slabs:

Joints may be closed with fuel resistant elastic materials, like

- a. Bituminous sealant, or
- b. Hose type elastic sealant (Neoprene profile sealing).

4.7.3 Why joints between concrete slabs are required to be closed:

Joints are required to be closed because otherwise,

- a. Surface water may penetrate into the sub-base or sub-grade, and
- b. Hard debris or stones may be pressed between adjacent concrete slabs.

4.7.4 Damage of joint sealing in concrete slabs:

first sealant of a concrete joint is expected to remain serviceable for a period of 4 to 6 years depending on the mechanical and thermal impact on the pavement. Later on due to the -

- a. partial loss of original elasticity, and
- b. shrinkage of the sealing material, it fails to adhere to the side flanks.

At that stage, mechanical forces applied to such aged sealant starts the sealant breaking off, and rotary brooms of sweeping accelerates the process.

4.7.5 Effect of joints in concrete slabs being permeable:

Once a joint becomes permeable then,

- a. The sub-grade is washed out, and
- b. Voids below the slab weaken the capability of the base material.

This effect results in destruction of the concrete. Basically, the sensitivity of the sub-grade to water determines the requirement of maintenance of the joints.

4.7.6 Protection of Concrete pavements from severe damage:

In order to protect the concrete pavements from severe damage, renewal action is taken whenever the joint sealing is observed to fail and break off.

4.7.7 Concrete joint maintenance:

4.7.7.1 Repair of concrete slab joints shall be done as follows: -

- a. All old sealing material has been removed. A so-called "joint plough" has been used to carry out this task.
- b. Then the bare slab flanks has been cleaned thoroughly of soil, grease and dust.
- c. Where edges are damaged they are repaired with a suitable synthetic resin grout.
- d. After inserting a new inlay to limit the depth of the sealing material, the joint are refilled with the liquid sealing material.

(Attention: Attention is paid not to fill the joint up to the top. A surplus of sealing material in the joint will swell above the top when the pavement expands under thermal stress. This lead to surface contamination later on.)

- e. The selected material must be fuel-resistant, particularly in pavement sections where fuel spillage may occur occasionally.

4.7.7.2 When joints are to be closed by plastic material, such as hollow Neoprene profiles, the same method for joint cleaning and preparation is applicable. To improve the sealing capacity of plastic material the following procedure shall be followed: -

- a. The concrete flanks shall be covered with an adhesive before placing the sealing profile into the joint.
- b. At joint intersections and ends the plastic material must be welded together to prevent water entering at the insert and it acting as a hose distributing water to the entire joint system.

4.8 Cracks and damage of Cement concrete:

4.8.1 Cause of cracks in cement concrete:

- a. Incorrect forming of expansion joints which has resulted in a transfer of force between concrete slabs;
- b. Delayed cutting of hinged joints (dummy joints) in the construction phase so that shrinkage due to hardening was able to generate random train cracks;
- c. Improper treatment during the initial hardening phase as, for instance, due to strong sun radiation on fresh concrete;
- d. Incorrect compacting of sub-base and therefore uneven settlement of sub-grade so that slabs are not supported equally;
- e. Insufficient dimensioning of concrete slabs in view of the load applied on them.

4.8.2 Repair of cracks in cement concrete:

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

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

4.8.2.3 When the sub-grade is particularly affected by water and optimum water tightness is required, the repair process shall be as follows: -

- a. A channel about 20 cm wide and 2 cm deep shall first be cut along the track of the crack.
- b. Then the crack shall be widened to a slot as described in the preceding paragraph.
- c. The cleaned slot shall be filled with a dummy insert.
- d. Then, after appropriate cleaning and priming, the channel shall be filled an epoxy resin grout.
- e. When the resin has hardened, the insert shall be removed from the widened crack and the resulting void filled with a fuel resistant thermoplastic sealing material.

4.8.3 Types of damage of Cement concrete:

- a. Porous and disintegrated surfaces,
- b. Separation of thin top surface layers,
- c. Braking up of the pavement where cracks extend to inner layers,

- d. Extreme polishing of surface created by polishing under traffic etc.

4.8.4 Cause of damage of cement concrete:

- a. Insufficient cement,
- b. Improper quality of aggregates,
- c. Segregation during placement,
- d. Evaporation,
- e. Abnormal temperature,
- f. Too high water content,
- g. Improper treatment during hardening.

4.8.5 Repair of damage of cement concrete:

4.8.5.1 Where the damaged layer is very thin:

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

4.8.5.2 Where the surface is too porous:

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

4.8.5.3 Where surface material is severely damaged with deep cracks:

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

4.9 Joints in Bituminous Pavements:

4.9.1 Necessity of Joints in Bituminous Pavements:

Recent experience shows that it is useful to provide joints in bituminous pavements. For airport asphalt construction, hard types of bituminous material are required. Reaction to temperature changes in such pavements is quite comparable with that in concrete. Unpredictable crack formation which is very likely to occur in bituminous pavements due to thermal stress may be avoided by providing joints in bituminous surfaces.

4.9.2 How to provide joints in Bituminous Pavements:

4.9.2.1 Stress reliever joints not wider than 8 mm and not deeper than 2/3 of the thickness of the wearing course may be cut into the pavements to control the crack formation. When the pavement shrinks at low temperatures, cracks will only appear under the joints and these can be sealed to prevent water penetration.

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

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

4.10 Cracks in bituminous pavements:

4.10.1 Cause of cracks in bituminous pavements:

Causes for cracks in bituminous pavements can be as follows:

- a. Thermal stress building up in vast pavement areas when there no expansion joints;
- b. An insufficient adhesion of construction joints between adjacent lanes;
- c. Deficiencies of sub-grade bearing strength at isolated points due to construction mistakes so that slabs are not supported equally.

4.10.2 Repair of cracks in bituminous pavements:

- a. The cracks shall be properly cleaned before filling.
- b. Cracks can be filled with a sealing emulsion without prior grinding;
- c. The filling can be carried out manually by using cans, or mechanically by using special pouring equipment;

- d. At first the crack's interior flanks shall be covered, and then in the second run the cracks shall be filled up.
- e. The procedure shall be repeated yearly or at longer intervals, depending on local climatic conditions.

(Note: Special emulsions of high fluidity are available that will penetrate deeper into the crack than hot bituminous sealing.)

4.11 Damage of bituminous pavements:

4.11.1 Types of damage of bituminous pavements:

The damage of bituminous surfaces can be broadly classified in the following way:-

- a. Damage is minor and affects the surface only.
- b. Damage is slightly deeper and affects more than the surface layer.
- c. Damage goes deeper and affects up-to the base layer.

4.11.2 Cause of damage of bituminous pavements:

The cause of damage of bituminous surfaces can be broadly classified in the following way: -

- a. Wrong composition of the bituminous mixture.
- b. Impact of fuel, grease or other chemicals or solvents.
- c. Extreme spot loading.
- d. Mechanical wear.
- e. Decay by weathering of the surface structure.
- f. Softening of the surface and deformation.

4.11.3 Repair of damage of bituminous pavements:

4.11.3.1 When the damage is minor and affects the surface only:

Bituminous seal, onto which quartz sand or crashed basalt material is spread, shall be sprayed and rolled. Good engineering practice shall be applied.

4.11.3.2 When the damage is slightly deeper and affects more than the surface layer.

- a. The whole affected layer, up-to a depth of minimum 3 cm, shall be removed by grinding.
- b. After grinding the strips shall be carefully cleaned from contamination and grinding materials.
- c. After cleaning, a bituminous binding layer shall be applied.
- d. Then the new bituminous layer shall be brought in and rolled for compaction.
- e. Compaction shall be carried out very thoroughly at the edges of the old asphalt in order to close the joints.
- f. The bed of the new layer shall be sharply edged to receive a clean seam.
- g. Covering the joints by spraying with a bituminous seal is recommended.

4.12 Pavements Edge damage:

4.12.1 Cause of Pavements edge damage:

- a) Undesirable transfer of force across the joint mostly produced by incorrect joint design.
- b) Stones pressed into the joints.
- c) The pavement material above the point of contact is split off due to the induced compressive stress.
- d) Application of extreme point loads near to a slab joint or slab edge.
- e) Corners are particularly sensitive to overload when for some reasons the slabs get insufficient support from the sub-base.

4.12.2 Risks of Pavements edge damage:

- a) Broken edges produce loose parts of various sizes which create a substantial risk to aircraft.
- b) Furthermore, surface irregularities on pavement are undesirable for aircraft and ground vehicles.

4.12.2.1 Immediate Remedial action:

Broken edges shall be repaired as soon as possible. At least, imminent danger to aircraft shall be minimized by-

- a. Removing all loose material from the pavement surface, and
- b. Provisionally closing the deeper openings in the pavement surface.

4.12.3 Repair of Pavements edge damage:

Repair of damaged pavement edges shall be done as follows:-

- a. Primarily careful investigation of the damaged section shall be carried out to find out the reason for the failure.
- b. To start the repair, the treated area shall be made big enough to cover all damage.
- c. The boundary shall be cut to a depth of at least 2 cm and all inside pavement material removed down to such a depth that all loose material is eliminated.
- d. 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.
- e. No bridge shall be built up between the two neighboring slabs, since sooner or later it would become the source of a new break in the repaired edge.

- f. The joint's flanks shall be cleaned, and dust and debris removed from the opening, preferably by compressed air.
- g. After preparing the cut surface with a primer, a form shall be put into the emptied joint.
- h. After hardening, the form in the joint shall be removed, flanks in the joint cleaned, and the joint shall be filled with a hot sealing material.
- i. Compacting shall be done layer by layer and when smoothing the surface a chamfer should be provided at the edge.
- j. A filler material shall be chosen such that it meets the requirements of the climatic impact on the airport's pavement.
- k. Filler material which obtains its nominal strength no sooner than 24 hours after mixing has proven to be more suitable than quick hardening material.
- l. Sufficient aggregate (quartz, glass pearls or other ceramic) shall be to achieve a lean mixture with a small shrinkage ratio.

4.12.4 Repair of broken corners:

Broken corners shall be repaired in the same way as described for e d g e repair. Attention shall be paid to the slab's need to expand in two directions. Furthermore, the surface of the repaired slab must be level with both neighboring slab surfaces.

4.13 Preventative Maintenance of Asphalt Pavements:

4.13.1 Components of pavement preservation system:

There are three components of a pavement preservation system:

- a. preventive maintenance,
- b. minor rehabilitation, and
- c. routine maintenance.

One method of preventative maintenance is the use of pavement sealers, which in turn makes minor rehabilitation and routine maintenance easier. Pavement sealers are applied to do the following functions:

- a. to protect the surface of Hot Mix Asphalt (HMA) pavement from the corrosive effects of gasoline, diesel oil, motor oil, and grease that drip or are spilled onto an asphalt-based surfaces; and
- b. to prolong the life of asphalt based pavements by decreasing oxidation (that occurs via exposure to air) and ultraviolet light bleaching (that occurs via exposure to sunlight) as well as preventing moisture from entering the pavement.

4.13.2 Effect of Preventative Maintenance of Asphalt Pavements:

The net effect is an extension of the performance life of new or existing asphalt-based pavement.

4.14 Repair of Deficiencies of Pavement surfaces:

4.14.1 Quality requirements of the movement areas:

High quality requirements have been specified for runway pavement surfaces, such as:-

- a) The surface texture shall provide good friction characteristics, and
- b) The runway surface shall be constructed without irregularities that could adversely affect the landing or take-off of an aeroplane.

(*Ref: Annex 14, Attachment A, Section 5, and the Aerodrome Design Manual, Part 3.*)

4.14.2 Maintaining the friction characteristics of runway pavement surfaces:

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:

- a. Surface dressing,
- b. Grooving of surface,
- c. Scoring of surface.

Details on these methods for improving runway surface texture are given in the *Aerodrome Design Manual, Part 3, Chapter 5*.

4.15 Unevenness of surface with aging:

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

4.16 Contamination of the Movement area and remedial actions:

4.16.1 Objects contaminating the Apron area:

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

4.16.2 Sources of Contamination:

Runway and taxiway contamination is mainly caused by objects stemming from the following sources:

- a. debris from damaged pavement,
- b. debris from joint sealings,
- c. rubber debris from aircraft tires,
- d. stones from grass mowing,
- e. metal or plastic parts from aircraft,
- f. sand and soil from heavy storms or engine blast of aircraft,
- g. dead birds or other small animals hit by aircraft.
- h. fuel, lubricants, hydraulic oils, marking paint or rubber.

4.16.3 Effects of Contamination:

For safety reasons the surfaces of runways, taxiways and aprons have to be clean of sand, debris, stones or other loose objects. As such, movement areas require constant monitoring and regular sweeping of surfaces. Otherwise the following accidents may happen:–

- a. Aircraft engines can easily ingest loose material, and suffer severe compressor blade or propeller damage.
- b. Propeller or jet engine blast may cause loose objects to be "shot" like bullets against adjacent aircraft, vehicles, buildings or people.
- c. Tread on tires of taxiing aircraft or any other moving vehicle may throw up objects and cause damage.
- d. Contaminants like oil and rubber deposits on runways may cause slipperiness and adversely affect the braking action of aircraft, particularly when pavements are wet.
- e. Contaminants cover surface markings creating problems for aircraft movement. A clean runway surface, therefore, is a safety requirement. (Ref: Annex 14, chapter 10)

4.16.4 Removal of Contamination:

4.16.4.1 Visual checks on Movement area:

Visual checks shall be carried out regularly as indicated below:

- a) At least every six hours during operating periods.
- b) Immediate checking shall be done when pilots report on the existence of objects or debris.
- c) Special attention shall be paid to the cleanness of runways and taxiways, when construction works on or near operational surfaces is going on.
- d) When construction machines or trucks use surfaces which are used by aircraft, more frequent checking shall be done.
- e) Inspection tours or walks shall 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.

- f) 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.

4.16.4.2 Sweeping the movement area:

Surfaces intended to be used by aircraft and ground vehicles have to be swept regularly. The frequency of cleaning / sweeping shall depend 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.

4.16.4.3 Removal of Fuel and Oil:

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 (DETERGENT OR SIMILAR Agent) followed by water flushing. If necessary, water jet cleaning may follow to achieve optimum results. Where fuel or oils are spilled accidentally the spillage, must immediately be informed to civil engineering section and fire section. Civil Engineering Section shall evaluate the requirement of spraying grease solvents. If it is required, spraying grease solvents shall be followed by water flushing. Normally, water flushing should be good enough for normal fuel spillage.

4.16.5 Cleaning equipment:

At AIRPORT, manual cleaning seems to be sufficient. Mechanical Sweeper shall be employed in case of requirement.

4.16.6 Personal discipline:

Awareness program shall be carried out periodically to keep aware all personnel of all agencies of the airport about keeping the aerodrome clean.

4.17 Rubber deposits on the Runway:

4.17.1 Sources of Rubber deposits:

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.

4.17.2 Effects of Rubber deposits:

The effects of rubber deposits on the runway are as follows:-

- a) Rubber deposit on the runway surface blocks the drainage under the wheel in wet conditions by filling the grooves in the pavement.
- b) Rubber deposit makes the runway slippery and affects the braking action of aircraft in wet condition.

4.17.3 Aim of removal of rubber deposits:

The aims of rubber removal from runway surface are the following:

- a. to restore the original macro roughness of the pavement surface;
- b. to provide good drainage under the wheel; and
- c. to restore braking action of aircraft in wet conditions.

4.17.4 Methods of removal of rubber deposits:

- a. Manually,
- b. Using Chemical,
- c. Water spray.

4.17.4.1 Chemical method:

In the Chemical method, chemicals dissolve not only rubber but also paint markings and bituminous material, and as such, there is high possibility of erosion of the bituminous pavement, and the markings shall be required to be repainted after each cleaning.

4.17.5 When shall the rubber deposits is removed:

Rubber deposits shall be removed from runways when friction measurements under wet conditions indicate significant loss of braking quality/slippery in critical runway sections.(Ref: Annex 14, Art. 9.4.7. and Airport Services Manual, Part 2 - Pavement Surface Conditions.)

4.17.5.1 Rubber Deposits Removal Schedule:

Frequency/ Schedule of Rubber deposit Removal shall be once in a year and additionally as and when required.

4.17.6 Runway Surface Friction Assessments:

4.17.6.1 Criteria when Runway Surface Friction is to be measured:

- a) Runway slippery when wet;
- b) Rubber deposit on runway;

- c) Petrol, oil & lubricant (POL) spillage;
- d) Runway slippery under unusual conditions.

4.17.6.2 Evaluation of runway surface frictions assessments results:

Evaluation will be done & assessment report prepared and action taken as a result of runway friction assessment in accordance with CAAB circular on Assessment of Runway surface friction characteristics-AC (AD)-03, chapter-4 shall be informed to:

- a) ED/Director/Airport Manager & Deputy Director(ATM) / SATO,
- b) Control tower,
- c) Sub divisional Engineer/Assistant Engineer - CIVIL.

Evaluation of runway surface friction assessment report shall be sent it to Aerodrome Standard Division (ASD) for onward action.

4.17.6.3 Runway Surface Friction Assessment Method (As per AC(AD)-03)

- a. A runway surface friction assessment is conducted under controlled conditions using self-wetting CFME, to establish the friction characteristics of a runway and to identify those areas of a runway surface that may require attention.
- b. Friction readings for the survey run are collected by the CFME along the line of the entire pavement length. An average friction value is determined every 10 metres along a run, enabling a 100-metre rolling average to be calculated. This is best visualized by the use of a sliding 100 meter cursor passing over the surface. The runway width should be divided into equal thirds; these portions of the pavement are referred to as ‘central’ and ‘outer’ trafficked portions. The friction level for each portion is determined by the lowest of the rolling averages. The procedure for calculating the rolling average for each run is repeated in a similar fashion for each of the three portions across the runway. In each case, the applicable runs across the width of each portion are first averaged before undertaking the rolling average calculation as described above.
- c. The aerodrome operator should determine the frequency of the assessments that will enable any significant change in runway surface friction characteristics to be identified and, if appropriate, for remedial maintenance to be conducted before the friction level falls below the MFL.
- d. The recommended periodicity of runway surface friction assessments is outlined in Table 1.

Table 1 Recommended interval Between Runway Surface Friction Assessment

Average number of movements on the runway per day	Interval between assessments
Less than 150	6 months
150 or more	3 months

Note: The average number of movements on a runway is determined by the total number of movements, on both runway directions. Runway Friction Assessed by ASFT Surface Friction Tester.

4.17.6.4 Runway Surface Friction Assessment Evaluation (As per AC (AD) -03 Chapter-4):

4.17.6.4.1 The friction level values obtained should be compared with the following criteria:

- a. The Design Objective Level (DOL)
- b. The maintenance Planning Level (MPL)
- c. The Minimum Friction Level (MFL)

4.17.6.4.2 The friction level values produced by different CFME vary slightly for any given runway surface friction characteristics; therefore, Table 3 indicates the correlation between the assessment criteria of CFME devices commonly in use Bangladesh.

Table 2: CFME and Friction Level Values/ Assessment criteria of friction level value

Test Equipment	Test Tire		Test Speed (Km/ h)	Test Water Depth (mm)	Design Objective for new Surface	Maintenance Planning Level	Minimum Friction Level
	Type	Pressure (kPa)					
Surface Friction Test Vehicle	B	210	65	1	0.82	0.60	0.50
	B	210	95	1	0.74	0.47	0.34

Description	Applicable Runs	Friction Level
Friction Level for Central	Run Numbers:	
Friction Level for Outer Portion (Right)	Run Numbers:	
Friction Level for Outer Portion (Left)	Run Numbers:	
Overall Friction Level	Average Value taken from all Standard Runs	

(2) Inspectors

(ASD) Comments.....

Runway Surface Friction Assessment Results

Airport	
Runway	
Date	

Is any portion of the runway below the MFL?	YES/NO
Remarks	
Action to be taken	
Recommended date of next assessment	

(3) Inspectors (ASD) Comments.....

4.18 RUNWAY PAVEMENT BEARING STRENGTH MEASUREMENT PROCEDURE & DURATION:

Pavement condition calculating the value of PCN continually during the service cycle of pavement. The value of PCN can be estimated by testing the response of stationary dynamic loads, adopting a Falling Weight Deflectometer (FWD) or a heavy weight Deflectometre (HWD) device that simulates the stress generated by aircraft movements. By evaluating the PCN continually in Airport Pavement Management System (APMS), cyclic determination of the load carrying capacity can be conducted to support the maintenance and rehabilitation (M&R) decision makers. This review summarizes the methodology for determining the PCN and the tests conducted for evaluating the strength of airport pavement presented in the published literature. Further, the review highlights the benefits of determining PCNs by adopting the FWD or HWD field data with more precise results through mechanistic procedure.

Table 1 Recommended interval Between Runway Bearing Strength Assessment

Average number of movements on the runway per day	Interval between
Less than 150	12 months
150 or more	6 months

Note: The average number of movements on a runway is determined by the total number of movements, on both runway directions. Runway Bearing Strength Assessed by HWD device.

CHAPTER 5: DRAINAGE OF THE AIRPORT

5.1 GENERAL:

Drainage of the airport is essential for the following major reasons:

- a. To maintain sufficient bearing strength of the soil for the operation of vehicles and/or aircraft at any time during the year;
- b. To minimize the attraction of birds and other animals representing a potential hazard to aircraft. Surface drainage is required to –
 - Clear all parts of the movement area of standing water; and
 - Prevent the formation of ponds or puddles.
 - Quick run-off of water is particularly important on runways to minimize the hazard of aquaplaning.

(Ref: *Airport Services Manual*, Part 2)

5.2 Lay out:

5.2.1 Two drainage systems:

For practical reasons an airport should have two drainage systems-

- a. One system which drains "clean" areas such as runways, taxiways, aprons, service roads, public roads and parking lots; and
- b. 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.

5.2.2 Drainage for the clean areas:

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. Due to 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 Karnofully Rivers. To protect these natural water courses from pollution, collector basins with sewage treatment plant should be installed.

5.2.3 Drainage for the areas likely to be polluted:

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 pre-treatment the collected drain water should pass through fuel separators before entering the sewage culvert.

5.2.4 Compliance with national or local regulations:

Generally, the airport operator will have to comply with rules on water treatment issued by the 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 program.

5.2.5 Cleaning of slot drains:

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. Where necessary, mud and sand deposits must be vacuumed off by special mobile cleaning equipment or manually.

5.2.6 Time intervals for cleaning slot drains:

The time intervals for cleaning depend on local experience with drain lines. Mostly cleaning of drain and sludge removal of adjoining canal inside airport perimeter are done in May by civil engineering section of Airport and City Corporation clean the portion of canal outside of airport perimeter. One cleaning action per year has proved to be the minimum. When sand has been used for winter services a second cleaning right at the end of the winter is recommended. 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.

5.2.7 Drain pipes or culverts between surfaces and collector basins:

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

5.2.8 Time intervals for cleaning drain pipes or culverts:

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 is less than 30 cm, cleaning **twice a year may be necessary**.

5.2.9 Oil and fuel separators:

Oil separators are integral parts of water collectors. Those are components of the drainage system of hangars, workshops and other technical working areas which must be provided with separator installations. The number and size of collectors depend on the drained area and quantity of precipitation. 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. Their capacity will be determined by the expected maximum drain water through-put.

5.2.10 Cleaning the oil and fuel separators:

The oil layer depth at the surface of the separator **must be checked weekly** and oil pumped off when necessary. 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 emulsification plant.

5.2.11 Cleaning the bottom and banks of the drain water collector basins:

The bottom should be cleaned **at least once a year**. The bottom and the banks of the drain water collector basins should be kept clear of plants. Embankments should be mowed regularly.

5.2.12 Removal of oil and fuel from separators:

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.

5.3 Water Hydrants:

5.3.1 Airport's water supply system:

The capacity of the airport's water supply system should comply with the requirements of fire fighting. 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,

5.3.2 Airport Fire hydrants:

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. Serviceability of pumps and hydrants shall be checked at least twice in a year.

CHAPTER 6: MAINTENANCE OF UNPAVED AREAS OF THE AIRPORT

6.1 GENERAL:

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

- a. Safety of aircraft on operating areas (this concerns runways, taxiways, strips and runway end safety areas);
- b. Safety of airborne aircraft (this concerns areas on the airport and in its nearby vicinity within the defined flight pattern where trees and bushes may grow); and
- c. Reducing bird hazards to aircraft (this concerns grass land within the airport's boundaries).

6.2 Reasons for maintenance of Green Areas on an Airport:

The major reasons for maintenance of green areas of an airport are as follows:

- a. To control animal life within the airport boundary to reduce the risk of animal strike with aircraft;
- b. To control the bird population and bird activities in order to keep the bird strike hazard as low as possible.
- c. To fulfill the requirements of obstacle clearance limitations.

6.3 Who can do the job?

The responsibility of maintenance of unpaved areas of the airport lies on the aerodrome operator. Of course, that does not necessarily mean that the work is to be carried out by the staff of the airport operator. The airport operator may contract with nearby farmers who can do the job on the following conditions: -

- a. The contractor shall do the work upon advice.
- b. The contractors shall provide their own equipment.
- c. The contractor can use the grass for cattle feed/ other purpose.
- d. Work performed by contractors must be monitored by authorized personnel to safeguard air traffic safety requirements.

6.4 Maintenance of Green Areas within strips:

6.4.1 Target of maintenance of Green Areas within strips:

The targets of maintenance of the green areas of the airport are as follows:

- a. Bearing capacity of the strips shall be maintained.
- b. Evenness of the strips shall be maintained.
- c. The height of grass of the strips shall be maintained such that it does not exceed 10 cm.

6.4.2 Procedures for maintenance of Green Areas within strips:

After construction work in strip areas, attention should be paid to retain the specified surface conditions. This can be done in the following manner:

- a. Where the bearing capacity has been reduced it must be improved by soil compaction.
- b. Humps and depressions shall be eliminated.
- c. To protect the surface against blast erosion a sound matting of grass should be provided.
- d. The grass should be mowed down to a height of about 10 cm.
- e. Regular mowing will be necessary to keep the grass low, the frequency depending on the climate.
- f. The cut material should be picked up since otherwise it might be sucked into jet engines, thus creating a potential hazard to aircraft operation.
- g. Mowing attracts birds as the freshly mowed areas are rich in bird food.
- h. To minimize the ever-present risk of bird strikes, mowing should take place preferably before periods of lowest air traffic.
- i. In other cases, bird protection measures shall be increased after mowing to keep the collision risk low.

6.5 Maintenance of Green Areas outside strips:

6.5.1 Target of maintenance of Green Areas outside strips:

The targets of maintenance of the green areas of the airport outside strips are as follows:

- a. The height of grass outside the strips shall be maintained such that it does not exceed 20 cm.
- b. The obstacle clearance criteria of the area shall be maintained.

6.5.2 Procedure for maintenance of Green Areas outside strips:

- a. Maintenance of grass surfaces should be determined by the individual needs of the site, i.e. the local species of birds and their habits.
- b. Most species of birds 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.
- c. For keeping large numbers of birds from settling, the optimum grass height has been observed to be around 20 cm. 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.
- d. Dry grass-land offers more food to birds than wet land. Therefore, unless bearing capacity of the runway and taxiway is not at risk, swampy patches can be tolerated as long as those do not attract aquatic birds.
- e. The grass should be mowed down to a height of about 20 cm and the cut grass should be picked up. Composting effects cut grass produce great numbers of microscopic organisms, insects, worms etc., and again, attract birds to the area.

- f. Special methods shall be applied, along with the maintenance of grass, 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.
- g. Trees and bushes shall be cut at such a height that they do not penetrate the obstacle limitation surface. To discourage birds from settling, all bushes carrying berries should be eliminated from the airport.
- h. 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.

6.6 Equipment for Maintenance of Grass:

As there are different types of mowers available the choice should be determined by local conditions, i.e. the size of the area to be maintained and the types of grass and plants on it. The following types are being used on airports:

- a. Spindle mowers,
- b. Cutter bar mowers,
- c. Rotary mowers,
- d. Flail mowers.

6.6.1 Spindle mowers:

Normally spindle mowers are trailing equipment. They are efficient on areas of low grass height, such as unpaved runways, taxiways etc. With the mowers arranged in groups (so-called mounted gangs), strips up to 8 m wide can be mowed in one run. Under favourable conditions the capacity can be 7 hectares per hour. Separate loaders are required to pick up the cut grass.

6.6.2 Cutter bar mowers:

Cutter bar mowers are appropriate for both high and low grass. The cutter bar is generally a separate piece of equipment attachable to various tractor types, often in combination with a trailed self-picking hay loader. The cutting width is less than 2 m, thus resulting in a low mowing capacity of about 1/2 hectare per hour. A special type of bar mower, the so-called chaff-cutters, cut strips up to 4 m wide and, in combination with hay loaders, achieve a mowing capacity of almost 2 hectares per hour.

6.6.3 Rotary mowers:

Rotary mowers are specialized on extremely high grass. They are produced in trailer form and mow a strip up to 5 m wide, thus achieving a mowing capacity of 4 hectares per hour.

6.6.4 Flail mowers:

The flail mowers are most effective for meadows with harder types of grass and plants, including low bushes. They are attachable to various types of towing equipment, have a maximum mowing width of 5 m and achieve a capacity of some 2 hectares per hour.

CHAPTER 7. DISABLED AIRCRAFT REMOVING EQUIPMENT

7.1 Removal Plan:

When a disabled aircraft is on a part of the airport where it interferes with the movement of other aircraft, it has to be removed as quickly as possible. Aircraft removal is a rather complex procedure touching quite a number of responsibilities of different parties. Bangladesh Airforce, Bangladesh Army and Bangladesh Fire service and Civil Defense shall be called for the main execution.

The relevant parties are:

- a. Aircraft registered owner,
- b. National authority for air safety and accident investigation (CAAB),
- c. Airport operator (Airport Management),
- d. Owner of removal equipment (CAAB, Army, BAF, BDFS&CD etc.) and
- e. Maybe others.

7.1.1 Removal Procedure:

The procedure has to be performed in compliance with the removal plan worked out for the airport to satisfy local circumstances.

Reference is made to: -

- a. Annex 14, 9.3;
- b. *Airport Services Manual*, Part 5, Guidance material on the establishment of the removal plan, procedures, techniques, methods and equipment;
- c. *Airport Services Manual*, Part 8 - Airport Operational Services. Removal of Disabled Aircraft and operation of the disabled aircraft removal service.

7.2 Personnel Training:

Regardless of how removal responsibility and removal performance is agreed, staff should be trained thoroughly to handle the available equipment in the event of an aircraft removal.

7.2.1 Training programme:

The personnel assigned to the task of aircraft removal should at first be given a detailed and specified training, and there after recurring training programme should take place at least once a year.

The programme has to include-

- (i) instruction on theoretical measures,
- (ii) methods to be applied, and
- (iii) Practical training in handling the equipment.

It should be continuously updated according to the most recent knowledge and experience available on aircraft removal techniques.

7.3 Storage of Equipment:

7.3.1 Where to store:

The location where all removing equipment will be stored should have the following advantages:-

- a. All removal equipment shall be stored at one location, if possible.
- b. The store units shall be designed for easy transport and loading.
- c. Equipment shall be stored in such a manner as to minimize the risk of damage by equipment and vehicle movements.

7.3.2 How to store:

Only careful storage and regular inspection can ensure that the equipment will be in good condition and that any aircraft removal operation will be successful and expeditious. Furthermore, proper storage and maintenance will extend the life of the equipment, which is important from an economical aspect.

The following cautionary system shall be followed while storing the equipment:-

- a. Equipment should be stored in a manner to ensure quick access at any time.
- b. As far as possible, equipment shall be stored in transportable units. This not facilitates access in cases of a removal action but also for equipment inspection and maintenance procedures.
- d. Equipment packed in boxes or on pallets shall be protected from the effect of weather such as wetness, moisture, heat, sunshine (ultraviolet radiation) which may rapidly destroy wooden, textile, plastic or rubber material.
- e. In order to protect equipment from detrimental climatic conditions, no material should be stored close to the equipment which would cause damage to it.
- f. In all possible cases, equipment shall be wrapped to protect from contamination.
- g. Wooden material, e.g. plywood sheets and cribbing timber, has to be stored flat to avoid warping.
- h. All steel material needs an oil or paint finish to protect against rust.
- i. Protection must also be taken against vermin (mice, rats, termites, etc.).
- j. Each unit shall be clearly marked for quick identification of the contents.
- k. All pieces of the stored equipment shall be listed. The list should identify their location within the store and show the maintenance needs.

7.4 Transportation plan of equipment:

A transportation plan shall be prepared that shows which vehicles are to be used for the transportation of removal equipment and how the vehicles are to be available in the event of an aircraft removal action.

7.5 Inspection of equipment:

Regular inspection of all equipment is recommended to ensure that the equipment sets are complete and serviceable at all times. Inspection shall be carried at least once in a month, and necessary action shall be taken.

7.6 Maintenance of removal equipment:

Many of the pieces of equipment may need maintenance work at periodic intervals. All regular maintenance work shall be carried out in accordance with the manufacturer's advice. Discovery of damage or deficiency should lead to immediate repair.

A general guideline on the Maintenance Schedule is given below:

7.6.1 Monthly Checks:

(1) Air Compressor units:

- a. Air compressors shall be subjected to a test run of at least five minutes once in a month. The following checks shall also be done.
- b. Tire pressure shall be checked.
- c. Oil content (compressor unit and engine) shall be checked.
- d. Diesel content of tank shall be checked.
- e. battery capacity and acid content shall be checked.
- f. cooling water content shall be checked.
- g. any other technical details in accordance with the manufacturer's advice.

(2) Drainage pumps, flood lights and diesel generators:

- a. Remedial action shall be taken for mechanical damage, oil and fuel leakage.
- b. Battery capacity and acid content shall be checked.
- c. Fuel and oil content shall be checked,

7.6.2 Half-yearly Checks:**(1) Protection pads (foam rubber pads) which are used to protect the lifting bags:**

Protection pads shall be checked and maintained in good condition through repair or replacement, as required.

(2) Air hoses:

Air hose shall be checked for integrity and cleanness.

(3) Hydraulic jacks:

Hydraulic jacks shall be inspected in conjunction with a test run at which time the equipment shall be checked for corrosion, oil leakage or any damage in accordance with the manufacturer's advice.

(4) Winches, cables and ropes:

- a. Winches, cables and ropes shall be checked for mechanical damage.
- b. Special attention shall be given to bends and corrosion of steel cables and other load bearing lifting equipment.
- c. Stress tests shall be carried out in accordance with relevant safety and/or manufacturer's advice.

(5) Additional equipment consisting of:

- Plywood sheets,
 - Steel and aluminum plates,
 - Cribbing timber,
 - Steel spikes for crib assembly,
 - Ground reinforcement mats (track ways or other),
 - Earth anchors, coppery coated steel grounding rods, cables and clips,
 - fencing material and warning signs,
 - tools such as bolt cutters, sheet metal shears, picks, shovels, crow bars, hammers and saws
- a. Shall be checked for completeness and proper condition.
 - b. Damage like corrosion, cracks, distortion or wetness shall be repaired or replaced, as required.

(6) Pneumatic lifting bags:

- a. Checks shall be done whether bag material has suffered from detrimental storage conditions such as high heat, direct sun radiation or wide temperature variations.
- b. The maintenance programme for lifting bags should include:
 - Cleaning of contamination, if required;
 - Inflation up to the checking pressure as indicated by the bag manufacturer;
 - Repair of all deficiencies or damage;
 - Correct preparation for storage, i.e. dry surfaces, air valves protected by caps, surface powdered with French chalk;
 - Wrapping of folded bags to transportable packs.

7.6.3 Yearly Checks:**(1) Air Hoses:**

- a. Air hoses should be stored on hose reels.
- b. The hoses must be unwound from their reels and stretched out on clean ground.
- c. A functional test can be accomplished by connecting them to the console module and applying air pressure. This procedure allows a check for any damage and the serviceability of all connections.
- d. Hoses shall be kept clean inside and outside to protect the rubber material.
- e. Ends of the hoses shall be closed by caps and reels shall be covered.
- f. Any deficiencies discovered shall be made good by repair or replacement.

(2) Console module:

Maintenance work shall include checking for-

- Integrity;
- Damage to any component;
- Serviceability of valves and stopcocks (function test under pressurized air according to manufacturer's advice);
- Function of pressure gauges.

7.7 Test Run of the Equipment:

A Test Run should be held once in a year as a part of the Maintenance Programme. In addition, a rolling test should be carried out every three months to check wheel brakes and lamps of the vehicle.

CHAPTER 8. MAINTENANCE OF EQUIPMENT AND VEHICLES

8.1 General:

8.1.1 RFF Operation vehicles:

Vehicles which are essential for the safe and smooth operation of aircraft at an airport shall be kept serviceable at all times through preventive and corrective maintenance. 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. As per Annex 14, Art.9.4, the following equipment and vehicles of an aerodrome are related with the safe operation of an airport:

- a. Rescue and fire fighting vehicles;
- b. Sweepers for removal of contaminants from aircraft operating areas;
- c. Mowers and other vehicles for control of grass height on unpaved areas.

8.1.1.1 Maintenance procedure:

Maintenance procedures should be implemented to ensure a standardized manner in which fire vehicles are maintained. Maintenance procedures should cover:

- a) Activities to be undertaken to ensure that disruptions to RFF services are minimized. For example, bringing reserve fire vehicles into operational services to maintain category levels, or conducting maintenance during breaks in aircraft movements where a vehicle may be taken out services without affecting category levels;
- b) The frequency of maintenance services;
- c) Activities to be undertaken at each type of maintenance service as recommended by the original equipment manufacturer (OEM). For example, visual check, inspections and measurements;
- d) Arrangements for technical support from the OEM or the OEM's local agent;
- e) Spare parts that should be held on site to enable regular maintenance to be conducted. For example; filters, belts, drier cartridges, lubricants, coolants, wiper blades;
- f) Generically common spare parts should be held on site to minimize downtime. Such as switches, light globes, relays, circuit breakers, bolts, nuts, washers, O-rings and seals;
- g) Arrangements with OEM and local suppliers for all other parts to ensure downtime is kept to a minimum;
- h) Tyre replacement requirements;
- i) Environmental procedures including appropriate disposal procedure for old parts as well as used lubricants and coolants;
- j) Any special measures to ensure safety of maintenance personnel such as procedures for working at heights, confined space entry and working with high pressure liquids/gases.
- k) The method of reporting and documenting any defects that have been identified with the fire; and
- l) Vehicles or rescues equipment by operational and maintenance personnel.

8.1.1.2 Performance testing of fire vehicles

Whilst ARFFS fire vehicle may pass its initial acceptance test for compliance against its specifications, there is no guarantee that it will continue to do so throughout its service life. All ARFFS fire vehicles have parts that wear with time and as a result performance is lost. To ensure that the fire vehicle continues to have the ability to respond, and discharge firefighting agents at the required amounts, regular performance testing should be undertaken including quantities checks of;

- a) 0-8 km/h acceleration;
- b) Braking;
- c) Flow rate from high and low flow deliveries;
- d) Foam admixing percentages;
- e) Monitor throw;
- f) Compressed air foam systems

Records of any performance tests undertaken should be kept.

8.1.1.3 Maintenance Documentation

A complete set of maintenance documentation should be requested to be delivered with the fire vehicle and rescue equipment during the procurement process. As a minimum this should include:

- a) Operating procedures;
- b) Maintenance procedures;
- c) Fault diagnosis and troubleshooting;
- d) Adjustment procedures;
- e) Removal/replacement of parts and repairable assemblies;
- f) Instructions for disassembly and reassembly of repairable components;
- g) Tolerances, specifications and capacities;
- h) Illustrations and exploded views;
- i) Schematic drawings;
- j) Circuits or hydraulic circuits;
- k) Special tools needed for repairing and adjusting; and
- l) Spare parts catalogue providing exploded views of the entire fire vehicles.

It is important that the technical documentation is in a format that can be easily read, understood and followed. Any schematic drawings should be a sufficiently large enough size to enable them to be easily read. This is very important for fault diagnosis whereby any circuits can be traced. It is a good idea to laminate these so that they can be kept clean of grease and still be read at a later time.

8.1.1.4 Maintenance record keeping

A comprehensive set of maintenance records should be kept for each fire vehicle. Keeping individual sets of maintenance records is also beneficial for each of the larger and more complex items of rescue equipment. Like items of rescue equipment, for example hoses, can be grouped together, however each item of equipment should be readily identifiable via a unique numbering system. Keeping such documentation has several benefits;

- a) Provides a historical record of the maintenance of the fire vehicle/equipment
- b) Be an organizational requirements for legal or compliance reasons;
- c) Provides evidence for any warranty claim that may be made against the OEM;

- d) Can be referred to in the future (if a similar fault occurs); and
- e) Provides evidence for any surveillance audit that may be undertaken for regulatory compliance.

Maintenance and calibration certificates should be maintained in a register for all special tools and test equipment.

8.1.1.5 Protective Clothing

The proper care and preventive maintenance of protective clothing is normally the responsibility of the fire fighter and ARFFS. Protective clothing needs to be inspected for serviceability on a regular basis;

- a) By the wearer prior to commencing duty;
- b) After use; and
- c) As required.

Minor repairs may be conducted at a local level; however, major repairs may need to be conducted by an external agency so that repair activities and/or materials do not compromise the protection standards of any protective clothing

Storage of protective clothing is also a factor to be considered;

- a) Storage should be away from direct light, especially sunlight;
- b) Avoid contact with contaminants; and

Avoid storing near objects that could physically damage the protective clothing

8.1.2 Passenger, Freight and Ground handling vehicles:

There are many other vehicles also 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 full time serviceable as part of the airport maintenance task.

8.2 Principles of organization of maintenance of vehicles:

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

- a. Maintenance is carried out by AIRPORT i.e. its own workshops;
- b. Maintenance is carried out by contractors in Workshops located on the airport; or
- c. Maintenance is carried out by contractors in Workshops located outside the airport.

8.2.1 Reasons for providing workshops at the airport:

The main reasons for providing workshops at the airport are:

- a. The difficulty of moving specialized and very big vehicles, which are not licensed for use on public roads, outside the airport area; and
- b. The time and manpower needed to move vehicles from the airport to remote workshops and vice versa.

8.2.2 Reasons for providing airport-owned workshops:

Reasons for providing airport-owned workshops are:

- a. Personnel can be supervised by the airport management and their schedule or work adjusted to fit the airport's needs;
- b. Personnel can be trained to specialize in maintenance tasks for all airport equipment and will gain much experience;
- c. Personnel can be organized in such a way as to carry out stand-by tasks outside the normal duty hours;
- d. Personnel can carry out maintenance tasks on installed equipment; and
- e. Other duties like aircraft removal, assistance in emergencies, etc. can be assigned to workshop personnel upon short notice.

8.2.3 Reasons for contracting with maintenance companies outside the airport:

Reasons for contracting with maintenance companies outside the airport are:

- a. Availability of expert knowledge, plants and tools for standard equipment overhaul and repair (e.g. motors, gear boxes, generators, drive axles of standard auto-motive design);
- b. Lack of own personnel or specialists for economic reasons (e.g. number of vehicles too low to warrant workshop installations and manning); and
- c. Need to overcome peak or bottleneck situations.

8.3 Schedule of Vehicle Maintenance:

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 shall be based on experience with maintenance needs.

8.3.1 Basis of preparing the Vehicle Maintenance Schedule:

The different types of vehicles of an airport do not run at the same rate or distance. Some of them are operated everyday and run quite good number of kilometers, some do not undergo long runs, though operated for long hours, while there are equipment which are often given static runs only. Thus their maintenance requirement and schedule will also vary. On the basis of that the vehicles and equipment can be grouped into the following categories for maintenance:

- a. Schedule on the basis of kms run.
- b. Schedule on the basis of hours operated.
- c. Time based schedule i.e. on the basis of Months or year.

8.3.1.1 Schedule on the basis of kms run:

Self- driven vehicles like standard cars, minibuses, Ambulances etc. which more or less run considerable number of kms regularly should fall under the schedule on the basis of kms run. User or operator of the vehicle must maintain record of the kms run.

This can be done by marking the next milometer reading when the maintenance shall be due.

8.3.1.2 Schedule on the basis of hours operated:

Vehicles or equipment like RFF vehicles, standard trucks, runway sweepers, mowers etc. which, although operated regularly for considerable hrs. do not run considerable number of kms should fall under the schedule on the basis of hours operated. User or operator of the vehicle must maintain record of the hours of operations. This can be done by marking the next milometer reading when the maintenance shall be due. An easy way of controlling the operating hours can be achieved by marking the limit of the vehicle on a label attached to the driver's panel or screen. Monitoring can also be carried out by fuelling personnel.

8.3.1.3 Fixed Interval or Time based schedule i.e. schedule on the basis of Months or Year:

For other equipment, fixed time intervals are practical. Special procedures are applied for winter equipment, which should undergo inspection and overhaul twice a year, i.e. Once before the winter season and then again shortly after it.

8.3.2 Categorization of Vehicle for Maintenance purpose:

It is very difficult to bring the various types of vehicles and equipment operated at an airport in a single maintenance programme. However, the following table will give some general guidelines on the issue:

Table 1: Equipment Maintenance Intervals

SN	Equipment	Maintenance		Remarks
		km driven	Hrs. Operate	
1	RFF vehicles, Ambulances	3,000 to 5,000	100 to 200	Whichever comes first.
2	Standard cars, minibuses,	5,000 kms.	---	
3	Special passenger buses	---	100 to 200	At least twice a year.
4	Standard trucks, runway sweepers, mowers.	---	100 to 200	At least twice a year.
5	Self-driven aircraft handling equipment (Fork lifters, electric power trucks, water trucks,	---	100 to 200	

8.3.3 Advantages of Fixed Interval or Time based schedules:

It is very difficult to bring the various types of vehicles and equipment operated at Airport. Fixed time intervals offer the advantage of well-balanced workshop utilization. Equipment with a low number of operating hours per year should fall in this category. But in such cases the equipment shall be inspected regularly. Otherwise, maintenance to

protect from true wear cannot be met, since the individual use of equipment is not considered.

8.3.4 Defining the maintenance intervals:

The user (or proprietor) of the vehicles will define the maintenance intervals in accordance with experience, manufacturer's recommendation and work-shop capacity. No standards, but only guidelines, can be given.

8.3.5 Advantages of Fixed Interval or Time based Schedule:

The maintenance programme for each type of vehicle or equipment will depend on the following factors:

- a. Function of the vehicle or equipment,
- b. Wear and tear characteristics, and
- c. Manufacturer's recommendation. Inspection must be carried out by specialists.

8.3.6 Servicing of radio-telecommunication equipment:

An important element of the maintenance of airport vehicles is the servicing of installed radio- telecommunication equipment, since, by the very nature of traffic control on an airport; the radiotelephone has to be serviceable at all times.

8.3.7 Inspections and maintenance:

Inspections and checks play a very important role in the process of maintenance of equipment and vehicles, and there by in keeping them serviceable up-to the mark. In the interest of safety, operating personnel must be advised to check the functioning of all 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 shall be taken out of service and repair shall be carried out as soon as practicable.

MOVEMENT AREA MAINTENANCE PROGRAMME

Under Civil Engineering Section:

S/N	Description	Frequency		Remarks
1.	RWY Marking	Once a year		More if required
2.	TWY Marking	Once a year		More if required
3.	Apron Marking	Once a year		More if required
4.	Rubber Deposit Removal	Once a year		More if required
5.	Joint Sealing Compound Replacement	Once every two years		More if required
6.	Drainage Cleaning	Once a year		Before rainy season
7.	Grass/Jungle cutting between RWY and TWY and other marshy areas	massive cutting	Once a year	Cutting Mechanically

Under SATO

S/N	Description	Frequency	Remarks
1.	Grass Trimming By Tractor	Round the year	
	RWY/TWY strip area	Twice a month	By machine/Manual
	RWY safety area	Twice a month	By machine/Manual
	Clearway area	Twice a month	By machine/Manual
	Approach light area	Once a week	Manual
	VOR/DME area	Once a month	Manual
	Around PAPI	Once a week	Manual
	Around individual RWY/TWY edge lights	Once a week	Manual
	Around signage	Once a week	Manual
	RWY/TWY shoulder area	Once a week	Manual
2.	Sweeping		
	RWY	Everyday	Mechanical Sweeper
	TWY	Everyday	Mechanical Sweeper
	Apron	Everyday	AK Traders
3.	Trimming of trees in approach paths	Twice a month	Manual