



# **Guide for maintaining runways in accordance to Annex 14 of ICAO**



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This document is intended to provide airport administrators a high level and an advance guide to apply ICAO Standard and Recommended Practices (SARP's) in their runway maintenance plans. This document has been developed as part of the initiatives of the Regional Aviation Safety Group – Panamerica (RASG-PA) to reduce runway excursions related to deficient runway maintenance programs.

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# FOREWORD

This guide is developed to provide Latin American and the Caribbean airport community a suitable and expedite guide about references and the best practices on runway maintenance according to ICAO's SARP's (Standards and Recommended Practices) and other related documentation. The guide presents "best practices" currently implemented at some airports as well as it provides references from IATA, ACI, the Flight Safety Foundation and FAA Advisory Circulars, focused on runway maintenance that may prevent Runway Excursions (RE), which is the most common runway maintenance-related type of incidents.

The guide acts as a "signpost" document to the relevant industry practices that cover all matters related specifically to runway maintenance. Future editions of the guide will consider the inclusion of more signposting information, including techniques for repairing and others.

The guide was developed by ACI-LAC from material drafted by a task force of the ACI-LAC Safety Committee, PA-RAST members with the key collaboration from ICAO's Regional SAM and NACC offices.

It has to be noted that an upcoming Amendment 11 to ICAO's Annex 14 Vol. I (Aerodromes) could generate significant changes to this guide. As an example, the recommended practice concerning maintenance in 10.1.1 will now be made a Standard.

Although ACI-LAC has made every effort to ensure accuracy of this document, it shall not be held responsible for any loss or damage caused by errors, omissions, misprints, or misinterpretation of the contents hereof.

With the Contribution of:



# 1

## Airport's Maintenance Organization and runway maintenance

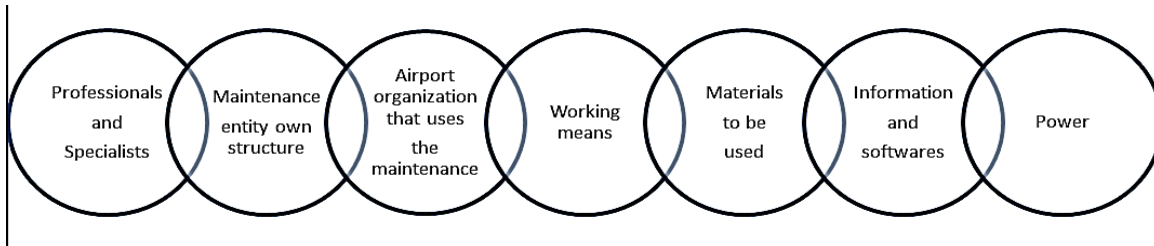
Airports as many other organizations need to provide maintenance to the facilities and assets to ensure serviceability and operational safety for the continuity of the business and services. No matter the size of the airport or aerodrome, runways are key infrastructures requiring their surfaces to be kept in optimal conditions in order to maintain continuous and safe aircraft operations during landing and departing. Airports may establish large or small maintenance organizations to cope with this operational responsibility.

**Best Practice:** depending on the airport's size and needs (after a complete assessment of all airport infrastructures and facilities), many different types of maintenance organizations may be established. Some airports assign the maintenance responsibility under the Operations area, other airports establish a Maintenance operational area, and others manage Maintenance as outsourcing service, etc. Nevertheless, a best practice is that pavement maintenance and visual aids maintenance be functional independent in the organizational chart with their own personnel resources.

Pavement maintenance responsibilities should be managed by a civil engineer, pavement expert and aerodrome engineer or similar, with broad knowledge and experience on techniques and procedures to prevent and repair pavement surface. This position may also be in charge or able to report to the responsible of the maintenance of the runway's markings, non-paved areas and drainages, that affects pavement performance. For visual aids maintenance it is recommended that an electrical, electronic or similar engineer be responsible for these activities.

As airports are entities that represent archetypes of tertiary organizations, the maintenance activity is fundamental for services offered to their users. Therefore, it is required that those "services for the user" take into account the following aspects: time, organization, implementation, cost and technical knowledge. The management of these aspects, as well as that corresponding to the rest of the

airport organization, should be guided to plan, programme and prevent, for which the officer in charge has a variety of resources synthesized (See Figure 1).



*Figure 1. Maintenance resources required*

The maintenance organization must be supported in terms of effectiveness on the principles of integrity, availability, reliability and quality (continuous improvement, commitment, processes and attitudes based on evidences).

#### **References for airport/runway maintenance organization:**

- ICAO's Doc 9137-AN/898 Part 9, Airport Services Manual, Airport Maintenance Practices
- Annex 14, ICAO, Chapter 10, Aerodrome Maintenance
- ICAO, Manual on Certification of Aerodromes, Appendix 1, Doc 9774 AN/969, 1<sup>st</sup> Edition
- IATA's Runway Excursion Risk Reduction Toolkit. <http://www.iata.org/iata/RERR-toolkit/main.html>
- ICAO's Aerodrome Best Practice RERR. [http://www.iata.org/iata/RERR-toolkit/assets/Content/Airports-CAAs/ICAO\\_Aerodrome\\_Best\\_practice\\_Landscape\\_format.pdf](http://www.iata.org/iata/RERR-toolkit/assets/Content/Airports-CAAs/ICAO_Aerodrome_Best_practice_Landscape_format.pdf)
- CAP 791 Procedures for Changes to Aerodrome Infrastructure, SRG, Civil Aviation Authority - UK. 30 June 2010.
- CAP 781 Runway Rehabilitation, SRG, Civil Aviation Authority - UK. 20 June 2010.
- Reglamento Aeronáutico Latinoamericano de Aeródromos. LAR 153 (under development). <http://www1.lima.icao.int/srvsop/document/lar>
- ACRP Report 80, Guidebook for Incorporating Sustainability into Traditional Airport Projects, ACRP, Sponsored by FAA.

# 2

## Runway's Pavement Condition

Airports are encouraged to implement an Airport Pavement Management Program, which not only evaluates the current condition of the airfield pavements, but also predicts its future condition through the use of historic information and pavement condition indicators (PCI). Pavement Management Programs or PMP help to identify optimal rehabilitation points by making use of data collected from the pavement condition surveys and predicting future conditions, indicating whether the distress is an environmental or traffic load related.

**Best Practice:** airports should train their staff or to contract expert consultancy service to create an Airport Pavement Management Program, which will give long term savings due to preventive measures.

### **References for runways pavement condition assessment and repair methods:**

- ICAO's Doc 9137-AN/898 Part 9, Airport Services Manual, Airport Maintenance Practices. Chapter 4.
- Annex 14, ICAO, Chapter 10, Aerodrome Maintenance
- ALACPA (Latin American and Caribbean Association of Airfield Pavements) website: <http://www.alacpa.org>
- ASTM D5340-11, Standard Test Method for Airport Pavement Condition Index Surveys
- FAA Advisory Circular 150/5380-6B (or latest version) - Guidelines and Procedures for Maintenance of Airport Pavements. [http://www.faa.gov/regulations\\_policies/advisory\\_circulars/index.cfm/go/document.information/documentID/22556](http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/22556)
- FAA Advisory Circular 150/5320-17 (or latest version) - Airfield Pavement Surface Evaluation and Rating Manuals. [http://www.faa.gov/airports/resources/advisory\\_circulars/index.cfm/go/document.information/documentNumber/150\\_5320-17](http://www.faa.gov/airports/resources/advisory_circulars/index.cfm/go/document.information/documentNumber/150_5320-17)

- Pavement maintenance/management policy example. [http://www.faa.gov/airports/northwest\\_mountain/engineering/design\\_resources/media/99\\_01.pdf](http://www.faa.gov/airports/northwest_mountain/engineering/design_resources/media/99_01.pdf)
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- Reglamento Aeronáutico Latinoamericano de Aeródromos. LAR 154 (under development). <http://www1.lima.icao.int/srvsop/document/lar>
- ACRP Synthesis 22, Common Airport Pavement Maintenance Practices, ACRP, Sponsored by FAA.
- TRB, Pavement Management 2009, Volume 2, <http://www.trb.org/Aviation1/Blurbs/162159.aspx>
- TRC, Implementation of an Airport Pavement Management System, February 2008, TRB.



# 3

## Runway's Friction/Surface Condition

Airports are encouraged to follow ICAO's guidelines and other documentation available on maintaining an adequate runway surface to ensure adequate texture depth, rapid drainage of rainfall runoff water and adequate friction characteristics and levels.

### Runway's Surface Friction construction

The effectiveness of different means of improving friction coefficients of wet runway surfaces should be assessed. ACI advocates adequate surface drainage, as well as removing rubber and contaminants from the runway surface on a regular basis. Any methods used for this purpose must meet local and international requirements<sup>1</sup>.

The surface drainage of a runway is one of the most important factors in optimizing the coefficient of friction between aircraft tires and wet pavement. Improvements in drainage processes (e.g. grooving) should therefore be sought. Other means of improving the braking action of landing aircraft, such as the use of tires with appropriate profiles, could be further developed. ACI recommends that further studies be carried out on the design of runway surfaces, including grooving, pavement composition, surface texturing and the effect of tire and landing gear design on runway braking action<sup>2</sup>.

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<sup>1</sup> ACI Policy and Recommended Practices Handbook (7<sup>th</sup> edition)

<sup>2</sup> ACI Policy and Recommended Practices Handbook (7<sup>th</sup> edition)

## Runway's Surface Friction measurement

Runway surface friction readings should be measured on a uniform scale, and there should be consistency between the scale used for maintenance testing and that used for operational testing<sup>3</sup>.

The time intervals and mean frequency of measurements depend on factors such as: aircraft type and frequency of usage, climatic conditions, pavement type, and pavement service and maintenance requirements. Examples on how to create this runway friction assessment programs are given on ICAO's DOC9137 part 2, appendix 5.

**Best Practice:** Reports from pilots of landing aircraft are a valuable source of information.

**Best Practice:** obtain, lease, share, or outsource runway friction test equipment/services to permanently survey runway friction conditions.

**Best Practice:** If there is no precise data to create the runway friction survey program, it is recommended to follow the underneath table. Nevertheless, as recommended by ICAO the maintenance department must adjust the frequency so that these measurements shall be sufficient to determine the trend of the surface friction characteristics of the runway. Also, check with local regulation so that these frequencies are not lower than required by Local Aviation Authorities (CAA).

Number of Daily Turbojet Aircraft Landing per Runway End	Minimum Friction Survey Frequency
Less than 15	1-Year
16 to 30	6-Months
30 to 90	3-Months
91 to 150	1-Month
151 to 210	2-Weeks
Greater than 210	Every week

<sup>3</sup> ACI Policy and Recommended Practices Handbook (7<sup>th</sup> edition)

## Runway's rubber buildup removal

Depending on the results, proceed with rubber removal. There are several rubber removal methods, waterblasting, shotblasting, chemical, grinders among others. Also, methods can be combined. A chemical method which loosens the rubber from the surface can be combined with waterblasting so that less pressure and water is used.

Airports must consider the environmental implications of using chemical system, and special care should be taken so that the rubber removal equipment includes an automate system to collect all the debris related to the rubber removal.

**Best Practice:** waterblasting is a best practice (if water supply is not an issue, due to its high water consumption), but there are other methods like shotblasting, chemical, grinders among others. Care should be practice when using shotblasting on grooved runways, but shotblasting may help if runway surface is polished.

### **References for runway friction/surface condition assessment and repair methods:**

- ICAO's Doc 9137-AN/898 Part 2, Airport Services Manual, Pavement Surface Conditions.
- ICAO's Doc 9157-AN/901 Part 1, Aerodrome Design Manual, Runways. Chapter 5.
- ICAO's Doc 9137-AN/898 Part 9, Airport Services Manual, Airport Maintenance Practices. Chapter 4.
- Annex 14, ICAO, Chapter 10, Aerodrome Maintenance
- ICAO's Aerodrome Best Practice RERR. [http://www.iata.org/iata/RERR-toolkit/assets/Content/Airports-CAAs/ICAO Aerodrome Best practice Landscape format.pdf](http://www.iata.org/iata/RERR-toolkit/assets/Content/Airports-CAAs/ICAO_Aerodrome_Best_practice_Landscape_format.pdf)
- ALACPA (Latin American and Caribbean Association of Airfield Pavements) website: <http://www.alacpa.org>
- ICAO's Cir 329 AN/191: Assessment, Measurement and Reporting of Runway Surface Conditions.
- FAA's Advisory Circular 150/5320-12C (or latest version) - Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces. [http://www.faa.gov/airports/resources/advisory\\_circulars/index.cfm/go/document.information/documentNumber/150\\_5320-12C](http://www.faa.gov/airports/resources/advisory_circulars/index.cfm/go/document.information/documentNumber/150_5320-12C)

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- Reglamento Aeronáutico Latinoamericano de Aeródromos. LAR 154 (under development). <http://www1.lima.icao.int/srvsop/document/lar>
- ACI Policy and Recommended Practices Handbook (7th edition) 2009 . <http://www.aci.aero/Publications/Full-Publications-Listing/ACI-Policy-and-Recommended-Practices-Handbook-7th-edition-2009>
- ACI Airside Safety Handbook. <http://www.aci.aero/Publications/Full-Publications-Listing/Airside-Safety-Handbook-2010>
- IN-2013/056: Definition of Contaminated Runway, Civil Aviation Authority - UK.
- European Action Plan for the Prevention of Runway Excursions (EAPPRE), Edition 1.0, January 2013, Eurocontrol.
- CAP 683 The Assessment of Runway Surface Friction Characteristics, SRG, Civil Aviation Authority - UK. October 2010.
- UK Winter Runway Assessment Trial 2012/2013 Trial Plan – WIG, Civil Aviation Authority - UK.
- ACRP Synthesis 11, Impact of Airport Rubber Removal Techniques on Runways, ACRP, Sponsored by FAA.

# 4

## Runway's Markings

To keep runway markings on optimal conditions, Airports need to evaluate markings to determine if remarking is needed or only maintenance is required. Some criteria, as recommended by *Report IPRF 01-G-002-05-1 Airfield Marking Handbook*<sup>4</sup> are:

1. Faded colors or appearance.
2. Poor nighttime visibility or retro-reflectivity.
3. Existing markings are worn 50 percent or more.
4. Existing markings are covered with contaminants.
5. Markings are not representing properly its meaning anymore (i. e., the information is wrong because its deterioration)
6. Rust discoloration.
7. Algae growth.
8. UV-damage.
9. Positions and dimension of existing markings (tolerances).

**Best Practice:** to increase contrast, on light colored surfaces (such as rigid pavement), signs edged with black color is a Best Practice.

**Best Practice:** to prepare the surface eliminating any contaminants, old paintings, oil, dirt, curing components (on new pavements), mold, rubber deposits, algae, or other substances that avoids proper bonding. The available practices for surface preparation or paint removal are waterblasting, shot blasting, drilling and chemical removing.

**Best Practice:** As a best practice, some airports obtain good results using Water-borne paint (specification TT-P-1952) and glass beads (specification TT-B-1325) type III (airport beads).

**Best Practice:** Pressurized guns deliver the most uniform flow of beads to the marking, are automatically triggered when the paint guns are activated.

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<sup>4</sup> *REPORT IPRF 01-G-002-05-1, "Airfield Marking Handbook", Innovative Pavement Research Foundation, USA, September 2008*

## References for airport markings maintenance methods and specifications:

- ICAO's Doc 9137-AN/898 Part 9, Airport Services Manual, Airport Maintenance Practices. Chapter 2, section 2.4.
- Annex 14, ICAO, Chapter 5
- Reglamento Aeronáutico Latinoamericano de Aeródromos. LAR 154 (under development). <http://www1.lima.icao.int/srvsop/document/lar>
- ALACPA (Latin American and Caribbean Association of Airfield Pavements) website: <http://www.alacpa.org>
- Innovative Pavement Research Foundation (IPRF), Airfield Marking Handbook. Report IPRF 01-G-002-05-1
- FAA's Advisory Circular 150/5340-1K - Standards for Airport Markings. [http://www.faa.gov/airports/resources/advisory\\_circulars/index.cfm/go/document.information/documentNumber/150\\_5340-1K](http://www.faa.gov/airports/resources/advisory_circulars/index.cfm/go/document.information/documentNumber/150_5340-1K)
- FAA's Advisory Circular 150/5370-10F - Standards for Specifying Construction of Airports. **ITEM P-620.** [http://www.faa.gov/airports/resources/advisory\\_circulars/index.cfm/go/document.information/documentNumber/150\\_5370-10F](http://www.faa.gov/airports/resources/advisory_circulars/index.cfm/go/document.information/documentNumber/150_5370-10F)
- Water-borne paint TTP-1952E specification. <http://www.wbdg.org/ccb/FEDMIL/ttp1952e.pdf>
- Federal specification for retro-reflective glass beads. <http://www.wbdg.org/ccb/FEDMIL/ttb1325d.pdf>

# 5

## Runway's Non-paved areas (STRIPS)

Runway strips are meant to be object free and resistant so that an aircraft that overruns or veers off can have space to stop without hitting any non-frangible obstacle that can damage the aircraft.

### **References for runway strips maintenance methods:**

- ICAO's Doc 9137-AN/898 Part 9, Airport Services Manual, Airport Maintenance Practices. Chapter 6.
- ICAO's Doc 9157-AN/901 Part 1, Aerodrome Design Manual, Runways. Chapter 5. Section 5.3
- ICAO's Annex 14
- Reglamento Aeronáutico Latinoamericano de Aeródromos. LAR 153 (under development). <http://www1.lima.icao.int/srvsop/document/lar>
- Reglamento Aeronáutico Latinoamericano de Aeródromos. LAR 154 (under development). <http://www1.lima.icao.int/srvsop/document/lar>
- ICAO's Aerodrome Best Practice RERR. [http://www.iata.org/iata/RERR-toolkit/assets/Content/Airports-CAAs/ICAO Aerodrome Best practice Landscape format.pdf](http://www.iata.org/iata/RERR-toolkit/assets/Content/Airports-CAAs/ICAO_Aerodrome_Best_practice_Landscape_format.pdf)
- ACI Airside Safety Handbook. <http://www.aci.aero/Publications/Full-Publications-Listing/Airside-Safety-Handbook-2010>

# 6

## Runway's End Safety Areas (RESA)

ACI endorses the Standard in ICAO Annex 14 that a runway end safety area (RESA) must extend beyond the end of a runway strip, to a minimum of 90 metres (for code number 3 or 4 runways), which corresponds to a minimum of 150 metres beyond a runway end or stopway<sup>5</sup>.

Where it is not possible to comply with the ICAO recommendation of 240 metres, for space and other development reasons, alternative solutions may include providing an arrestor bed, or other equivalent mitigating measures<sup>6</sup>.

At airports where adequate distance and suitable terrain is available, a greater length of RESA than the ICAO Standard should be provided<sup>7</sup>.

### **References for runway en safety area design and maintenance methods:**

- ICAO's Doc 9137-AN/898 Part 9, Airport Services Manual, Airport Maintenance Practices. Chapter 6.
- ICAO's Doc 9157-AN/901 Part 1, Aerodrome Design Manual, Runways. Chapter 5. Section 5.4
- ICAO's Annex 14, chapter 3, section 3.5.
- Skybrary Runway End Safety Area. [http://www.skybrary.aero/index.php/Runway\\_End\\_Safety\\_Area](http://www.skybrary.aero/index.php/Runway_End_Safety_Area)
- Reglamento Aeronáutico Latinoamericano de Aeródromos. LAR 153 (under development). <http://www1.lima.icao.int/srvsop/document/lar>
- Reglamento Aeronáutico Latinoamericano de Aeródromos. LAR 154 (under development). <http://www1.lima.icao.int/srvsop/document/lar>
- FAA's Advisory Circular 150/5220-22B - Engineered Materials Arresting Systems (EMAS) for Aircraft Overruns.

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<sup>5</sup> ACI Policy and Recommended Practices Handbook (7<sup>th</sup> edition)

<sup>6</sup> ACI Policy and Recommended Practices Handbook (7<sup>th</sup> edition)

<sup>7</sup> ACI Policy and Recommended Practices Handbook (7<sup>th</sup> edition)



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- CAP 683. The Assessment of Runway Surface Friction Characteristics. <http://www.caa.co.uk/application.aspx?catid=33&pagetype=65&appid=11&mode=detail&id=165>
- ACI Policy and Recommended Practices Handbook (7th edition) 2009 . <http://www.aci.aero/Publications/Full-Publications-Listing/ACI-Policy-and-Recommended-Practices-Handbook-7th-edition-2009>
- ACI Airside Safety Handbook. <http://www.aci.aero/Publications/Full-Publications-Listing/Airside-Safety-Handbook-2010>
- SN-2012/004: Runway End Safety Areas (RESA) and Runway Excursion Guidance for Aerodromes, Civil Aviation Authority - UK.
- ACRP Report 29, Developing Improved Civil Aircraft Arresting Systems, ACRP, Sponsored by FAA.

# 7

## Runway's – Taxiways – Apron - Obstacles lighting, Signs and Electrical Systems

Approach, runway's, taxiway's, apron's lighting systems and electrical system associated can be critical to safe aircraft operations at night and in reduced visibility conditions.

**Best Practice:** a maintenance program, and its staff, should be prepared so that is able to support inspections, schedule and non-schedule repairs, and the plan should consider enough spare parts to maintain regulatory and operational levels.

### **References for runway lighting assessment and repair methods:**

- ICAO's Doc 9137-AN/898 Part 9, Airport Services Manual, Airport Maintenance Practices. Chapter 2.
- ICAO, Manual on Certification of Aerodromes, Appendix 1, Doc 9774 AN/969, 1<sup>st</sup> Edition
- Annex 14, ICAO, Chapter 10, Aerodrome Maintenance
- ICAO's Aerodrome Best Practice RERR. [http://www.iata.org/iata/RERR-toolkit/assets/Content/Airports-CAAs/ICAO Aerodrome Best practice Landscape format.pdf](http://www.iata.org/iata/RERR-toolkit/assets/Content/Airports-CAAs/ICAO_Aerodrome_Best_practice_Landscape_format.pdf)
- FAA's Advisory Circular 150/5340-26B - Maintenance of Airport Visual Aid Facilities. [http://www.faa.gov/airports/resources/advisory\\_circulars/index.cfm/go/document.information/documentNumber/150\\_5340-26B](http://www.faa.gov/airports/resources/advisory_circulars/index.cfm/go/document.information/documentNumber/150_5340-26B)
- Reglamento Aeronáutico Latinoamericano de Aeródromos. LAR 153 (under development). <http://www1.lima.icao.int/srvsop/document/lar>
- ACI Airside Safety Handbook. <http://www.aci.aero/Publications/Full-Publications-Listing/Airside-Safety-Handbook-2010>
- SN-2012/004: Runway End Safety Areas (RESA) and Runway Excursion Guidance for Aerodromes, Civil Aviation Authority - UK.

# 8

## ACRONYMS AND ABBREVIATIONS

ACI	Airports Council International
AN14	ICAO's Annex 14
ASTM	ASTM International
Doc	Document
FAA	Federal Aviation Administration (USA)
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ISO	International Organization for Standardization
JIG	Joint Inspection Group
LAC	Latin America and Caribbean
NACC	North America and the Caribbean
PA-RAST	Pan-America Regional Aviation Safety Team
RERR	Runway Excursion Risk Reduction
RESA	Runway End Safety Areas
SAM	South America
SMS	Safety Management System
SARP	Standards and Recommended Practices (ICAO)