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GOVERNMENT OF INDIA
OFFICE OF DIRECTOR GENERAL OF CIVIL AVIATION

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AERODROME ADVISORY CIRCULAR

Subject: Guidance on Movement Area Pavement Maintenance Procedures at Aerodromes.

1. Introduction

1.1 Para 10.2.1 & 10.2.2. of Civil Aviation Requirement Section 4, Series B, Part I requires the aerodrome operators in India to establish a maintenance program including preventive maintenance program wherein surface of all movement areas including pavements (runways, taxiways, and aprons and adjacent areas) shall be inspected and their conditions monitored regularly with the objective of avoiding and eliminating any foreign object debris (FOD) that might cause damage to aircraft or impair the operation of aircraft systems. It is also mandated that the aerodrome maintenance program shall include the procedure pertaining to maintenance of runway surface in a condition such as to preclude formation of harmful irregularities.

1.2 Also, para 10.4 of CAR Section 4, Series B, Part-I specifies the runway pavement overlay specifications to be adopted by aerodrome operators. However, there is a need to further elaborate on the procedures to be formulated while planning runway pavement overlaying operations at aerodromes.

1.3 The above procedures are required to be formulated by aerodrome operators and included in their Aerodrome Manuals as per AD AC 01 of 2006.

1.4 This circular is promulgated to guide the aerodrome operators regarding the elements to be included in their maintenance programme.

2. FOD Prevention Programme

2.1 All aerodromes shall have a comprehensive FOD prevention programme in order to ensure safety of aircraft operations at aerodromes. Few elements are suggested to be considered by the aerodrome operators while formulating their FOD prevention program in the following few paragraphs. The list is not

exhaustive and aerodrome operators are advised to adapt or include other aspects which they feel shall be effective in eliminating the FOD hazards at aerodromes.

2.2 Foreign Object Debris (FOD) by definition is an inanimate object within the movement area which has no operational or aeronautical function and which has the potential to be a hazard to aircraft operations.

2.3 The FOD prevention program call for the surface of aprons, taxiways and runways to be kept clear of any loose stones or other objects that might cause damage to aeroplanes or engines or impair the operation of aeroplane systems. Turbine engines are extremely susceptible to damage as a result of foreign object ingestion. Although damage to aeroplanes is usually associated with engine ingestion, substantial damage to tires is also a significant aspect of the overall problem. Debris constitutes a potential hazard to the safety of operations and has in the past been directly responsible for aeroplanes abandoning take-offs or executing emergency landings. Apart from the safety aspect, the unscheduled replacement of damaged parts may involve significant economic penalties for airline operators. The cleanliness of the entire airport surface should, therefore, be a matter of ongoing concern, requiring attention by airport operators.

2.4 One of the most effective measures to minimize the problem of debris on the movement area is frequent inspection and sweeping, including the use of sweeping equipment with magnetic attachments. The aerodrome operator should formulate and implement a comprehensive inspection program for operational area.

2.5 A potential source of debris, particularly on aprons, obviously stems from the activities of the airline operators themselves in the handling and servicing of their aeroplanes. Airline personnel, other apron users, such as aeroplane caterers, fuel suppliers, forwarding agents and handling agents, should be given training and recurrent reminders on the need for apron cleanliness and airport operators should also assist by ensuring that covered bins for litter and other debris are provided in sufficient number and are used.

2.6 Cargo areas, by the very nature of the operations they support, are particularly susceptible to contamination from strapping, nails, paper and wood, which may become detached from crates or other containers in the course of freight handling. Other equipment which has been found in cargo areas includes loose buckles from cargo tie down nets, loose turnbuckles and large sheets of polythene film. To the extent that forwarding agents operate in these areas, the airport operator should ensure that they assume their share of the responsibility for keeping it in good condition. Where night activities are frequently involved, good illumination is necessary so that the areas can be kept clean

2.7 On taxiways, bypass areas and holding bays, and on runways themselves, the presence of stones and other debris as a result of erosion of the adjacent areas can constitute a problem. Until runway and taxiway shoulders are adequately sealed, care is needed to ensure that vegetation and grass cuttings do not present an ingestion problem to overhanging engines.

2.8 Deterioration of the bearing surface itself, leaving loose sand, fragments of concrete and bitumen, is another possibility, and concrete joints, if not properly filled, are excellent traps for debris. Such joints should be filled to permit effective sweeping. There is also an indication that kerosene spillage on bitumen taxiways and runways, caused by the venting of fuel tanks of aeroplanes in motion, can result in deterioration of the surface and engine ingestion problems. These areas should be frequently inspected and prompt repair work carried out, whenever necessary, so as to prevent further break-up of the pavement.

2.9 Where constructions is in progress on an airport, the operator should, if possible, prohibit use of the movement area by contractors' vehicles or at least minimize it by restricting them to marked lanes, particularly when they are engaged in transporting the type of loads from which spillage frequently occurs, such as building waste, gravel and fill. Earth and stones adhering to the wheels of such vehicles can also become dislodged and subsequently create a hazard to aeroplanes using the same areas. Where building construction is in close proximity to the movement area, it is important that some form of screening be provided to prevent sand and small stones from being blown onto the movement area by high winds or jet blast. Following the completion of construction, the contractor must remove all debris from the surrounding areas.

2.10 Guidance on carrying out daily inspections of the movement area is given in the ICAO DOC 9137 (Airport Services Manual Part 8), the ICAO DOC 9476 (Manual of Surface Movement Guidance and Control Systems -SMGCS) and the ICAO DOC 9830 (Advanced Surface Movement Guidance and Control Systems (ASMGCS) Manual)

2.11 Additional guidance on sweeping/cleaning of surfaces is contained in the ICAO Doc 9137 (Airport Services Manual Part 9). Guidance on precautions to be taken in regard to the surface of shoulders is given in Attachment A, Section 9 of ICAO Annex 14 Vol-I and ICAO Doc 9157 (Aerodrome Design Manual Part 2).

3. Tolerances for Runway Surface Unevenness

3.1 Surface unevenness of runways, together with the pavement's bearing capacity and runway's friction level constitutes an essential part of air safety. Airfield pavement surfaces must be free of any irregularities that could be detrimental to aircraft operations. Surface smoothness, or sometimes termed roughness (the opposite of smoothness), is critical for safe operation of aircraft during takeoff and landing runs. An uneven runway can lead to discomfort for pilot and

passengers, higher user costs, a longer brake-path when landing and/or an aborted take-off and to an increasing chance of a tire-burst. A rough runway surface can lead to additional maintenance of the pavement.

3.2 The unevenness of newly constructed airport pavements is acceptable when it is constructed within the limit of 3 mm deviation from a 3 m straight-edge.

3.2 Caution should also be exercised when installing runway lights or drainage grilles in runway surfaces to ensure that adequate smoothness of the surface is maintained.

3.3 The operation of aircraft and differential settlement of surface foundations will eventually lead to increases in surface irregularities. Small deviations in the above tolerances will not seriously hamper aircraft operations. In general, isolated irregularities of the order of 2.5 cm to 3 cm over a 45 m distance are acceptable as shown in the figure A. Although maximum acceptable deviations vary with the type and speed of an aircraft, the limits of acceptable surface irregularities can be estimated to a reasonable extent. The following table describes tolerable and excessive limits.

Surface Irregularity	Length of irregularity (m)								
	3	6	9	12	15	20	30	45	60
Acceptable surface irregularity height (cm)	2.9	3.8	4.5	5	5.4	5.9	6.5	8.5	10
Tolerable surface irregularity height (cm)	3.9	5.5	6.8	7.8	8.6	9.6	11	13.6	16
Excessive surface irregularity height (cm)	5.8	7.6	9.1	10	10.8	11.9	13.9	17	20

a) if the surface irregularities exceed the heights defined by the acceptable limit curve but are less than the heights defined by the tolerable limit curve, at the specified minimum acceptable length, herein noted by the tolerable region, then maintenance action should be planned. The runway may remain in service. This region is the start of possible passenger and pilot discomfort;

b) if the surface irregularities exceed the heights defined by the tolerable limit curve, but are less than the heights defined by the excessive limit curve, at the specified minimum acceptable length, herein noted by the excessive region, then maintenance corrective action is mandatory to restore the condition to the acceptable region. The runway may remain in service but be repaired within a reasonable period. This region could lead to the risk of possible aircraft structural damage due to a single event or fatigue failure over time; and

c) if the surface irregularities exceed the heights defined by the excessive limit curve, at the specified minimum acceptable length, herein noted by the unacceptable region, then the area of the runway where the roughness has been identified warrants closure. Repairs must be made to restore the condition to within the acceptable limit region and the aircraft operators may be advised accordingly. This region runs the extreme risk of a structural failure and must be addressed immediately.

Note that "surface irregularity" is defined herein to mean isolated surface elevation deviations that do not lie along a uniform slope through any given section of a runway. For the purposes of this concern, a "section of a runway" is defined herein to mean a segment of a runway throughout which a continuing general uphill, downhill or flat slope is prevalent. The length of this section is generally between 30 and 60 meters, and can be greater, depending on the longitudinal profile and the condition of the pavement. The maximum tolerable step type bump, such as that which could exist between adjacent slabs, is simply the bump height corresponding to zero bump length at the upper end of the tolerable region of the roughness criteria of **Figure A**. The bump height at this location is 1.75 cm.

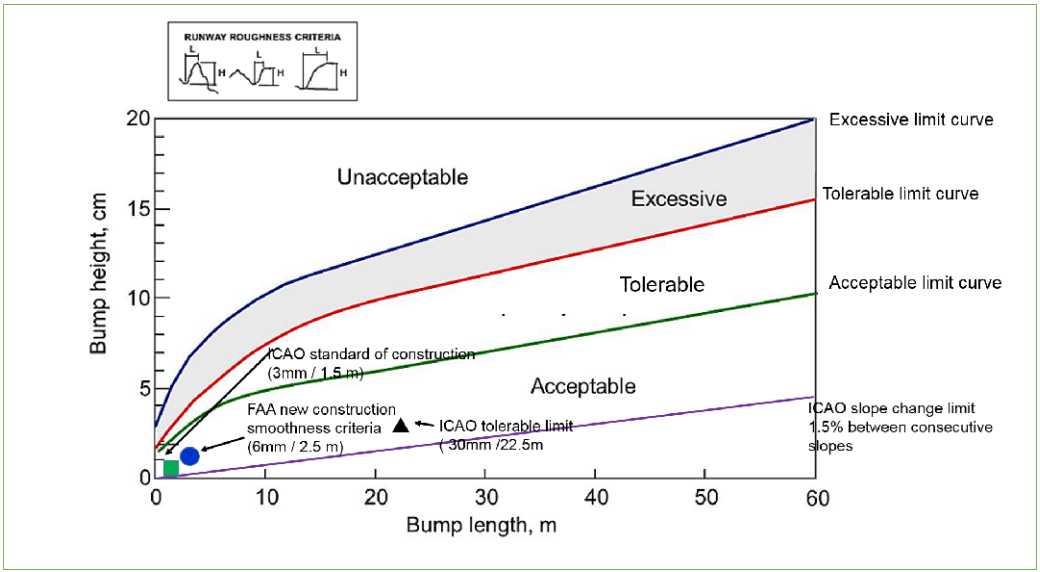

Figure A.
Comparison of roughness criteria

Note.— These criteria address single event roughness, not long wavelength harmonic effects nor the effect of repetitive surface undulations

3.4 Further guidance regarding temporary slopes for overlay works on operational runways are given in para 4 of this circular.

3.5 Deformation of the runway with time may also increase the possibility of the formation of water pools. Pools as shallow as approximately 3 mm in depth,

particularly if they are located where they are likely to be encountered at high speed by landing aeroplanes, can induce aquaplaning, which can then be sustained on a wet runway by a much shallower depth of water. Improved guidance regarding the significant length and depth of pools relative to aquaplaning is the subject of further research. It is, of course, especially necessary to prevent pools from forming whenever there is a possibility that they might become frozen.

4. Runway Friction Testing

4.1 A paved runway shall be maintained in a condition so as to provide surface friction characteristics at or above the minimum friction level. The following table shows the acceptable friction level with different friction-measuring devices for new or resurfaced runway surfaces, maintenance planning levels and minimum friction levels.

Runway Friction Levels

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)					
(1)	(2)		(3)	(4)	(5)	(6)	(7)
Mu-meter Trailer	A	70	65	1.0	0.72	0.52	0.42
	A	70	95	1.0	0.66	0.38	0.26
Skiddometer Trailer	B	210	65	1.0	0.82	0.60	0.50
	B	210	95	1.0	0.74	0.47	0.34
Surface Friction Tester Vehicle	B	210	65	1.0	0.82	0.60	0.50
	B	210	95	1.0	0.74	0.47	0.34
Runway Friction Tester Vehicle	B	210	65	1.0	0.82	0.60	0.50
	B	210	95	1.0	0.74	0.54	0.41
TATRA Friction Tester Vehicle	B	210	65	1.0	0.76	0.57	0.48
	B	210	95	1.0	0.67	0.52	0.42
RUNAR Trailer	B	210	65	1.0	0.69	0.52	0.45
	B	210	95	1.0	0.63	0.42	0.32
GRIPTESTER Trailer	C	140	65	1.0	0.74	0.53	0.43
	C	140	95	1.0	0.64	0.36	0.24

4.2 ICAO Doc 9137 (Airport Services Manual Part 2), contains further information on this subject, on improving surface friction characteristics of runways.

4.3 Runway surface friction characteristics for maintenance purposes shall be periodically measured with a continuous friction measuring device using self-wetting features and documented. The frequency of these measurements shall be sufficient to determine the trend of the surface friction characteristics of the runway.

4.4 Guidance on evaluating the friction characteristics of a runway is provided in Attachment A, Section 7 of ICAO Annex 14. Additional guidance is included in the ICAO Doc 9137 (Airport Services Manual Part 2).

4.5 The objective is to ensure that the surface friction characteristics for the entire runway remain at or above a minimum friction level.

4.6 Guidance for the determination of the required frequency is provided in Attachment A, Section 7 OF ICAO Annex 14 and in the ICAO Doc 9137 (Airport Services Manual Part 2) Appendix 5.

4.7 Corrective maintenance action shall be taken to prevent the runway surface friction characteristics for either the entire runway or a portion thereof from falling below a minimum friction level.

4.8 A portion of runway in the order of 100 m long may be considered significant for maintenance or reporting action.

4.9 When there is reason to believe that the drainage characteristics of a runway, or portions thereof, are poor due to slopes or depressions, then the runway surface friction characteristics should be assessed under natural or simulated conditions that are representative of local rain, and corrective maintenance action should be taken as necessary.

4.10 When a taxiway is used by turbine-engined aeroplanes, the surface of the taxiway shoulders should be maintained so as to be free of any loose stones or other objects that could be ingested by the aeroplane engines.

5. Removal of Contaminants

5.1 Standing water, mud, dust, sand, oil, rubber deposits and other contaminants shall be removed from the surface of runways in use as rapidly and completely as possible to minimize accumulation.

5.2 Taxiways should be kept clear of standing water, etc., to the extent necessary to enable aircraft to be taxied to and from an operational runway.

5.3 Aprons should be kept clear of standing water, etc., to the extent necessary to enable aircraft to manoeuvre safely or, where appropriate, to be towed or pushed.

5.4 Whenever the clearance of standing water, etc., from the various parts of the movement area cannot be carried out simultaneously, the order of priority after the runway(s) in use should be set in consultation with the affected parties such as rescue and firefighting service.

5.5 Whenever water is present on a runway, a description of the runway surface conditions should be made available using the following terms:

DAMP — the surface shows a change of colour due to moisture.
WET — the surface is soaked but there is no standing water.
STANDING WATER — for aeroplane performance purposes, a runway where more than 25 per cent of the runway surface area (whether in isolated areas or not) within the required length and width being used is covered by water more than 3 mm deep.

6. Runway Pavement Overlaying Procedures

6.1 Apart from the specifications mentioned in Para 10.4 of CAR Section 4, Series B, Part-I, aerodrome operators are required to develop detailed plans to be adopted for returning the runway for operations in case of contingency. The plan for pavement repair and overlay during off-peak periods should also include such detail as to allow ready determination of the limits of pavement repair, finish grades and depths of overlay. Plans and specifications are to be used for each work period by the contractor and inspection personnel, and should be clear and precise in every detail.

6.2 A suggested list of details to be included in the plan is prepared and mentioned below. The list is not exhaustive and operators are encouraged to add other elements as necessary in the plan.

a) Temporary ramps. At the end of each hot mix asphalt concrete overlay work period, it will be necessary to construct a ramp to provide a transition from the new course of overlay to the existing pavement. The only exception to construction of a ramp is when the depth of the overlay is 4 cm or less. In multiple lift overlays, these transitions should be not closer than 150 m to one another. As far as possible, the overlay should proceed from one end of the runway toward the other end in the same direction as predominant aircraft operations so that most aircraft encounter a downward ramp slope, In the event of continued operational change of direction, it would be advantageous for the overlaying to proceed upgrade since an upgrade ramp is shorter and avoids long thin tapers. The construction of the ramp is one of the most important features in the work period. A ramp that is too steep could cause possible structural damage to the operating aircraft or malfunction of the aircraft's instruments. A ramp that is too long may result in a ravelling of the pavement, and foreign object damage to aircraft engines, as well as taking excessive time to construct. The longitudinal slope of the temporary ramp shall be between 0.8 and 1.0 per cent, measured with reference to the existing runway surface or previous overlay course. The entire width of the runway should normally be overlaid during each work session. Exceptional circumstances, e.g. adverse weather conditions, equipment failure, etc. may not permit the overlaying of the full runway width during a work session. Should that be the case, the edges need to be merged with the old pavement

surface to avoid a sudden level change in the event an aircraft veers off the overlaid portion. The maximum transverse slope of the temporary ramp should not exceed 2 per cent. A temporary ramp may be constructed in two ways, depending upon the type of equipment that is available. The most efficient way is to utilize a cold planning machine to heel-cut the pavement at the beginning and at the end of the work period overlay (refer to Appendix 'A' figure **B**). If cold planning equipment is not available, then a temporary ramp should be constructed as shown in Appendix 'A' Figure **C**. In no case should a bond-breaking layer be placed under the ramp for easy removal during the next work period. Experience has shown that this bond-breaking layer almost always comes loose causing subsequent breaking-up of the pavement under aircraft operations.

b) In-pavement lighting. Details depicting the removal and re-installation of in-pavement lighting are to be included on the plans where applicable. The details should depict the removal of the light fixture and extension ring, placement of a target plate over the light base, filling the hole with hot mix dense graded asphalt until overlay operations are complete, accurate survey location information, core drilling with a 10 cm core to locate the centre of the target plate, and final coring with an appropriate sized core machine. The light and new extension ring can then be installed to the proper elevation.

c) Runway markings. During the course of off-peak construction of a runway overlay, it has been found acceptable, if properly covered by a NOTAM, to mark only the centre line stripes and the runway designation numbers on the new pavement until the final asphalt lift has been completed and final striping can then be performed. In some cases where cold planning of the surface or multiple lift overlays are used, as many as three consecutive centre line stripes may be omitted to enhance the bond between layers.

Sd/-
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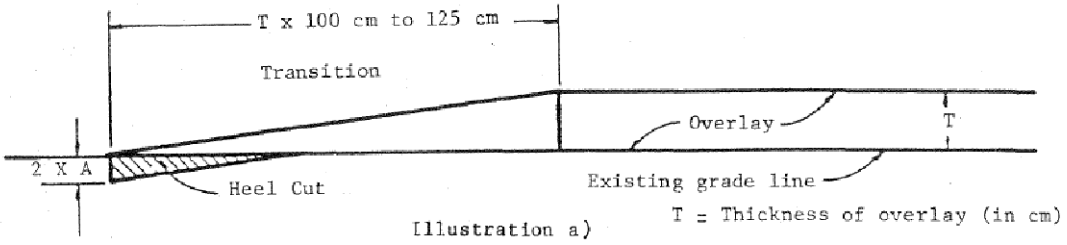

Illustration a)

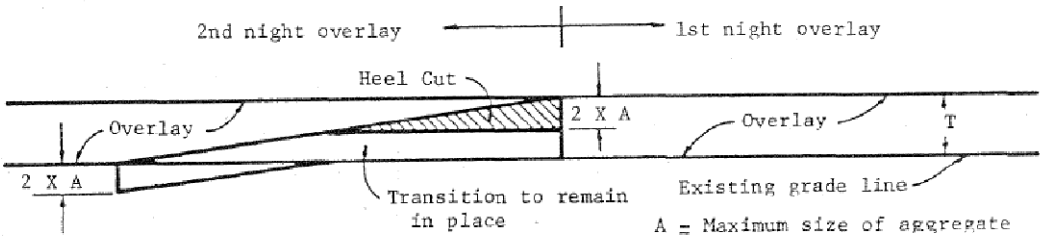

Illustration b)

Figure-**B** Temporary ramp construction with cold planing machine

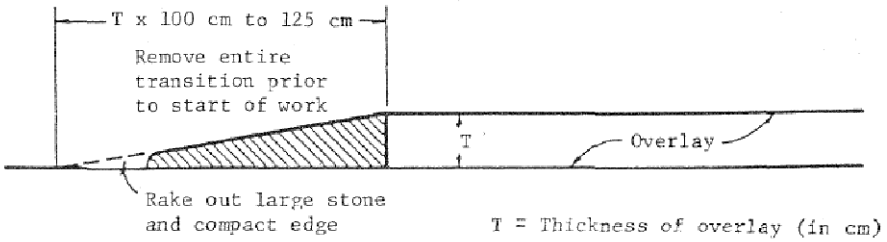

Figure-**C** Temporary ramp construction without cold planing machine