AIRPORTS COUNCIL INTERNATIONAL

# Runway Safety HANDBOOK

## First Edition 2014

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First Edition (2014)

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# FOREWORD

Runway safety is a significant challenge and a top priority for airport operations which is why ACI is proud to present this new handbook on Runway Safety, aimed at airport operators. Its content has been distilled from a wide range of guidance material from Civil Aviation Authorities, ACI Member Airports' operational safety procedures, ICAO and other international aviation organizations' publications pertaining to runway safety.

The content of this handbook also builds upon the existing guidance in the ACI Airside Safety Handbook (4th edition 2010). While remaining short and succinct, the Runway Safety Handbook provides checklists for action, as well as an explanation of risks to be assessed and means of mitigation available. As stated in the text, local risk assessments are inevitably necessary.

Safety on runways is clearly of great importance to Aerodrome Operators, who want to avoid or mitigate all foreseeable risks of accidents occurring from runway incursion, excursion, confusion and FOD. These risks and issues have been discussed many times at ACI conferences and committee meetings; therefore, ACI believes that it has the responsibility to put forward a guide to best practice, to assist its members. The Runway Safety Handbook forms part of a coordinated approach to Safety Management Systems for ACI's members.

In the area of staff development, ACI's Global Training offers a range of courses relevant to runway safety, via both classroom delivery and online.

**Angela Gittens**
Director General
ACI World

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# INTRODUCTION

The issues of *Runway Incursions, Runway Excursions, Runway Confusions, FOD and Wildlife Management* have been the most serious concerns related to runway safety. Over the past decade, these concerns have been addressed in conjunction with ICAO and others through the production of new best-practice materials and more recently through ICAO's runway safety programme, including a series of regional Runway Safety Symposia.

The ACI World Safety and Technical Standing Committee (STSC) developed this Handbook to provide methodologies and best practices that can be implemented to assist airport operators to achieve a "state of the art" level of runway safety. This handbook provides guidance material for the development of a runway safety programme for all aerodrome (large or small) as well as ways to tailor, improve and expand existing programmes. The Handbook's four chapters are focused on the perspective of aerodrome operators:

- **Runway Safety** describes how to establish a Runway Safety Team and implement a Runway Safety Programme;
- **Planning and Design** explains how to prevent or mitigate infrastructural hazards of runway incursion, excursion and confusion during Master Planning and Designing;
- **Operations** provides methodologies of runway inspection, dissemination procedures for Aero-nautical Information Service (AIS) and best practices of FOD management and obstacle control; and
- **Maintenance, Temporary Restriction and Construction** provides proactive activities to prevent or mitigate accidents or incidents for those activities.

The aim has been to produce a current 'best practice' guidance document without it being overly detailed. Therefore, of necessity, it cannot cover all situations. Further information is available from the expanded Useful Documents and Websites section at the end of this Handbook. These best industry practices, and methodologies, should be implemented in a manner commensurate with the type and level of aircraft activities at a particular airport.

# 1 Runway Safety

Runway excursions, incursions and confusion present some of the greatest aviation hazards, potentially creating very serious consequences. A number of fatal accidents have occurred around the world resulting from these events.

In recognition of the seriousness and growing frequency of these events, a number of years ago ICAO, the FAA and EUROCONTROL introduced concerted programmes to reduce the numbers of runway incursions and excursions. One of their conclusions was that a Local Runway Safety Team should be established at each airport. Additional information can be found in the *ICAO Doc 9870 - Manual on the Prevention of Runway Incursions;*

> **3.1.1** A runway incursion prevention programme should start with the establishment of ***runway safety teams*** at individual aerodromes.

## 1.1 Runway Safety Team

A Runway Safety Team is an essential part of any airport runway safety programme. It is most important to break down barriers between the different operational organizations at the airport. Once these bodies treat each other as genuine partners in runway safety, it is easier to share awareness of safety issues identified at the airport and develop agreed solutions. Local Runway Safety Teams may not necessarily replace existing cross-disciplinary teams such as an Airside Safety Committee, but should be integrated within the overall safety plan for the airport.

### 1.1.1 Function of a Local Runway Safety Team (LRST)

The function of any successful Runway Safety Team will be to advise Airport Management and Operations Staff on:

- Prevailing local conditions on the runway, taxiways and adjacent areas;
- Issues of concern and importance; and
- Mitigating measures and solutions to identified issues.

### 1.1.2 Reporting Culture

It is of paramount importance that a clear, free and fair safety-reporting culture be established at the airport, especially a "just culture" in which individuals and their teams are aware that reporting mistakes or potentially unsafe actions and procedures will not be punished, unless negligence was involved. Reporting of all safety-relevant events must be strongly encouraged and valued. Without such a safety culture, Runway Safety Teams cannot have access to all information on occurrences which may lead to potentially unsafe situations. All staff must have constant and active awareness of the potential for error and the consequences of such errors.

### 1.1.3 Establishing a Local Runway Safety Team

The team should consist of, as a minimum, representatives from at least the three main groups associated with manoeuvring area operations. Specifically, representatives from the Aerodrome Operator, from the Air Navigation Service Provider and/or local Air Traffic Controllers and pilots from Aircraft Operators which operate at the aerodrome must be represented. In addition, any other organisations that operate on the manoeuvring area should participate when applicable.

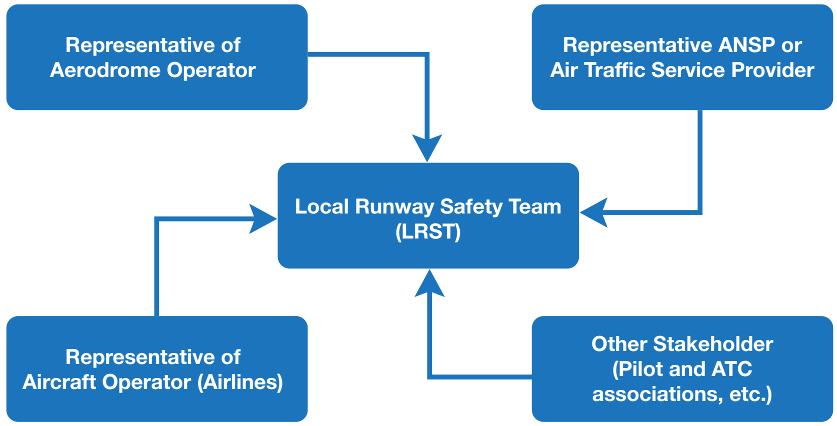



**Figure 1.** Example of Composition of LRST

### 1.1.4 Terms of Reference and Actions

The LRST will assist in enhancing runway safety by conducting the following tasks:

- Review compliance of the aerodrome with ICAO SARPs in Annex 14;
- Monitor runway incidents by type, severity and frequency of occurrence;
- Identify risk factors and local issues;
- Identify particular locations where risks exist ("hot spots");
- Identify problems in daily operations;
- Solicit assistance, e.g. advice and peer reviews, by safety experts from within the industry;
- Contribute to active development of solutions to these issues;
- Ensure that the best possible solution is implemented;
- Disseminate information on developed solutions to stakeholders; and
- Initiate a comprehensive safety-awareness campaign to ensure that all stakeholders' staffs are aware of safety issues.

- Learning the lessons from other incidents

### 1.1.5 Hot Spots

A **hot spot** is defined as a location on an airport movement area with a history of potential risk of collision or runway incursion, and where heightened attention by pilots and drivers is necessary.

By identifying hot spots, it is easier for users of an airport to plan the safest possible paths of movement in and around that airport. Planning is a crucial safety activity for airport users, pilots and air traffic controllers alike. By making sure that aircraft surface movements are planned and properly coordinated with air traffic control, pilots add another layer of safety to their flight preparations. Proper planning helps avoid confusion by eliminating last-minute questions and building familiarity with known problem. areas.

### 1.1.6 Identification of Potential Runway Issues

A Local Runway Safety Team will be able to draw on the combined operational experience gained throughout the careers of its members, on industry best practices through publications and established safety-information forums, as well as airport information. Local Runway Safety Teams should participate in industry meetings, in order to assimilate the latest information and practices. Potential runway issues may entail:

- Design and maintenance of the runway;
- Markings, signs and lightings;
- Standard operating procedures for airport staff – missing, inappropriate or incomplete procedures;
- Birds and wildlife;
- Foreign object debris (FOD);
- Incursions & excursions (by aircraft); and
- Incursions (other than by aircraft).

### 1.1.7 ACI Recommended Training (Airport Perspective)

Each individual member of the LRST should be qualified and should have received the best safety training possible in his/her sphere of expertise. APEX In Safety also recommends that LRST members obtain safety training in other spheres which may overlap with their own, within the area of operations. We recommend that each member maintain competency in each of the following:

- ACI Runway Incursion Awareness and Prevention course;
- ACI Global Safety Network (GSN); and
- ACI/ICAO Aerodrome Certification course.

Please visit www.aci.aero/training for further information on relevant safety training courses.

## 1.2 Runway Safety Awareness

An important objective for Local Runway Safety Teams is to raise awareness of runway safety matters and share good practices to prevent runway incursions, excursions, wildlife events, vehicle and mobile equipment occurrences.

A local **safety awareness campaign** should be initiated at each aerodrome to identify runway safety issues from the combined operational experience of the established Local Runway Safety Team. Timing of awareness campaigns is important. Making a hot spot map or conducting a runway safety briefing at the start of a busy season, or just before a period of weather deterioration, can be helpful to all operational staff.

**Lessons learned** from LRST experience, the individual careers of its members, and industry best practices from publications and safety campaigns should be gathered for information-sharing to all members. A LRST should ensure wide dissemination of the safety recommendations derived from accident and incident investigation findings as well as other relevant lessons learned, for example from operational experience and best risk-mitigation practices.

## 1.3 Change Management (Construction)

Runway construction or temporary restrictions for maintenance may create hazards for aircraft operation. It is recommended that the RST should undertake a safety assessment at each stage of the planning of the construction or maintenance.

**Planning Stage:** The construction plan (or long term maintenance plan) should be reported to the LRST and the LRST should perform a safety assessment via document to review such items as:

- The construction site protection plan (including markings, signs and lighting);
- The construction site access plan (including the communication plan to ATC);
- Prescriptive traffic control plans, including phasing predicated on aircraft access; and
- The Aeronautical Information plan (AIP or NOTAM).

**Initial Construction Stage:** the LRST should perform a safety assessment through site inspection and document review before beginning construction, to review such items as:

- Protection of the construction site and measurements according to the plan;
- Protection measurement from local potential hazards; and
- The published AIP or NOTAM.

**Closing Construction and Reopening Stage:** the LRST should perform a safety assessment through site inspection and document review before closing the construction site and reopening the runway, to check items such as:

- Clearance of construction fencing, stationary equipment and vehicles, etc. from the site
- Compliance of the constructed area's markings, signs and lighting with ICAO SARPs; and
- The revision of the AIP or NOTAM.

More information about preparation for construction safety can be found in Chapter 4.

# 2 Planning and Design

The principal concept for aerodrome planning is to provide sufficient aerodrome capacity and optimize operational efficiency without adversely affecting safety. Aerodrome design has traditionally been mainly concerned with the issues of safety and security. However, operational efficiency and environmental protection have gradually become equally important factors. Additionally, most airports are facing restrictions to their development.

ICAO SARPs, guidance materials, and each State's regulations for aerodrome infrastructure and facilities must be respected, together with local restrictions. Restrictions such as the land usage plan, crosswind, noise, and environmental and economic issues may cause difficulties in fulfilling all the regulatory requirements for the aerodrome. This chapter mainly covers infrastructural safety issues which need to be taken into account to enhance runway safety.

## 2.1 Master Plan for New Infrastructure

**The Airport Master Plan** is a document that presents the short-term (1-5 years), intermediate-term (6-10 years) and long-term (10-20 year) development goals of an airport and is typically evaluated and updated every 5 to 10 years. The Airport Master Plan provides the following:

- A graphic presentation of the future development of the airport and anticipated land uses in the vicinity of the airport;
- A schedule for development;
- An achievable financial plan;
- Justification for the plan technically and procedurally; and
- An implementation plan that satisfies local, state, and federal regulations.

The Master Plan should be reviewed at least annually and adjusted as appropriate to reflect conditions at the time of review. It should be thoroughly evaluated and modified every five years, or more often if changes in economic, operational, environmental and financial condition indicate an earlier need for such revision. It is recommended that the aerodrome operator should be proactively involved in the master planning to eliminate potential hazards being created by aerodrome infrastructure, such as the runway and taxiway layout, etc., and to accommodate future aircraft developments.

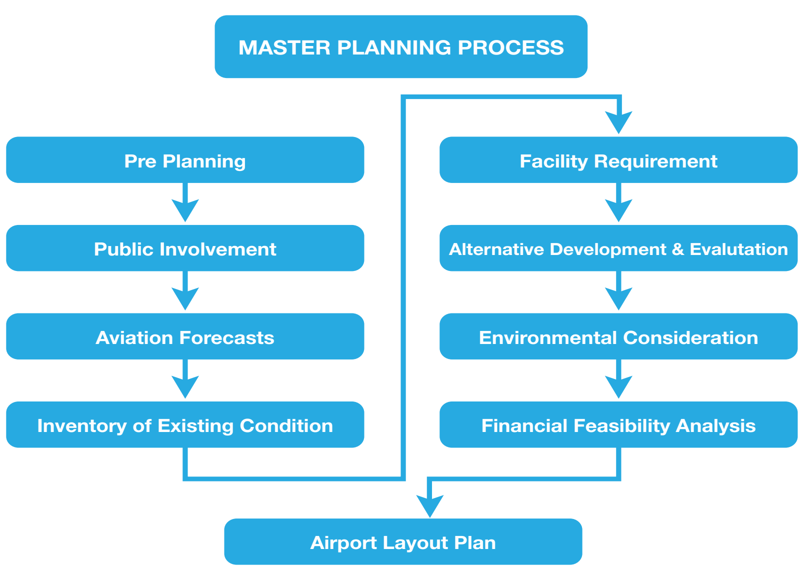



**Figure 2.** Example of Master Planning process

It is critical for the success of the aerodrome for it to produce a Master Plan. This should be based on a series of broad concepts of how the aerodrome will need to develop over a given time. This plan will need to be the subject of comprehensive consultation and general agreement by the planning team. A Master Plan can take the form of a simple listing of objectives and projects, or at the other end of the scale may be a complex set of documents produced by a dedicated planning team and using inputs from all parts of the business. The Master Plan should embody the following general characteristics:

- Safety must feature as one of the Key Master Planning Objectives; and a requirement for safety assessments for all developments should be formally expressed. This should be reflected in the aerodrome's Safety Management System;
- The plan needs to take into account forecast demand for a range of aerodrome activities including traffic levels, passenger numbers, freight throughput and the maintenance or improvement of service levels, together with any special requirements applicable to the aerodrome;
- The plan should cover a fixed timescale depending on aerodrome needs and expected future events. Within the life of the plan there should be fixed milestones for review and to commence development of the succeeding plan;
- The plan should have flexibility, with arrangements in place for review and updating to meet changing situations; and
- The plan should act as the focal point of planning activity, so that developments flow from it in an ordered and coordinated fashion. Every project should be considered within the context of the whole plan. All too often, projects completed in isolation have precluded later development or resulted in limited choice and/or an erosion of safety standards.

## 2.2 Design of New Infrastructure

New aerodrome infrastructure design should fully comply with ICAO SARPs and State regulations. Even though complying with SARPs, many airports have complicated hazards inherent to their infrastructure, such as:

- Cross runways;
- Converging runways;
- Closely spaced parallel runways with rapid exit taxiway leading directly to another runway;
- Y-shaped taxiway intersections;
- Taxiways crossing a rapid exit taxiway; and
- One or more taxiways connecting to converging runways.

The primary focus of the design of the runway areas of an airport should be safety and efficiency of operation. Clearly, the reduction of potential runway incursions is an integral part of this goal and so incursion prevention measures should be a part of the design of new runways and taxiways.

Key elements to eliminate incursion risk airport design are:

- **Cross Runways and Converging Runways** should be avoided because they usually require complicated connecting taxiways and also restrict flight operations. But crosswind is one of the most important factors of the runway layout. Aerodrome operators should perform a careful study analysing prevailing winds and the performance of the aircraft that will be accommodated on the new runways. If cross or converging runways are inevitable, aerodrome operators should prepare prevention measures for runway incursion. Such runways usually are no longer proposed in new runway master plans, since current aircraft can tolerate higher crosswind components;

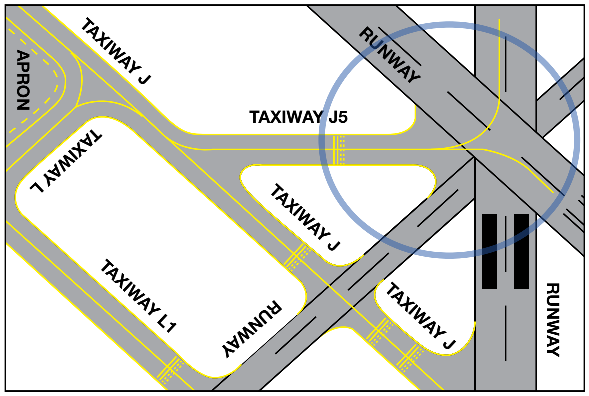



**Figure 3.** Example of cross runways and complicated taxiways connection

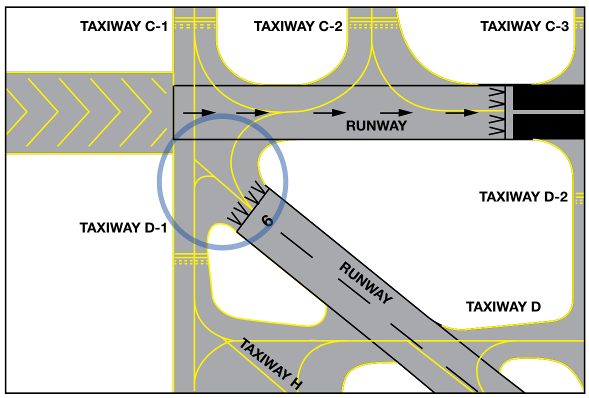



**Figure 4.** Example of complicated taxiway layout caused by converging runways

- **Closely spaced parallel runways** should be avoided in the design of airports, because they restrict capacity, as well as limiting space for exit taxiway and holding points. If they are inevitable because of restricted land availability, aerodrome operators should prepare mitigation measures for runway incursions such as perimeter taxiways and stop bars. In this case, stop bars are recommended to be used on a 24-hour basis;
- **Taxiway Layouts** should be designed to minimize restriction to aircraft movement to and from the runways and apron areas. Taxiway layouts should be capable of maintaining a smooth, continuous flow of aircraft ground traffic at the maximum practical speed with a minimum of acceleration or deceleration;
- **Entrance Taxiways** for a runway should be restricted to those required for lining up for takeoff and should be perpendicular to that runway;
- **Exit Taxiways** should include a straight portion following the turnoff curve sufficient for an aircraft to come to a full stop, clear of both the duty runway and an intersecting taxiway;
- **Rapid Exit Taxiways** should be designed in such a way that crossing another runway via a rapid exit taxiway is not possible. A rapid exit taxiway should never be used for entry to a runway; and
- C**omplicated Taxiway Layouts** linking adjacent runways – such as multi-taxiway intersections, Y-shaped taxiways, taxiways crossing high speed exits and taxiways connecting to V-shaped runways – should be avoided in the design. If any of these are unavoidable, mitigation measures for runway incursion should be included in the design.

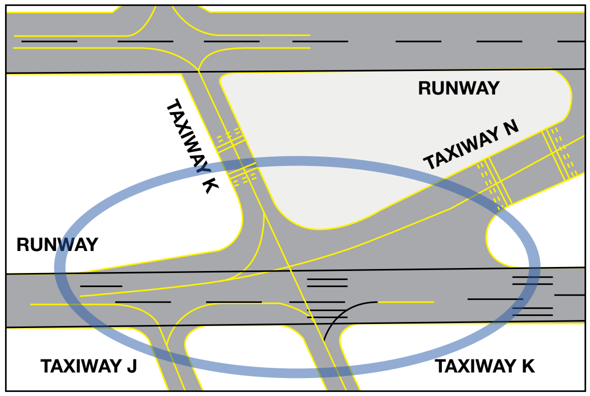



**Figure 5.** Example of closely spaced parallel runway with rapid exit taxiway leading directly to another runway

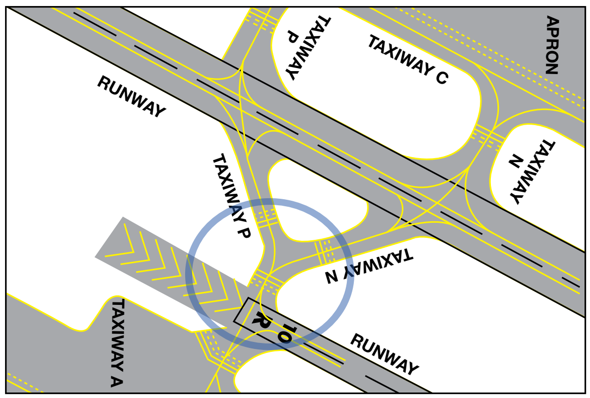



**Figure 6.** Example of Y shaped taxiway

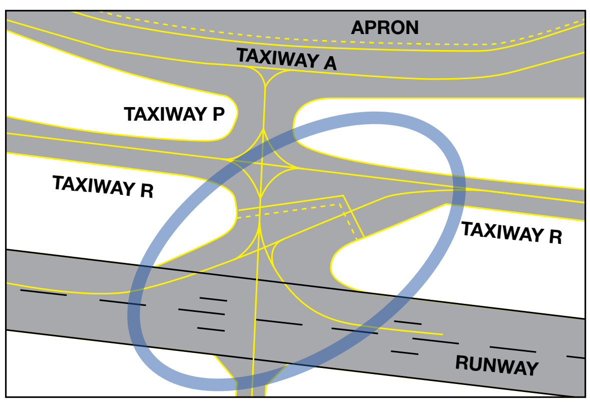



**Figure 7.** Example of taxiway crossing high-speed exit and wide-throated runway entrance

## 2.3 Planning and Redesign of Existing Infrastructure

In order to mitigate runway incursion hazards and allow capacity expansion, existing infrastructure may need to be modified. For this, it is fundamental that airport managers should not plan in isolation but at all stages of the planning process must draw in the ideas, understanding and experience of the range of operators at the airport. For planning matters it is essential to consider the following:

- Good communication with all operators and service providers at the airport;
- Shared risk assessments as part of planning for all categories of projects and works;
- The consistent application of best practice across the aerodrome;
- Good communication with the relevant civil aviation authority (CAA) departments;
- Good communication with local planning organizations; and
- Evaluation of human factor risks.

ACI is forecasting that passenger traffic will more than double over the next two decades. Aerodrome operators should prepare for future development to accommodate increasing demand. Most aerodromes are facing restricted land availability for future development.

The better crosswind performance of modern aircraft may provide a good opportunity for airports with cross runways to modify existing infrastructure. Some airports have closed some of their cross runways and redeveloped them to become taxiways and aprons, in order to accommodate increasing movement demands. Aerodrome operators should first perform studies on the effects of crosswind on aircraft operations.

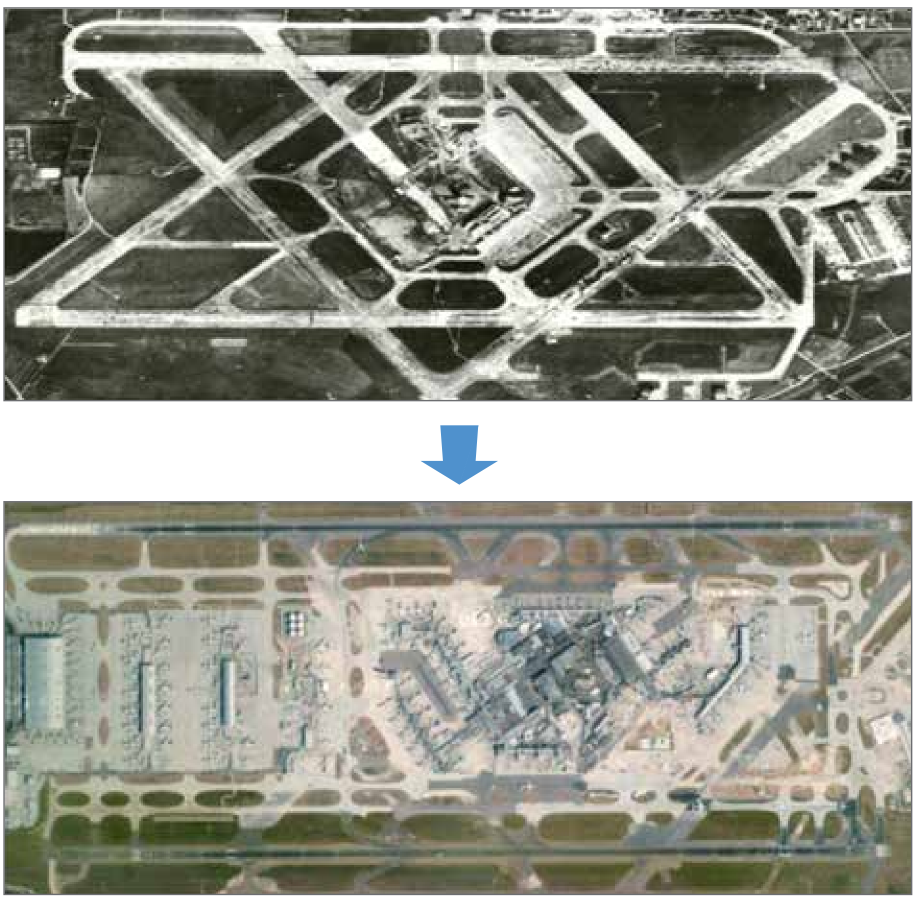


**Figure 8.** Example of efficient land usage by eliminating cross runways, London Heathrow Airport

For closely spaced parallel runways, it is recommended that measures be taken to prevent runway incursion. For example, perimeter taxiways can alleviate the potential for runway incursion at airports with complex runway layouts. They can also significantly reduce delays and thus enhance capacity. During planning and designing of perimeter taxiways, aerodrome operators should take account of obstacle limitation surfaces.

The illustration below shows the use of perimeter taxiways. If the perimeter taxiway cannot be located sufficiently far away from the runway to prevent infringement of obstacle limitation surfaces by taxing aircraft, holding position markings, mandatory signs and stop bars should be installed on the perimeter taxiways.

**Figure 9.** Example of perimeter taxiway, Fraport AG

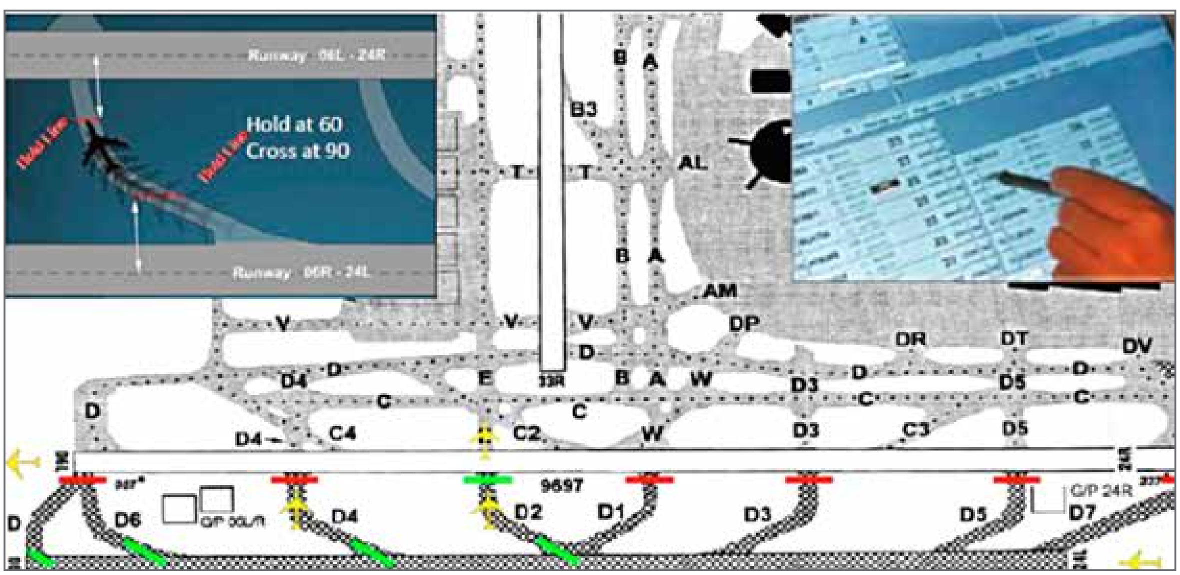



**Figure 10.** Example of 24-hour stop bar operation at closely spaced parallel runways, Toronto Pearson Airport

Controllable stop bars, as in Chapter 2.5, can be another measure useful in preventing runway incursion, especially where runway incursion hot spots have been identified.

## 2.4 Taxiway Naming Convention

A simple and logical method for designating the taxiways should be developed. The following general guidelines should be followed:

- Naming of the taxiways begins on one side of the aerodrome and carries on to the other extremity (e.g. from east to west or from north to south);
- The letters I, O and Z are not used, in order to avoid confusion with the numbers 1, 0 and 2. Neither is the letter X used, because it is used to indicate closure of portions of taxiway or runway;
- There can be no duplication of the use of a taxiway name;
- A taxiway crossing a runway should be named differently on the two sides of the runway. However, some aerodromes designate crossing taxiways with high traffic volume using the same name on both side of the runway (FAA recommendation); and
- Number and letter combinations should not result in confusion with runway designations. E.g., if an airport has a runway "4L," a taxiway designation of "L4" should not be used.

ACI recommends that a taxiway accessing a runway should be identified by a code consisting of a letter followed by a figure (e.g. A1, A2, A3 ... A12), beginning with 1 but not 0, from the extremity of the runway and continuing without missing a number. As far as practicable, this type of identification is not used for other, less critical parts of the aerodrome: only one letter is used. The goal of this practice is to warn a pilot or a vehicle driver of proximity with a runway.

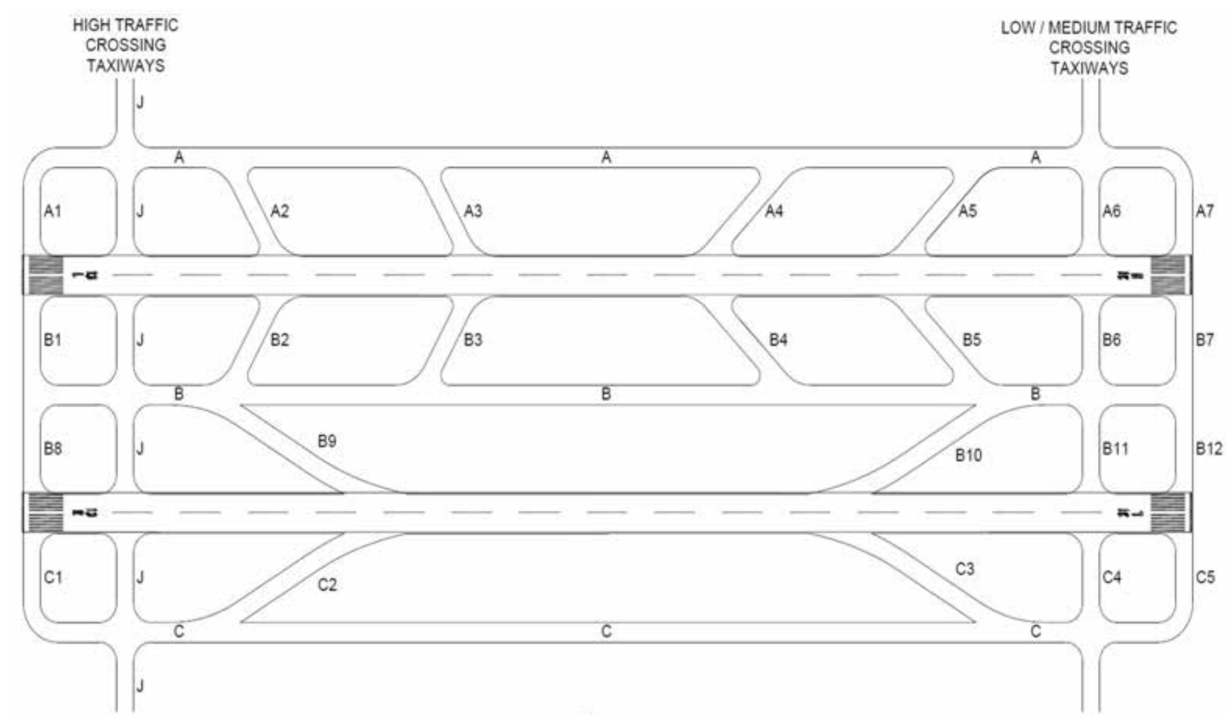



**Figure 11.** Example of taxiway naming

## 2.5 Stop Bars

Based on the concept **"Never cross RED"**, stop bars are among the most valuable measures for preventing runway incursions by aircraft and vehicles. Even though ICAO only requires stop bars for low-visibility operations, ACI recommends that stop bars should be provided at every runway holding position for newly constructed runways where justified by traffic levels and prevailing visibility conditions.

Stop bars consist of a row of red, unidirectional, in-pavement lights installed across the entire taxiway at the runway holding position, and elevated red lights on each side. A controlled stop bar is operated in conjunction with the taxiway centreline lead-on lights, which extend from the stop bar toward the runway. Following the ATC clearance to proceed, the stop bar is turned off and the lead-on lights are turned on. The stop bar and lead-on lights should be automatically reset by a sensor or backup timer. It is recommended that Stop bars should be installed with Runway Guard Lights, configuration A type which is to warn pilots, and drivers of vehicles, when they are operating on taxiways, that they are about to enter a runway.

Stop bars operating 24 hours per day in all weather conditions can provide significant safety benefits to pilots and drivers operating aircraft and vehicles on the manoeuvring area, as part of effective runway incursion prevention measures. The installation of stop bars and the development of procedures for their operation should be coordinated with the airport's air traffic service provider to ensure the stop bars can be operated safely and effectively, without imposing significant additional workload on controllers. A safety assessment of the installation should be conducted prior to implementation particularly at airports with complex runway/ taxiway geometries, to permit the choice of the most appropriate aids and procedures to prevent inadvertent incursions.

The stop-bar control HMI (human-machine interface) should allow visual monitoring of the stop bars' ON/OFF status, as well as control of the stop bar using a touchpad screen or mouse control. It is recommended that the HMI should give controllers acoustic and visual alarms when an aircraft or a vehicle overruns a red-lit stop bar.

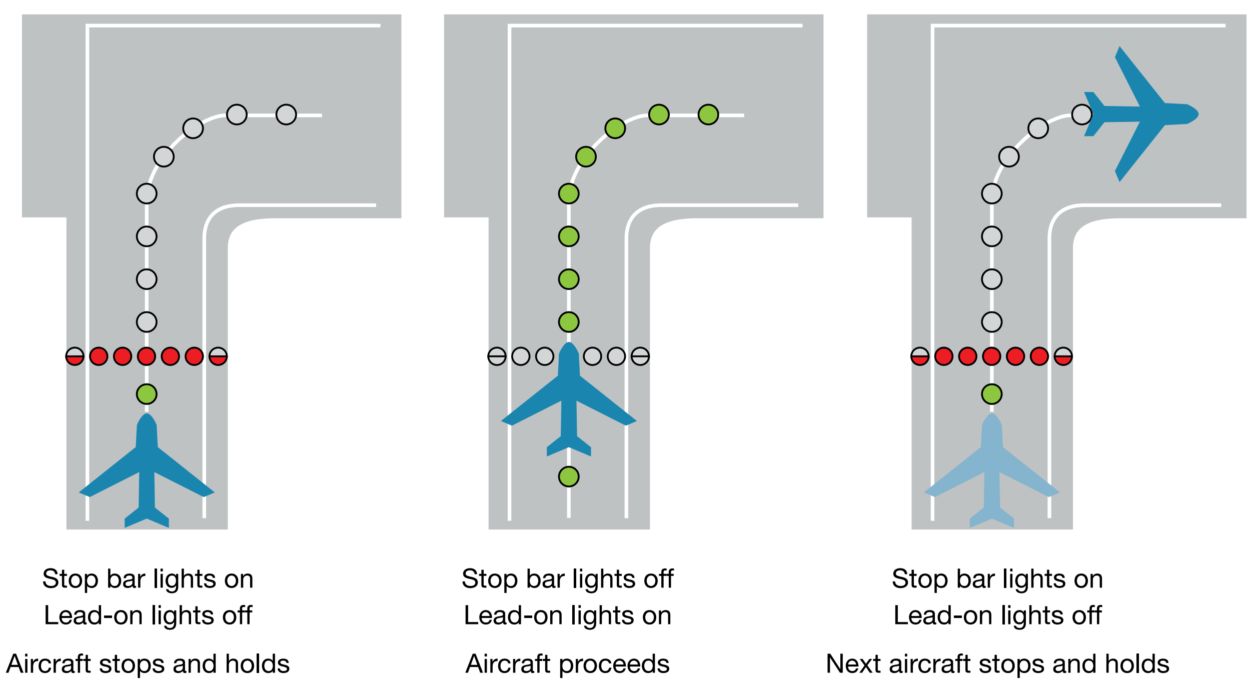



**Figure 12.** Simple lighting sequence in stop bar concept

## 2.6 Visual Aids

### 2.6.1 Markings

One of the best and easiest ways to prevent or mitigate runway incursion is to enhance runway holding position markings at all runway entrances.

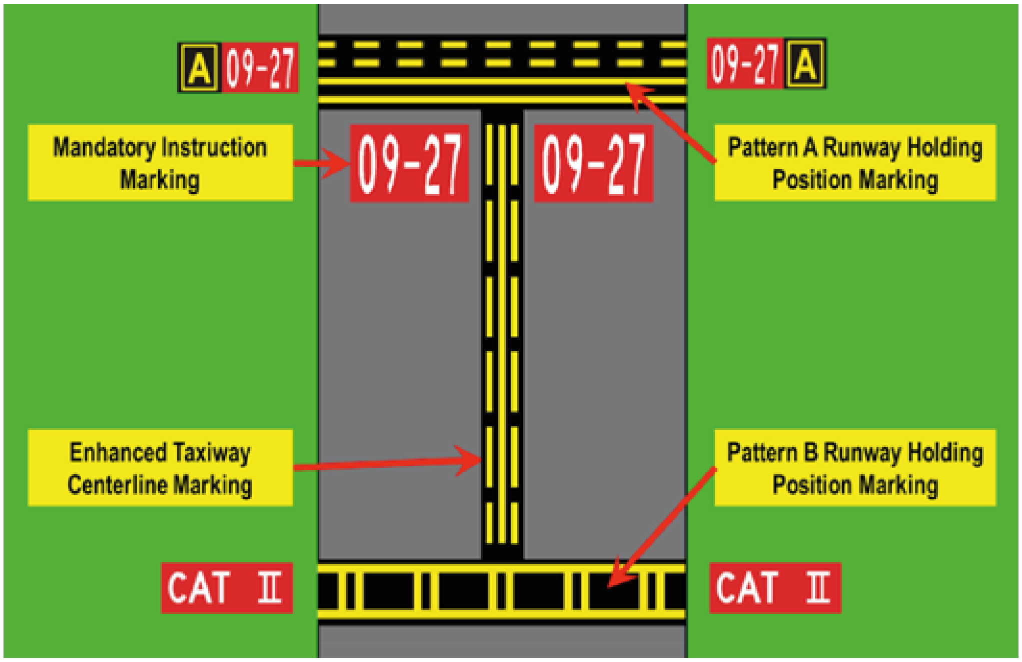



**Figure 13.** Example of Runway Holding Position Markings

**Pattern A Runway Holding Position Marking**: Painted yellow on the taxiway pavement and co-located with the holding position sign, this consists of two solid yellow lines with two dashed lines. Prior to reaching the solid lines, it is imperative to **STOP** and not to cross the line until clearance is received from ATC. When the tower is closed or at a non-towered airport, crossing is permitted only when the runway is clear of aircraft, and then with extreme caution.

**Pattern B Runway Holding Position Marking:** These holding position markings for ILS critical areas appear on the pavement as yellow horizontal ladders and extend across the width of the taxiway. A sign with white characters on a red background (as shown) is typically situated adjacent to these ILS holding position markings. Aircraft must hold short of this area when instructed to by ATC.

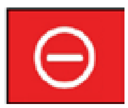
**Enhanced Taxiway Centreline Marking:** This is a dashed line painted on each side of the existing taxiway centreline extending up to 45m from the holding position marking. This is to alert aircraft and vehicles that they are approaching a runway.

**Mandatory Instruction Marking (runway designator):** These markings indicate the runway designator in white letters on a red background. They are placed prior to the taxiway runway intersection on both sides of the taxiway centreline if sufficient space is available. This should increase the conspicuity of the actual holding position markings, convey directionality (i.e. when turning off the runway, the text would be upside-down), and provide both sides of the cockpit of an approaching aircraft with visible cues.

## 2.6.2 Signs

All signs conform to a colour code that clearly indicates the function of each sign. Mandatory signs use red and white, and information signs use yellow and black. The choice of colours was influenced by colour conventions in other modes of transport where colours have specific and well-understood meanings. It was also influenced by the need to use pairs of colours which, in combination, provide signs that are legible in the widest possible range of conditions. Contrast ratios between the elements of the sign are a major factor in determining the legibility of a sign. There are four types of signs:


**Mandatory instruction sign:** This identifies a location beyond which an aircraft or vehicle shall not proceed without authorization, such as the entrance to a runway or critical area. It has a white inscription on a red background. A mandatory instruction sign is always provided at a taxiway / runway intersection, and a runway / runway intersection on each side of the runway-holding position.



A no-entry sign should be provided at locations such as a taxiway not allowed to be used to enter a runway (e.g. a rapid exit taxiway)


Mandatory signs should also be provided where aircraft or vehicles can infringe an obstacle limitation surface (OLS).


**Location sign:** This identifies the taxiway on which you are currently located. It has a yellow inscription on a black background. A yellow border should be added to enhance visibility. These signs are installed along taxiways either in isolation or in conjunction with direction signs or runway holding position signs. A sign with a letter and number (e.g. A1) may designate a holding point or an access taxiway.


**Direction sign:** This identifies the designations of each taxiway at a taxiway intersection and features arrows indicating the approximate direction of turn needed to align with each taxiway. It has a black inscription on a yellow background and is located before the intersection, along with a location sign. At runway exit points, a direction sign identifies the taxiway(s) available.


**Destination sign:** This has arrows identifying direc-tions to specific aerodrome destinations (e.g. terminals and services). It also has a black inscription on a yellow background.

### 2.6.3 Aerodrome Ground Lighting

All lighting concerning runway operation must be in compliance with ICAO SARPs. An aerodrome operator planning and designing runway lighting should bear in mind that too many lighting colours at the runway holding position may create confusion for pilots.

New technologies such as REL (Runway Entrance Lights), THL (Takeoff Hold Lights) and RWSL (Runway Status Lights) are being discussed and implemented in some States. These are totally independent, automatic systems, separate from existing airfield lighting systems.

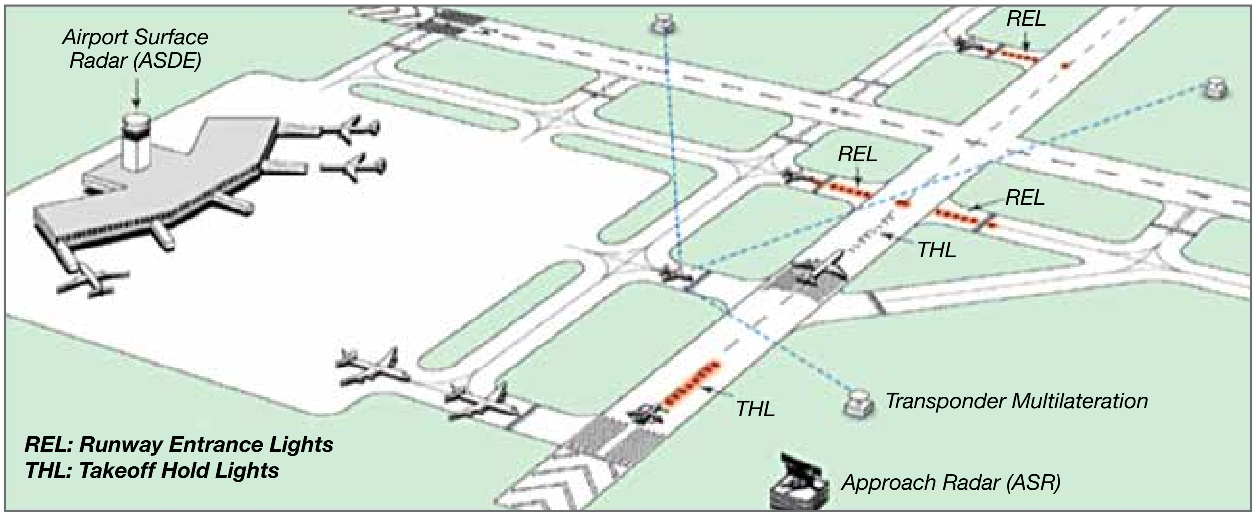



**Figure 14.** New lighting technologies for preventing runway incursion

ACI recommends that aerodrome operators focus on Advanced Surface Movement Guidance & Control Systems (A-SMGCS), rather than new systems, for enhancing the prevention of runway incursions.

As mentioned in the preceding section "Stop bar", installation and 24-hour operation of stop bars based on A-SMGCS may be a more economical and efficient measure for the airport operator.

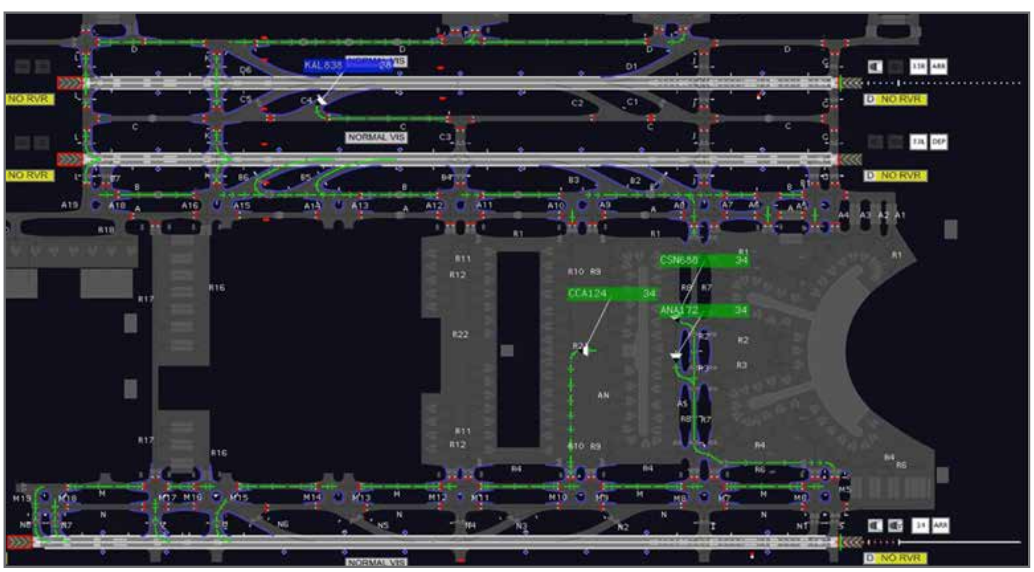


**Figure 15.** Example of A-SMGCS, Incheon International Airport

## 2.7 RESAs

RESAs (Runway End Safety Areas) are designated areas at each end of the runway intended to minimize the risk of damage to an aircraft, when the aircraft overruns or undershoots a runway. RESAs are required at each end of the runway strip enclosing runways where the code number is 3 or 4, and instrument runways where the code number is 1 or 2.

The minimum length requirement for a RESA is 90m from the end of the runway strip for all code 3 and 4 runways, and code 1 and 2 instrument runways. It is recommended that all new runways be equipped with RESAs extending at least:

- 240m from the end of the runway strip for code 3 and 4 runways; and
- 120m from the end of the runway strip for code 1 and 2 instrument runways.
- 30m from the end of the runway strip for code 1 and 2 non-instrument runways.

A RESA should be the same width as the associated cleared and graded area of the runway strip, with a minimum of twice the runway width, symmetrically disposed about the extended centreline of the runway.

Where sufficient length of RESA cannot be provided, an arresting system may be installed as an alternative. Research programmes and evaluation of actual aircraft overruns into arresting systems have demonstrated that the performance of some arresting systems can be predictable and effective in arresting aircraft overruns.

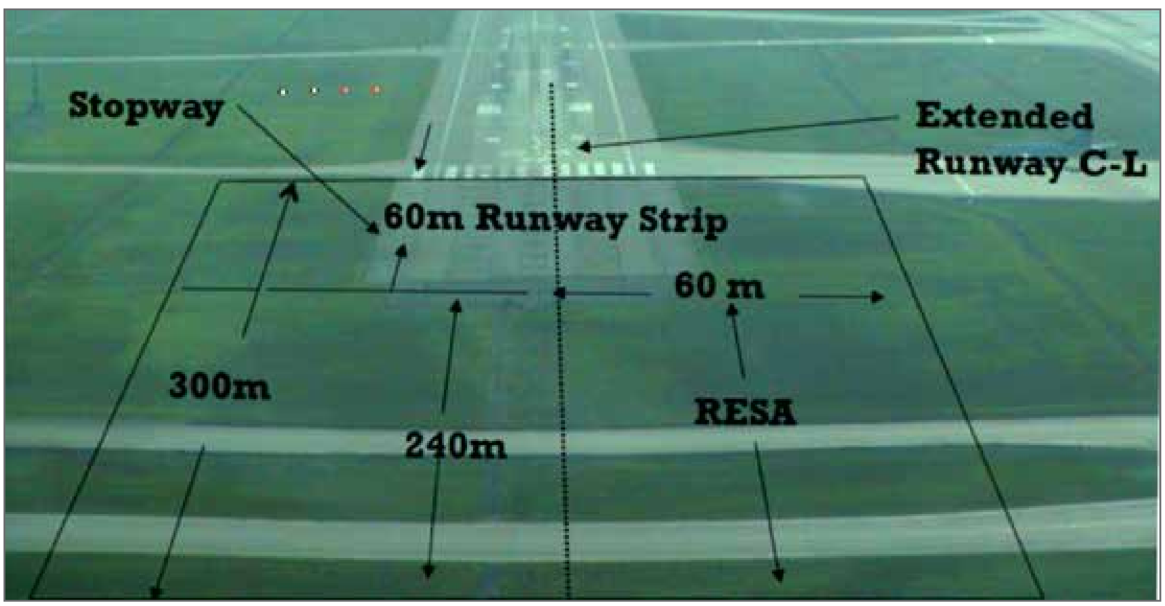



**Figure 16.** Depicted Runway End Safety Area showing recommended dimensions for a code 3 and 4 runway

# 3 Operations

## 3.1 Runway Inspection

Runway inspection should be regular and as frequent as possible. Each inspection should be performed using vehicles and performed at slow speed. Inspection results should be recorded and kept in the Airside daily report management system. Please note the following:

- Four inspections are required daily, as described:
  - Dawn inspection: A detailed surface inspection covering the full width of all runways should be undertaken. This should take approximately 15 minutes for each runway (two runs, generally 3m from the centreline);
  - Morning inspection: On all runways, normally carried out on an ON/OFF basis and concentrating on the area between the runway edge lights;
  - Afternoon inspection: Using the same procedure as the morning inspection; and
  - Dusk inspection: This should cover all runways. It is designed to bridge the gap in runway inspections when the lighting inspection is not required until late in the evening, and should cover the whole runway surface;
- Before commencing any runway inspection, clearance must be obtained from ATC. On entering the runway a positive entry call must be made. On leaving the runway, ATC must be advised when the inspection vehicle is clear of the runway strip;
- All inspections are carried out an ON/OFF basis (i.e. the inspection vehicle may be required to enter or leave the runway at short notice). The runway-entry call to ATC should be made on each occasion that the inspection vehicle enters the runway;
- It is essential to maintain a listening watch on the appropriate R/T channel during any runway inspection;
- The concept of “one runway, one frequency, one language” is recommended;
- If, during an ON/OFF inspection, ATC requires the inspection team to clear the runway, the vehicle should move outside the protected area of the runway or the runway strip. It must then remain outside the protected area of the runway or the runway strip while awaiting re-entry instructions;
- Clearance must be obtained before crossing any runways;
- Runway inspections should normally be carried out in the direction opposite to that being used for landing or taking off for safety reasons. In the case of the first-light runway inspection involving two runs in the same direction, the “back-tracking” must be done outside the protected area of the runway or the runway strip and can be used to inspect the runway from a distance or inspect the taxiways adjacent to the runway in question;
- On final completion of a runway inspection the team should advise ATC of the fact and report the state of the runway; and
- The time of commencement and completion of the inspection must be noted and included in the Record of Inspection Log.
- Authorized vehicles should be painted in contrasting and conspicuous colors, display a company logo or identification number, and carry a flashing yellow beacon.

**Paved area inspection** should pay attention to the following points:

- Existence of foreign objects that can cause damage to engines; accumulation of rubber;
- Cracks in or damage to the paved surfaces;
- Surface drainage; areas which are submerged after rain;
- Damage to lighting facilities;
- Condition of markings and signs;
- Condition of in-pavement lights;
- Existence of damage to the approach lighting system and threshold lights, caused by aircraft jet blast; and
- Cleanliness/existence of unauthorized obstacles at the end of the runway.

**Unpaved area inspection** should look for the following points:

- The general state of ground cover vegetation, particularly to ensure that excessive vegetation length is not obscuring lights, signs and markers;
- Any developing sinkage or settlement;
- Unreported aircraft wheel tracks;
- Condition of signs and markings;
- Strength of grass areas adjacent to paved area (especially, the condition of the portions close to paved surfaces used for aircraft movement should be checked and recorded);
- Any submerged grassed area (a priority action for frequently submerged areas); and
- Any noticeable difference between the heights of the unpaved area and the paved area.

**Reporting**: If a dangerous unserviceability is discovered during a runway inspection (e.g. damaged pit covers or broken lights) the fact should be immediately reported by R/T, so that appropriate and prompt ATC action can be taken. In addition, airport operations should be informed. If the runway is closed as a result of such damage the inspection team should continue its inspection whilst awaiting the arrival of airport maintenance support. The team should also be prepared to inspect any subsidiary runway if required.

Whenever water is present on a runway, a description of the runway surface conditions on the centre half of the runway 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; and
- STANDING WATER: For aircraft performance purposes, this term applies to 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 3mm deep.

Whenever an operational runway is contaminated by snow, slush, ice or frost, the runway surface condition must be assessed and reported. The description of the runway surface condition should use the following terms: and should include, where applicable, an assessment of contaminant depth:

*• DRY SNOW; • WET SNOW; • COMPACTED SNOW; • WET COMPACTED SNOW; • SLUSH; • ICE; • WET ICE; • FROST; • DRY SNOW ON ICE; • WET SNOW ON ICE; • CHEMICALLY TREATED; • SANDED.*

**Measurement of runway surface friction:** ICAO Annex 14 states that a paved runway shall be maintained in a condition so as to provide surface friction characteristics at or above the minimum friction level specified by the State. Maintenance friction testing of uncontaminated runways must be carried out at regular intervals.

ICAO Circular 329 - *Assessment, Measurement and Reporting of Runway Surface Conditions* states that friction measurement devices have two distinct and different uses at an aerodrome:

- for maintenance of runway pavement, as a tool for measuring friction related to the: i) maintenance planning level; and ii) minimum friction level
- for operational use as a tool to aid in assessing estimated surface friction when compacted snow and ice are present on the runway.

When a runway is not in normal dry condition, as a result of a meteorological or other reason, the surface friction of the runway must be assessed and this information provided to ATC. If the runway is considered slippery, a surface friction test should be performed.

For operational purposes, surface friction should be assessed in the following conditions:

- Whenever the runway is affected by snow or ice;
- When pilots and airlines request ; and
- When requested by ATC.

Runway friction should be measured as follows, subject to state requirements:

- The friction should be measured continuously along the whole length of the runway;
- The measurement location should be within about 5m of the runway centreline; and
- Friction calibration results should be kept for at least 5 years.

Runway friction should be reported according to the categories set out in ICAO Annex 14, Attachment A, section 6: Assessing the surface friction characteristics of snow-, slush-, ice- and frost-covered paved surfaces.

**Table 1** Example of Movement Area Daily Check List

| | | | | | |
|---|---|---|---|---|---|
| | | | | | DATE : ________ |
| **Inspection Areas** | **Dawn** | **Morning** | **Afternoon** | **Dusk** | **Remarks** |
| Inspector: | ________<br>________<br>________ | ________<br>________<br>________ | ________<br>________<br>________ | ________<br>________<br>________ | |
| Paved areas | | | | | |
| 1. Existence of foreign objects | | | | | |
| 2. Cracks or damage | | | | | |
| 3. Condition of surface drainage | | | | | |
| 4. Condition of markings on TDZ | | | | | |
| 5. Existence of any abandoned obstacles in the safety zone at the end of the runway | | | | | |
| Unpaved areas (Runway Strip/Taxiway Strip) | | | | | |
| 1. Wheel tracks | | | | | |
| 2. Condition of surface drainage | | | | | |
| 3. Condition of surface/turfed areas | | | | | |
| 4. Difference (over 7.5cm) between levels of paved areas | | | | | |
| 5. Obstacles, whether retained or not | | | | | |
| Visual Aids | | | | | |
| 1. Difficulty of identification of lights, signs and markers | | | | | |
| 2. Runway markings | | | | | |
| 3. Taxiway markings | | | | | |
| 4. Runway/taxiway signs | | | | | |
| 5. Runway lights | | | | | |
| 6. Taxiway lights | | | | | |
| 7. Lights of wind direction indicator | | | | | |
| 8. Markers | | | | | |
| 9. Markers for obstacles | | | | | |
| Others | | | | | |
| 1. Others | | | | | |

S: Satisfactory, U: Unsatisfactory, N/I: Not Inspected

## 3.2 Wildlife Prevention

Wildlife hazard, just as any other hazards to aviation safety, should be identified and managed under a Safety Management System in order to reduce the risk. Each aerodrome operator should develop a Wildlife Hazard Management Plan for the aerodrome and surrounding areas, in particular runway approach and take-off areas. This involves maintaining records of wildlife population in and around the aerodrome, collecting data on actions, and detailing the response of wildlife to management actions.

More information about implementation of wildlife hazard management plans and wildlife intervention best practices can be found in ACI's Wildlife Hazards Management Handbook (2nd edition, 2013).

## 3.3 FOD Management

Foreign object debris (FOD) may damage aircraft through direct contact, such as by cutting aircraft tires or by being ingested into engines, or as a result of being projected by jet blast. FOD may also cause other material damage or injure people.

The majority of instances of FOD can be attributed to lack of standards in an organization, personal complacency or disregard for procedures. These may also lead to additional sources of FOD caused by:

- Insufficient housekeeping, training or controls;
- Deterioration of facilities;
- Improper tools and equipment;
- Improper or careless maintenance or assembly; and
- Fatigue and scheduling pressures.

A FOD-prevention program of training, facility inspection, maintenance, and coordination between all affected parties can minimize FOD and its effects. FOD includes a wide range of material, including loose hardware, pavement fragments, catering supplies, building materials, rocks, sand, pieces of luggage, and even wildlife. The establishment of an effective and compliant FOD prevention and control program will:

- Provide employee training;
- Identify potential problem areas and actions;
- Provide the tools for employees to prevent FOD incidents;
- Assist management in proper planning;
- Allow coordination of corrective actions;
- Establish a climate of "Continuous Awareness"; and
- Use the lessons learned by the industry to reduce costs and improve safety.

Maintenance and maintaining control of FOD includes using several methods:

- **Vacuum Cleaning Vehicle**. Sweeping is the most effective method for removing FOD from airside areas. A vacuum cleaning vehicle removes debris from cracks and pavement joints, and should be used in all areas except for those that can be reached only with a hand broom. All airside areas, including aircraft manoeuvring areas, aprons and gates and the areas adjacent to them, should be swept routinely.
- **Magnetic bars.** These bars can be suspended beneath tugs and trucks to pick up metallic material. However, the bars should be cleaned regularly to prevent them from dropping the collected debris. Vehicles operating on the airside should be inspected periodically to ensure that they have no loose items that can fall off.
- **Rumble strips.** Driving over rumble strips may dislodge FOD from vehicle undercarriages. The strips, which are 30cm to 45cm long, can be moved and used at transitions from the landside to the airside, or adjacent to airside construction areas.
- **FOD Detection System.** Recently automatic detection systems have reached the market and some airports have evaluated and adopted them. Due to the high cost of such systems at the present time, most airports are unable to justify the purchase. Two technologies are available, Radar and Electro Optical, and Hybrid using both. Such technology will probably never replace the need for traditional inspection.
- **Tool Management (Tracking) System.** Such a system reduces FOD risk by ensuring all tools are returned and it is recommended that all maintenance responsibilities of aerodrome

operations departments introduce a tool management (tracking) system. Using barcode or RFID identification, a tool management system can provide automatic identification of tools and technicians, along with their location.

## 3.4 Obstacle Control

Every aerodrome operator should establish Obstacle Limitation Surfaces (OLS) in accordance with ICAO SARPs for safe take-off and landing of aircraft. Objects other than approved visual and navigational aids should not be located within the obstacle restriction area or the aerodrome without specific approval of each state's CAA. If there are any objects penetrating these surfaces, the aerodrome operator should remove or mark and/or light them.

### 3.4.1 Establishment of OLS (Obstacle Limitation Surface)

Establishment of obstacle limitation surfaces at each aerodrome depends on types of instrument runways, either non-precision approach or precision approach runways. Established obstacle control surfaces must be prevented from becoming unusable by the growth of obstacles. Obstacles range from fixed - (temporary or permanent), to mobile objects, or parts thereof which penetrate the obstacle limitation surfaces.

The following OLS should be established for a non-instrument runway and non-precision instrument runway:

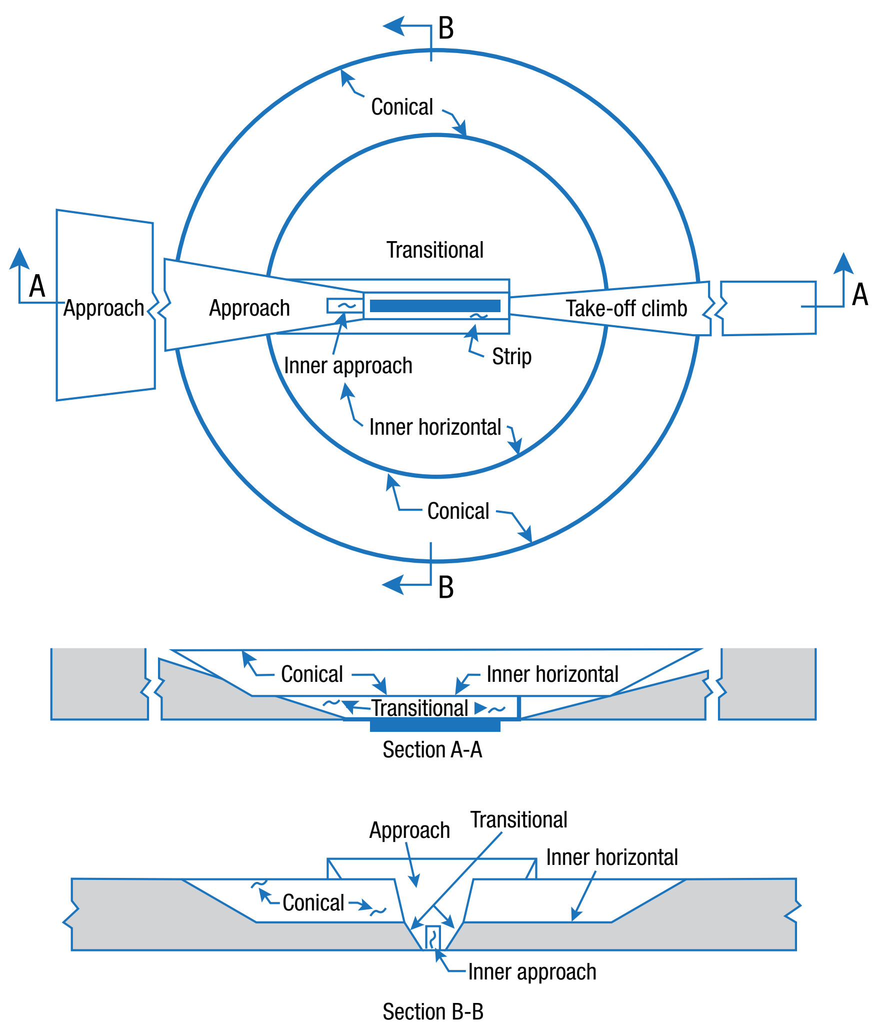



**Figure 17.** Obstacle Limitation Surfaces

- Conical Surface;
- Inner Horizontal Surface;
- Approach Surface;
- Transitional Surface; and
- Take-off Climb Surface.

The following OLS should be established for a precision instrument runway:

- Outer Horizontal Surface (as may be defined by the State);
- Conical Surface;
- Inner Horizontal Surface;
- Approach Surface;
- Inner Approach Surface;
- Transitional Surface;
- Inner Transitional Surface;
- Balked Landing Surface; and
- Take-off Climb Surface.

Where two OLS surfaces overlap, the lower surface must be used as the controlling OLS. Detailed information about 'Dimensions and slopes of obstacle limitation surfaces' can be found in ICAO Annex 14, table 4-1.

### 3.4.2 Procedures for Aerodrome Operators to Control OLS

Aerodrome operators must establish procedures to monitor the OLS and the critical obstacles associated with aircraft operation and have them included in the aerodrome manual. Each aerodrome operator should monitor the OLS applicable to the aerodrome and report to its civil aviation authority any infringement or potential infringement of the OLS.

When a new obstacle is detected, the aerodrome operator should disseminate the information to pilots through a NOTAM, in accordance with aerodrome reporting procedures set out in Chapter 3.2. Information on any new obstacle should include:

- The nature of the obstacle – for instance, structure or machinery;
- Distance and bearing of the obstacle from the start of the take-off end of the runway, if the obstacle is within the take-off area, or the approach area;
- Height of the obstacle in relation to the aerodrome elevation; and
- The period for which it will remain an obstacle (if it is a temporary obstacle).

Temporary obstacles and transient (mobile) obstacles, such as road vehicles, rail carriages or ships, in close proximity to the aerodrome and which penetrate the OLS for a short duration should be referred to the CAA to determine whether they will be a hazard to aircraft operation.

Fences and levee banks that penetrate the OLS should be treated as obstacles.

Obstacle surveys of areas underlying the obstacle control surfaces at both proposed and existing airports are performed to identify the location and height of objects that may constitute infringements of these surfaces. Survey specifications are used to obtain the obstacle data necessary to comply with the ICAO SARPs contained in the relevant Annexes and the requirements of each State's regulations.

Obstacles must be designated: for example, tree, hill, pole, tower, spire, vent, chimney, mast, post, antenna, building, house, etc.

### 3.4.3 Type A Charts

A Type A chart is a chart which identifies information on all significant obstacles within the take-off area of an aerodrome up to 10km from the end of the runway. A Type A chart should be prepared for each runway that is used in international operations.

Obstacle data to be collected and the manner of presentation of the Type A chart should be in accordance with the standards and procedures set out in ICAO Annex 4. An electronic chart may replace a paper chart.

Where a Type A chart has been prepared and issued the take-off flight area should be monitored and any changes to the Type A chart information must immediately be communicated to all users of the Type A chart. Obstacles may be recorded in an electronic Terrain and Obstacle database (e-TOD).

## 3.5 Communication/Surveillance

Because of growing air traffic, the complex layout of aerodromes and the range of tasks which need to be performed by airport staff, vehicle drivers need well-defined procedures for communication with the local Air Navigation Service Provider (ANSP).

Air traffic controllers manage aircraft movements on the aerodrome and prevent collisions between aircraft and other aerodrome users. At all times, runway incursions need to be prevented by all means available and therefore robust procedures and a vehicle driver training curriculum is of utmost importance. Only by applying adequate and standard communication procedures and radio telephony practices will aerodrome operators succeed in preventing the incorrect presence of vehicle drivers and ground servicing staff on runways and protected areas.

### 3.5.1 Radio Frequencies and ICAO Phraseology

ATC has dedicated radio frequencies for establishing two-way radio communication with aircraft operators, ground servicing staff and aerodrome operators. At some airports, Radio Telephony Frequency (RTF) is used for establishing communication with vehicle drivers. Using RTF allows the use of local, non-aviation-standard language between vehicle drivers and ATC, but the use of Radio Telephony Frequencies imposes the use of standard ICAO phraseology and enhances general situational awareness for all manoeuvring area users.

This means pilots will be able to monitor vehicle movement and may be able to identify potential runway conflicts early. Vehicle drivers, when adequately trained, may identify aircraft movement on the routing they had planned or may hear and observe aircraft waiting for departure or on final approach for a specific runway they intend to cross. In that way enhanced situational awareness may lead to reduced numbers of runway conflicts and reduced ATC frequency overload and may avoid worst-case-scenario runway incursions.

Aerodrome staff – and more specifically vehicle drivers with a functional need to drive on taxiways and runways or in the protected area of the runway – need specific training to be able to use radio equipment correctly and apply standard ICAO phraseology.

It is recommended that aerodromes and ANSPs develop a clear standard operating procedure on what phraseology needs applied by both parties, including standard phrases for:

- Radio checks and readability scale;
- Radio communication failures (transmitting blind);
- The use of predefined and process-specific call signs;
- Position lost;
- Position reporting; and
- Runway crossing requests.

Training curriculum should include sessions where vehicle drivers are able to practice pronunciation, transmission techniques and message priorities.

### 3.5.2 Stop bars - communication procedures

When the runway(s) of the aerodrome is (are) equipped with stop bars, it is of utmost importance to provide a clear procedure indicating how vehicle drivers need to perform while approaching a lit stop bar, as well as procedures specifying the required actions to take when a stop bar would give an indication of failure. It is a generally accepted best practice **never to cross a red (lit) stop bar,** not even with the approval of the air traffic controller. If instructed to cross a red stop bar, pilots and drivers should ask ATC to switch off the stop bar or provide an alternative routing. Vehicle drivers should always inform the air traffic controller when a runway crossing clearance is in contradiction with the stop bar status of the position where they have been approved to cross.

## 3.6 Vehicle and Driver Training

Driver Training and Licensing should be split into at least “Apron” and “Manoeuvring Area” and specific training given for each, and that only those who really need access to the Manoeuvring Area are given the enhanced training and permit which is necessary for driving on or close to taxiways and runways.

Vehicle drivers and other personnel operating on the Manoeuvring Areas need to be trained according to a well-defined, robust training curriculum. The following areas should be part of initial and recurrent training:

- Airport layout, identification of a given point on the standard chart used at the airport including designation of runways, taxiways , etc.;
- Applicable airport vehicle traffic rules, holding position and stop bar regulations, and procedures pertaining to vehicle operations;
- Definitions of runway protected areas, NAVAID sensitive and critical areas, runway strips, runway end safety areas;
- Interpretation and color-coding of airfield signs, pavement markings, and lighting;
- Proper terminology (including phonetic alpha-bet) and standard procedures for radio communi-cations with airport traffic control (ATC):
  - – Radio Telephony Frequencies;
  - – Vehicle call signs;
  - – ATC call signs applicable per area of respon-sibility;
  - – Procedures for contacting ATC, check-in via air band and position-reporting;
  - – Runway crossing requests;
  - – Radio communication failure procedures;
  - – Position lost procedures; and
  - – Vehicle breakdown procedures.
- Established routes for runway inspections, wildlife control activities, emergency response;
- Hazards associated with jet blast, prop wash, FOD, maintenance and construction works;
- Situational awareness:
  - – Be well prepared before commencing a task:
    - ✓ ATIS;
    - ✓ NOTAMS;
    - ✓ Maintenance and construction work sche-dules; and
    - ✓ Pre-operational vehicle and radio communi-cation equipment checks;
- Human Factors:
  - – Fatigue;
  - – Sterile vehicle cockpit;
  - – Operational stress due to:
    - ✓ Changed tasking or planning
    - ✓ Adverse weather
    - ✓ Aircraft emergency situations; and
  - - Multitasking;
- Other information:
  - – Various aircraft navigation aids;
  - – Location and understanding of critical areas associated with instrument landing system (ILS) and very high frequency omni-directional range (VOR) navigational aids;
  - – Traffic patterns associated with each runway (left or right) and location of downwind, base, final, and crosswind legs; and
  - – Traffic patterns and runway usage for instrument approaches and reduced visibility.

## 3.7 Incident reporting/Investigation/Statistics

A safety reporting system requires collection of information on actual or potential safety deficiencies and the filing of reports.

“Safety Occurrence” is the term used to embrace all events which have or could have significance in the context of airport safety, ranging from accidents and serious incidents through incidents or events which must be reported, to occurrences of lesser severity which, in the opinion of the reporter, could have safety significance.

The objective of a safety occurrence reporting sys-tem is to improve the safety of airport and aircraft operation by timely detection of operational hazards and system deficiencies. It plays an essential role in accident prevention, enabling the identification of appropriate remedial actions by prompt analysis of safety data collected and by the exchange of safety information.

As laid down in Annex 19, ICAO requires that airport operators (and other aviation service providers) must implement (i.e. develop and maintain) a safety management system (SMS). This must include a formal process of collecting recording, acting on and generating feedback about hazards in operations.

The process is based on a combination of reactive, proactive and predictive methods of safety data collection. Guidance on safety occurrence reporting is contained in Doc 9859 – Safety Management Manual and ICAO Annex 13 – Aircraft Accident and Incident Investigation.

Effective safety reporting of hazards and incidents by operational personnel is an important cornerstone of the management of safety. Therefore an operational environment in which operational personnel have been trained and are constantly encouraged to report hazards is a prerequisite of effective safety reporting.

The incident reporting system should be non-punitive, with limited immunity provided through law and regulatory guidance.

Aerodrome operators receive, processes and analyse mandatory and voluntarily submitted incident reports from airport personnel, air traffic controllers, pilots, dispatchers, flight maintenance technicians and others.

Reports submitted to the aerodrome operators may describe both unsafe occurrences and hazardous situations. Of particular concern to the RST is the quality of human performance in the airport manoeuvring system.

The purpose of the reporting system is to identify deficiencies and discrepancies in the airport runway and taxiway system in order to improve the current airport system. The aerodrome operators should provide data collected from the reporting system to plan and improve the airport manoeuvring area system.

The aerodrome operators should identify system deficiencies and issue alerting messages to persons who are in positions to correct them. It should keep a database of all incidents at the airport to serve the needs of all those who are engaged in the promotion of safe operation at the airport.

After analysis by the aerodrome operator, incident summary should be made available to LRST.

## 3.8 Adverse Weather

In order to ensure safe operation of aircraft at airports during lower-than-standard visibility CAT I, CAT II and CAT III approaches and during low-visibility take-offs and taxiing, low visibility procedures (LVPs) should apply in the movement area.

LVPs have been devised to allow aircraft to operate safely from and into aerodromes when the weather conditions do not permit normal operations. They should cover comprehensively all relevant issues relating to surface movement other than by aircraft within the designated aircraft manoeuvring area.

On aerodromes where the ground marking and lighting is adequate (i.e., complying with ICAO standards), aircraft ground traffic can often be sustained safely at reasonable flow rates in reduced visibility. However, an aircraft is at its most vulnerable during the landing and the take-off phases of flight, when the option for avoiding action if an obstruction is encountered may be very limited and the aircraft is likely to be badly damaged or destroyed if it collides at high speed with any sizable object. Making the necessary transition to visual reference during the final stage of approach to land in low visibility is critical and certain requirements must be met to reduce the risk of runway excursion.

A low visibility take-off also requires careful attention to correct runway alignment before the take-off is commenced. If a rejected take off (RTO) is carried out, the pilots must maintain awareness of runway length remaining using whatever external visual cues are available and relevant, including runway lighting, signage or other markings available.

As visibility deteriorates, the possibility of runway incursions by aircraft, vehicles and personnel increases. The risk of inadvertent runway incursion by taxiing aircraft is greatest at aerodromes with complex layouts and multiple runway access points. This risk can only be managed adequately by the application of procedures that provide pilots with clear, unambiguous guidance on routing and holding points when performing ground-traffic patterns.

The safe operation of airside vehicles depends upon drivers being adequately trained, thoroughly familiar with the aerodrome layout in all visibility conditions and complying with procedures, signs, signals and ATC instructions. In low-visibility conditions special awareness is required and special procedures, including restrictions on normal access, may be invoked. All these measures are an essential part of the airport operator's SMS.

Aerodromes that wish to continue operating in poor visibility or are available for instrument approaches in weather conditions featuring low cloud ceilings are required to develop and maintain LVPs. Aerodromes that provide precision instrument approaches are required to develop and maintain additional procedures which ensure that suitable measures are in place to protect the signals produced by the ground-based radio navigation equipment.

The point at which LVPs should be implemented will vary from one aerodrome to another, depending on local conditions and the facilities available. The point at which LVPs are to be implemented must be clearly defined and should be related to specific visibility, runway visual range (RVR) or cloud ceiling measurements (e.g. RVR below 600m or cloud ceiling below 200ft). Aerodromes may define higher values for visibility RVR and ceiling than the ICAO standards depending on local circumstances.

Adequate consideration should be given to the time taken to implement fully all of the measures required to protect operations in low-visibility conditions. Provision should also be made to ensure airlines and other organisations with movement area access are given sufficient notice of the introduction of LVPs. This is particularly important where companies exercise control over their own apron areas and maintenance facilities.

## 3.9 Protection of Navigational Aids

This chapter aims to provide procedures to ensure there will be no interference with the operation of air navigational aids located at the aerodrome and outside the aerodrome that may be caused by erection of structures or aerodrome activities within the vicinity of navigation aids or associated aerodrome and ground aid (AGA) systems.

### Responsibilities

The aerodrome operator has overall responsibility for establishing procedures to ensure that activities or work under its direct or indirect control do not have an adverse impact on the safe operation of navigation aids. It is particularly important for the aerodrome operator to have procedures for the protection of sites for radar and radio navigational aids located on or outside the aerodrome, to ensure that their performance is not degraded. Procedures should include arrangements for:

- Control of activities in the vicinity of NAVAID installations;
- Ground maintenance in the vicinity of these installations; and
- The supply and installation of signs warning of hazardous radiation.

The procedures for each NAVAID should be clear and precise and should specify:

- When, or in what circumstances ,an operating procedure is to be activated;
- How an operating procedure is to be activated and which actions are to be taken;
- The persons who are to carry out the actions;
- The equipment necessary for carrying out the actions; and
- That vehicles do not enter the navigation aid restricted areas of the airside or any other adjacent locations without prior ANSP (air navigation service provider) approval. Vehicles crossing near the navigation aids should maintain a speed of not more than 30 km/h in order to avoid signal interference.

### Clearance and location for NAVAIDs

Clearances and locations of radar and other navigational aid facilities associated with the aerodrome must be shown in the aerodrome plan, to ensure that the relevant radar and navigation aids are easily identifiable in order to enable their protection.

### Site requirements

Physical site requirements will vary significantly depending on the type of NAVAID communication. It is not possible to specify a general requirement and so requirements must be on a specific basis.

### Clearance requirements

Reliable VHF/UHF communications require a clear line-of-sight path between the base station and aircraft and vehicles using the facilities. The construction of buildings, towers, etc., may prevent reliable communications, so construction cannot be allowed within a safe distance specified by the equipment manufacturer.

### Satellite ground stations

The site requirement is a square area of dimension 25m by 25m.

## 3.10 AIS/AIP

Aeronautical information is constantly changing. Changes in navigation aids, along with runway and taxiway information changes, must be notified to the Aeronautical Information Service (AIS). This aeronautical information is provided in the form of the Integrated Aeronautical Package, which consists of the following elements:

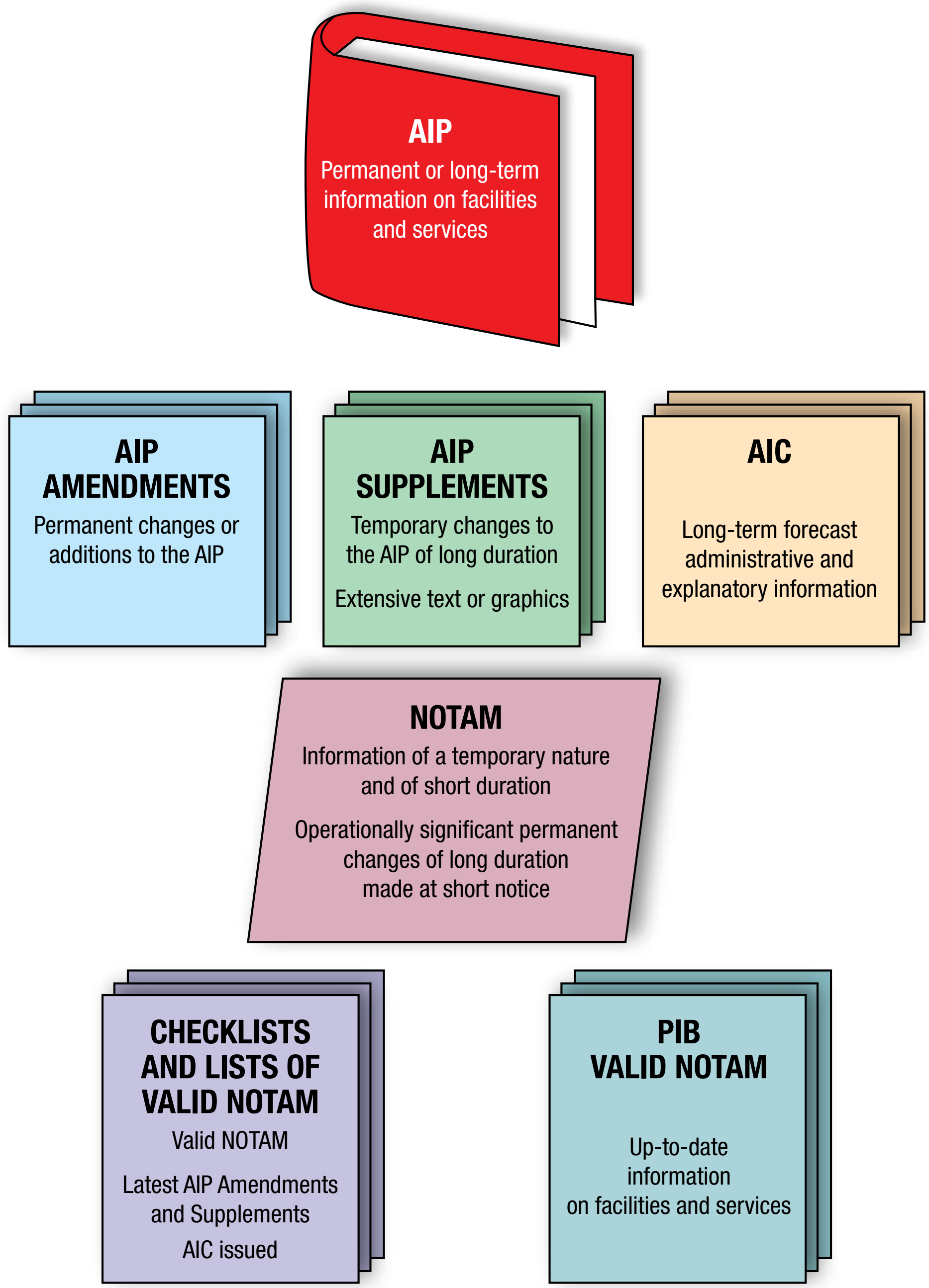
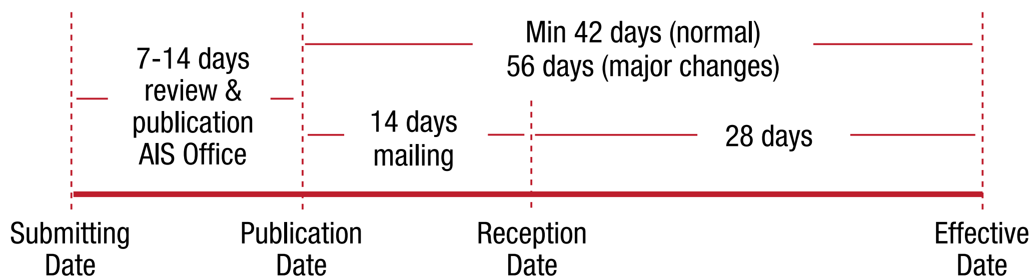



**Figure 18.** Aeronautical Information Service hierarchy

### 3.10.1 AIRAC

For safety and efficiency, it is essential, that pilots, air traffic controllers, air traffic flow managers, flight management systems and aviation charts all have the same data set. This can only be achieved by following the Aeronautical Information Regulation And Control (AIRAC) cycle.

In short, **AIRAC** defines that in all instances, information provided under the AIRAC system shall be published in paper copy form and shall be distributed by the AIS unit at least 42 days in advance of the effective date, with the objective of reaching recipients at least 28 days in advance of the effective date. Whenever major changes are planned and where additional notice is desirable and practicable, a publication date of at least 56 days in advance of the effective date should be used. The two weeks between the Publication Date and Reception Date are basically to allow for postal distribution of the (mostly) paper publications.




| | |
|---|---|
| Effective Date | Date at which changes take effect |
| Publication Date | Date at which the AIS organization sends out the information.<br>▸ Should be at least 42 days (56 for major changes) before effective date. |
| Reception Date | Date at which the user should receive the publications.<br>▸ Should be at 28 days before the effective date. |

The **AIRAC cycle** was adopted in 1964 and has effective dates with 28-day intervals as below:

| # | 2014 | 2015 | 2016* | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|
| 01 | 9 Jan | 8 Jan | 7 Jan | 5 Jan | 4 Jan | 3 Jan |
| 02 | 6 Feb | 5 Feb | 4 Feb | 2 Feb | 1 Feb | 31 Jan |
| 03 | 6 Mar | 5 Mar | 3 Mar | 2 Mar | 1 Mar | 28 Feb |
| 04 | 3 Apr | 2 Apr | 31 Mar | 30 Mar | 29 Mar | 28 Mar |
| 05 | 1 May | 30 Apr | 28 Apr | 27 Apr | 26 Apr | 25 Apr |
| 06 | 29 May | 28 May | 26 May | 25 May | 24 May | 23 May |
| 07 | 26 Jun | 25 Jun | 23 Jun | 22 Jun | 21 Jun | 20 Jun |
| 08 | 24 Jul | 23 Jul | 21 Jul | 20 Jul | 19 Jul | 18 Jul |
| 09 | 21 Aug | 20 Aug | 18 Aug | 17 Aug | 16 Aug | 15 Aug |
| 10 | 18 Sep | 17 Sep | 15 Sep | 14 Sep | 13 Sep | 12 Sep |
| 11 | 16 Oct | 15 Oct | 13 Oct | 12 Oct | 11 Oct | 10 Oct |
| 12 | 13 Nov | 12 Nov | 10 Nov | 9 Nov | 8 Nov | 7 Nov |
| 13 | 11 Dec | 10 Dec | 8 Dec | 7 Dec | 6 Dec | 5 Dec |

### 3.10.2 Aeronautical Charts

An **aeronautical chart** is a map designed to assist in the navigation of aircraft. It is published in a relevant part of the AIP. Aeronautical charts include:

- Aerodrome chart;
- Aircraft Parking/Docking Chart;
- Aerodrome Ground Movement Chart;
- Aerodrome Obstacle Chart — ICAO Type A;
- Aerodrome Terrain and Obstacle Chart — ICAO Type B;
- Precision Approach Terrain Chart;
- Area Chart;
- ATC Surveillance Minimum Altitude Chart;
- Visual Approach Chart;
- Precision Approach Terrain Chart;
- Standard Arrival Chart — Instrument (STAR);
- Standard Departure Chart — Instrument (SID);
- Instrument Approach Chart; and
- Bird Concentration Chart.

Detailed information on aeronautical charts can be found in ICAO Annex 4 'Aeronautical Charts' and Doc 8697 'Aeronautical Chart Manual'.

### 3.10.3 Hot Spots Depiction in Aerodrome Chart

Aerodrome operators should generate AIP charts to show runway hotspots. Once issued, these charts must be kept up to date and revised as necessary. All identified hot spots should be examined for short or long term opportunities for mitigation of or removal of the hazard identified. These actions include:

- Awareness campaigns;
- Enhanced visual aids (signs, markings and lights);
- Use of alternative routings;
- Changes to the movement area infrastructure, such as construction of new taxiways, and decommissioning of taxiways; and
- Closed-circuit television (CCTV) for mitigating blind spots in the aerodrome control tower.

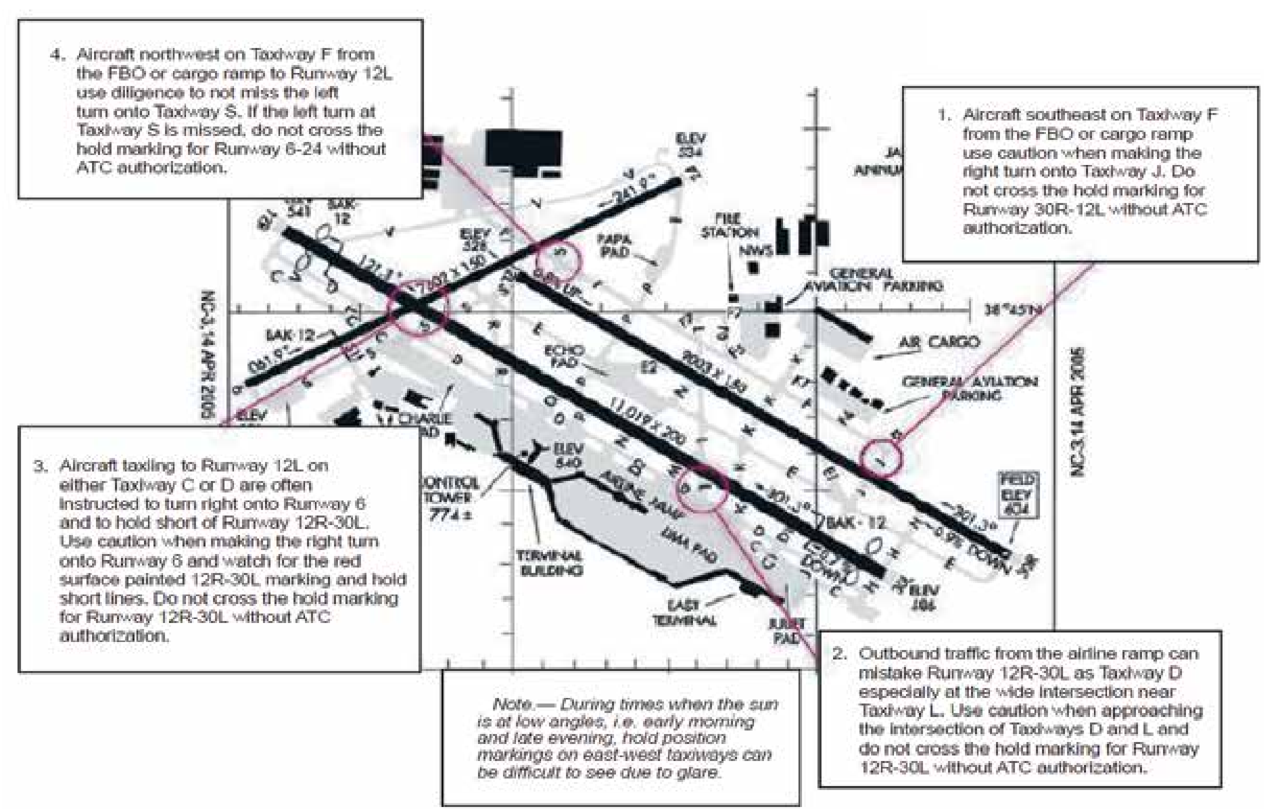



**Figure 19.** Example of depiction of hot spot in aerodrome chart

# 4 Maintenance, Temporary Restrictions and Construction

Maintenance, temporary restrictions and construction on and around runways and taxiways present significant hazards to aircraft operations. Many serious acci-dents involving these hazards have occurred throughout the world. This chapter provides pro-active activities to help prevent or mitigate accidents or incidents arising from these hazards.

## 4.1 Maintenance for Runway Safety

### 4.1.1 Maintenance – General

The **required level of safety** can only be achieved by proper maintenance of all the elements composing a runway. Maintenance includes measures to keep or restore the runway's operational function as well as measures to check and to evaluate the present function of a runway element. The basic components of maintenance are:

- **Inspection**, which 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 type of check involved, 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;
- **Servicing and overhaul**, which comprise all measures to maintain or return a facility or device to its required operating condition. These measures should be carried out according to a plan specifying the time for the service, the nature of the service and the report of compliance; and
- **Repair**: Whenever inspection or servicing discovers deficiencies, repair measures have to be planned and carried out as soon as practicable. Repair can comprise minor work or major work such as runway surface treatment with consequential traffic interruption.

Efficiency and safety of operation can only be expected from facilities that are in good operational condition. The maintenance of facilities, described above, is a necessary prerequisite to such a condition. Furthermore, maintenance minimises wear and tear, and so controls and extends considerably the life span of technical components.

### 4.1.2 Surface Condition

The surface of a runway should be maintained in a condition that precludes harmful irregularities or release of any fragment that would be a hazard to aircraft operation. Particular attention should be paid to the paved surfaces and pavement edges:

- Pavement lips - the area between full-strength pavement, and shoulders and safety areas.(e.g. FAA part 139, Pavement lips shall not exceed 7.5cm);
- Determine if there are any cracks wide enough to cause directional control problem for an aircraft;
- Determine if there are any holes that could cause directional control problems for an aircraft. (e.g. FAA part 139, A hole is considered to be a safety risk if it exceeds 12.5cm diameter and exceed 7.5cm depth and its sides exceed a slope of 45 degree);
- The surface should be kept clean of mud and any other foreign debris. It should also be kept free of solvents or other liquids that may be used to clean the surface or which are accidentally spilled on the movement area; and
- No water ponding or ice sheeting should be allowed that may obscure markings or impair aircraft control.

Should any of the above conditions or any other unsatisfactory conditions exist, the Airport Operations department should initiate prompt action to make the needed repairs. When a maintenance action is delayed, a responsible department should request a NOTAM from the Flight Information Office. Detailed information about NOTAMs can be found in Chapter 3.

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 contaminants off the surface to major repair. From experience, the following three surface friction-enhancing techniques are recommended:

- Surface dressing;
- Grooving; and
- Scoring or milling.

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, major corrective action, such as the construction of an overlay, may become necessary.

As the accompanying diagram illustrates, the rate of deterioration of the pavement sharply increases at a certain point in time, resulting in an accelerated decline in pavement condition. This pavement life-cycle curve demonstrates that $1 spent for preventative maintenance early in the pavement's life is equivalent to $4 to $5 spent later in its life. A life cycle cost (LCC) maintenance program should be considered when planning surface condition maintenance.

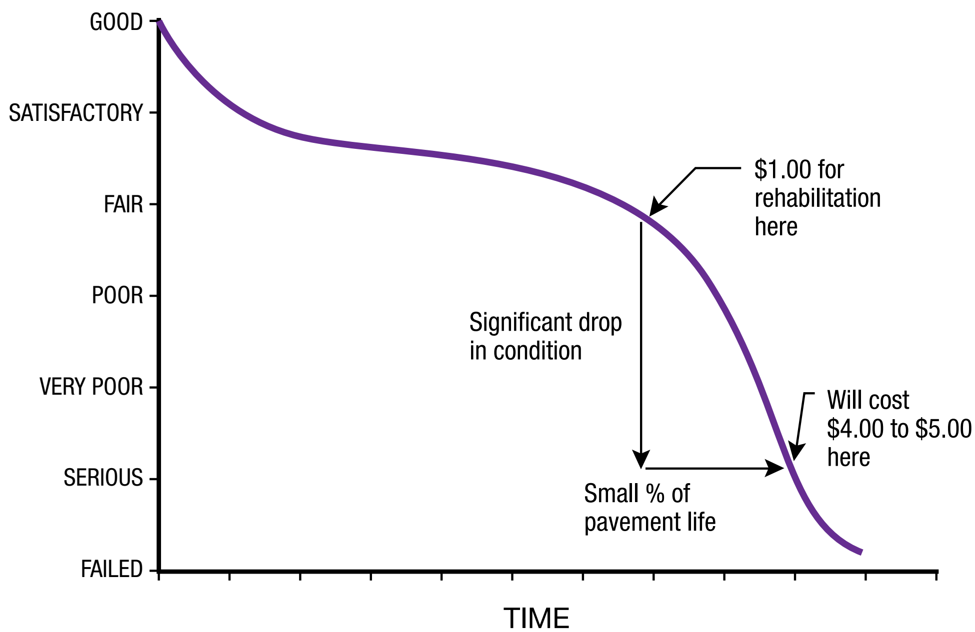



**Figure 20.** Typical Pavement Life Cycle Curve

## 4.1.3 Visual Aids and Non-Visual Aids

Performing maintenance on several kinds of visual aids and NAVAIDs requires workers to traverse the active manoeuvring area, so all workers must have full knowledge of air traffic control and radio communication procedures. Workers should be fully familiar with the airport runway and taxiway layout to avoid any possibility of runway incursions. All air traffic control instructions should be read back to the controller and if the worker has any question regarding the instructions of the controller, the worker should ask the controller to repeat the message. All vehicles operated within the aircraft operations area should be properly marked and lit.

**Preventive Maintenance Program:** Reliable functioning of visual aids and NAVAIDs is critical to airport safety, capacity, and operation, especially for low visibility operations. So it is essential that a preventive maintenance program is established to ensure reliable service and proper equipment operation. Each visual aid should have an established PMI (Preventive Maintenance Inspection) schedule, such as:

| Maintenance Requirement | DAILY | WKLY | MTHLY | QTRLY | SMANY | ANNLY | UNSCH |
|---|---|---|---|---|---|---|---|
| Check lamps for operation. | X | | | | | | |
| Check operation of controls. | | | X | | | | |
| Check for damage by service vehicles or aircraft. | | | X | | | | |
| Clean lamps and filters. | | | X | | | | |
| Check mechanical parts for damage. | | | X | | | | |
| Check lightning arresters. | | | X | | | | |
| Check for water damage or insect infestation. | | | X | | | | |
| Check for presence of rodents. | | | X | | | | |
| Record output current and input voltage of adapter (if used). | | | X | | | | |
| Check alignment and aiming of light boxes. | | | X | | | | |
| Check levelling and operation of tilt switch. | | | X | | | | |
| Check integrity of obstacle-free approach plane. | | | | X | | | |
| Check insulation resistance of underground cables. | | | | | X | | |
| Check resistance of grounding system. | | | | | X | | |

**Table 2.** Example of PMI for PAPI

**Runway lighting minimum serviceable rates:** The aerodrome operator should maintain minimum serviceable rates complying with operational conditions, for instance:

| Facility description | Maintenance standards (CAT II / III) |
|---|---|
| Runway centreline lights, Runway edge lights, Runway threshold lights, Approach lighting systems (up to 450m in length) | 95% |
| Runway touchdown zone lights | 90% |
| Approach lighting systems (when exceeding 450m in length) | 85% |
| Runway end lights | 75% |
| Runway centreline lights, Runway edge lights, Runway threshold lights, Approach lighting systems, Runway touchdown zone lights, Runway end lights, Stop bar lights, Taxiway centreline lights | Two consecutive faulty lights are not allowed (installation interval defined by Airport Operations Standards and Standards for Aeronautical Lighting) |

**Table 3.** Runway lighting minimum serviceable rates

**Maintenance of markings:** The aerodrome operator should establish a repainting plan for markings in the paved area. To facilitate prompt dispatch for repainting, full sets of tools and paints of appropriate colors should be provided at all times at on-site work control centres. The repainting schedule depends on the status of the change or fading in color of the markings.

### 4.1.4 Removal of Contaminants

Paved surfaces on runways can be contaminated by snow, slush, ice, standing water, mud, dust, sand, oil, marking paint or rubber, etc. Contaminants may cause slipperiness and may cover surface markings. In addition to reducing surface friction, foreign materials and objects may cause damage to aircraft fuselages or engines, or hazardously affect the operation of aircraft systems. They should be removed immediately when they are found.

**Rubber Removal:** The aim of rubber removal is to restore the original macro roughness of the pavement surface. Such restoration is important to provide good drainage under the wheel in wet conditions. If possible, the removal should take place during off-peak hours. Several different methods are available:

- High Pressure Water Blast Method: Rubber removal is accomplished by high pressure water jets directed at oblique angles to the pavement surface;
- Mechanical Blasting Method (Grit Blasting): Replacing high pressure water with solid material such as metal spheres or peach stones;
- Chemical Method: The area of pavement to be treated is sprayed with a liquid chemical from a tank vehicle having a spray bar, or by hand with hose and nozzle. The chemical's reaction time ranges from 8 to 15 minutes, depending on the depth of the rubber film. Due to the chemical agents' volatility and toxicity, it is imperative that extreme care is exercised when employing them. If the chemical remains on the surface for too long, painted markings or even the surface itself may be damaged. Also, the influence of the chemical solvent on the drainage system, the surrounding vegetation, the wildlife and nearby streams must be considered;
- Chemical and High Pressure Water Blasting Method: A combination of dissolving the rubber deposit with chemical agents followed by a through flushing with high-pressure water is considered a more modern practice; and
- Hot Compressed Air Method: Using hot air to burn away the rubber deposits may have the advantage of reducing the mechanical strain imposed on the runway. Residual carbon deposits may be removed with a brush-machine.

It is recommended, based on the number of landings on the runway, that the annual plan for removal of rubber deposits should be established in advance at the beginning of the year.

**Removal of Snow and Ice:** Snow clearing should start as soon as possible after the beginning of a snowfall, since vehicles can work very fast as long as the snow cover is still thin. When the wind is calm or in the absence of strong side winds, snow removal is performed strip-wise from the center to the edge of the paved surface. With strong side winds the removal starts from the windward side of the surface and moves to the lee side.

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

- Climatic conditions;
- The extent of the area which has to be cleared, and
- Time needed for clearing.

It is recommended, if necessary, that a **snow plan** should be established before the beginning of the winter season and a **snow removal control office** should be operated during the winter season. The snow plan contains information on:

- Responsibilities for winter services;
- Rules on air traffic interruptions for snow and ice removal operations;
- Rules on communication and information on the performance of winter services;
- Priorities for snow and ice clearing of aircraft movement areas;
- Availability of vehicles and equipment for snow and ice removal;
- Performance of winter service; and
- Method of friction measurement on aircraft movement areas.

### 4.1.5 Drainage

Drainage facilities should be managed to facilitate water run-off during the rainy season, to maintain sufficient bearing strength in the soil for the operation of vehicles or aircraft, and to minimize the attraction of birds and other animals representing a potential hazard to aircraft by:

- Removing accumulated earth and sand; and
- Preventing aquatic weeds from growing.

All waterways should be checked and dredged, if necessary, before a rainy season begins.

### 4.1.6 Vegetation Control

It is essential to control vegetation adjacent to the runway area for the following reasons:

- To ensure continued obstacle clearance with regard to the protection surfaces;
- To ensure that all visual and navigational aids are clearly visible and can operate within the predetermined limits; and
- To ensure that vegetation does not attract birds.

When mowing grass, the height of grass should be kept lower than about 15cm within the boundary of the runway strip, and should not exceed about 25cm in any other area. However, other standards may be applicable based on scientific study such as bio-environmental research. It may help to choose types of grass or other plants which are not edible to the local bird population. Further details can be found in the ACI Wildlife Hazard Management Handbook 2nd Edition (2013).

Any mowing or cutting work within the runway safety area or close to the protection surfaces should be carried out when the runway is not in use. Mowed or cut grass should be removed from the movement area promptly so as not to provoke foreign object damage.

## 4.2 Temporary Restriction

### 4.2.1 Declared Distances

Declared distances are the operational distances notified to flight crews and indicate safe distances appropriate to the proposed take-off or landing runway and so the crews are able to abort safely a take-off run from that runway. Declared distances allow flight crew to determine aircraft loading and performance.

A runway complying with ICAO SARPs is suitable for take-off and/or landing for international commercial air transport and should be declared in distances useable for that purpose. For take-off runways, the following distances must be calculated, communicated and preferably displayed by means of information signs:

- Take-Off Run Available (TORA);
- Take-Off Distance Available (TODA);
- Accelerate-Stop Distance Available (ASDA); and
- For runways used for landing, the Landing Distance Available (LDA) is applicable.

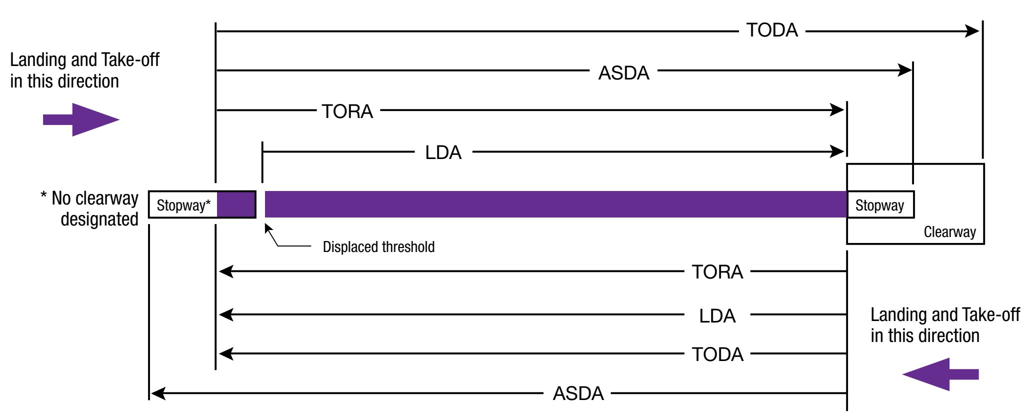



**Figure 21.** Diagram of Declared Distances

For take-off runway scenarios, the following possibilities exist:

- If the runway is provided with a stopway, the ASDA includes the length of the stopway;
- If the runway is provided with a clearway, the TODA will include the length of the clearway;
- If the runway is not provided with either a stopway or a clearway and the threshold of the runway is defined as being on the extreme end of the runway planes, all four declared distances should equal the total length of the runway; and
- For the landing runway, where a displaced threshold is in place, the Landing Distance Available will be the total runway length reduced by the distance of the displacement.

When planned airside maintenance or construction work is taking place or when other circumstances would have an influence on the total length of the available runway surface, the declared distances need to be recalculated.

For calculation of the declared distances focusing on the take-off process, the following parameters need to be identified and considered during the recalculation in respect of the remaining runway length available and the presence of obstacles:

- Take-off climb surface;
- Runway strip;
- Runway end safety area; and
- Runway end (this might be a newly defined temporary runway end).

As a result of the recalculation, the declared TORA, TODA and ASDA may be subject to change. Changed (temporary) declared distances or temporary reduced declared distances need to be communicated well in advance to aircraft operators and by all means possible, but at the very least in compliance with ICAO Annex 15 'Aeronautical Information Services'.

**RKSI AD 2.13 DECLARED DISTANCE**

| RWY Designator | TORA (M) | TODA (M) | ASDA (M) | LDA (M) | Remarks |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| **15R** | **3 750** | **4 050** | **3 870** | **3 750** | |
| TWY K* | 3 000 | 3 300 | 3 120 | - | |
| TWY B5** | 2 250 | 2 550 | 2 370 | - | |
| TWY B6* | 2 550 | 2 850 | 2 670 | - | |
| **33L** | **3 750** | **4 050** | **3 870** | **3 750** | |
| TWY J* | 3 000 | 3 300 | 3 120 | - | |
| TWY B2* | 2 550 | 2 850 | 2 670 | - | |
| TWY B3** | 2 250 | 2 550 | 2 370 | - | |

**Table 4.** Example of AIP AD 2.13 Declared Distance

For calculation of the declared distances focusing on the landing-process, the remaining landing distances available need to be recalculated taking into account the following parameters:

- Obstacles that may be present in the approach and transitional surfaces, which include the Obstacle Free Zone, which consists of the inner approach, inner transitional and balked-landing surfaces;
- Obstacles in the approach surface that require the threshold to be displaced; and
- Although landing lengths are less critical, aircraft performance charts should be consulted to check that runway length requirements for take-

off provide adequate runway length for landing. A landing length is determined that provides for an aircraft to clear all obstacles in the approach path by a safe margin and to make it possible for an aircraft to stop safely.

If declared take-off-related distances are reduced, aerodrome operators should consider if intersection take-offs are still feasible and safe. When such take-offs are considered safe and operationally feasible for aircraft operators, aerodrome operators are recommended temporarily to install TORA signage indicating the reduced available take-off run available to aircraft operators. Aerodrome operators may consult carriers' performance calculations to cross-check the performances of those aircraft types which the runway will serve.

### 4.2.2 Displaced Threshold

A threshold is normally located at the beginning of a runway, if there are no obstacles penetrating above the approach surface or other applicable obstacle limitation surfaces. Because of temporary changes, for instance due to maintenance or construction works, it may be desirable to displace the threshold temporarily or even permanently. When studying the location of thresholds at precision approach instrument runways, consideration should be given to the ILS reference height data and the determination of the obstacle clearance limits.

In determining that no obstacle penetrates above the approach surface, account should be taken of mobile objects at least within that portion of the approach area within 1200m longitudinally from the threshold and of an overall width of not less than 150m, 75m each side of the runway centreline.

During scheduled temporary maintenance or construction works, consideration should be given to displacing the threshold to prevent equipment or other obstacles from penetrating the obstacle limitation surfaces and the approach surface. If the objects cannot be removed, the threshold should be relocated permanently. The threshold should ideally be displaced down the runway for the distance necessary to ensure that the approach surface is clear of obstacles.

Displacement of the threshold will inevitably have an influence on the landing distance available and this may be of greater operational significance than penetration of the approach surface by marked and lighted obstacles. Any decision to displace a threshold should therefore consider an optimal balance between the considerations of clear approach surfaces and adequate landing distance available.

Account should be taken of the types of aircraft which the runway is intended to serve; the limiting visibility and cloud base conditions under which the runway will be used; the position of obstacles in relation to the threshold and extended centreline; and, specifically in the case of precision approach runways, the significance of obstacles to the determination of obstacle clearance limitations.

An obstacle-free surface to the threshold should not be steeper than 3.3 per cent where the code number is 4, or steeper than 5 per cent where the code number is 3.

### 4.2.3 Dissemination of Information

When aerodrome maintenance or construction works would temporarily affect runway parameters, declared distances, obstacle limitation surfaces, approach and take-off climb surface or NAVAID protected sensitive and critical areas, the aerodrome operator needs to disseminate all amended information by as many means as practicably possible and available. In preparing the works it is important to discuss the possible impact on runway availability, declared distances, temporary fixed and mobile objects, availability of NAVAIDs and taxiway routing to and from runways.

Aerodrome operators should discuss proposed airside works with the Local Runway Safety Team (see chapter 1) These meetings may review work schedules, the impact of works on aircraft and ground servicing operations, the outcome of hazard identification and risk assessments, and change cases. This is all information which needs to be amended and disseminated. Terms of reference for this kind of platform may include:

- Legal basis and scope;
- Goal:
  - Have all aerodrome operations and safety stakeholders, infrastructural services and pro-

ject managers and aeronautical service providers work together to establish:

- ✓ High level coordination between works and between works and aircraft and ground operations;
- ✓ Evaluation of work schedules;
- ✓ Evaluation of hazard identification and risk assessments including adaptation of mitigating measures;
- ✓ Dissemination to all impacted or affected parties of information relating to temporary construction and maintenance works with an impact on aircraft operations and ground servicing activities; and
- ✓ Dissemination of information related to permanent changes to aerodrome infrastructure and operations;

- Tasks:
  - Collect all intended changes or planned changes to infrastructure and operations;
  - Discuss the impact of temporary changes or changes with a permanent character and accompanying construction phases on:
    - ✓ Aircraft operations;
    - ✓ Air traffic control services and NAVAIDs;
    - ✓ Ground servicing processes;
    - ✓ Emergency response;
    - ✓ Adverse weather operations;
    - ✓ Wildlife management;
    - ✓ Inspection and control of the aerodrome; and
    - ✓ Runway conditions including friction and obstacles;
  - Prepare, evaluate and validate information and data related to the works and permanent changes, as required per ICAO Annex 15, by means of:
    - ✓ Aeronautical Information Publication (AIP) amendment;
    - ✓ Aeronautical Information Publication (AIP) supplement;
    - ✓ Aeronautical information regulation and control (AIRAC);
    - ✓ Notice to airmen (NOTAM);
    - ✓ Pre- and post-flight preparation information/data;
    - ✓ Automatic terminal information service (ATIS) – D-ATIS and or Voice-ATIS; and
    - ✓ Aeronautical charts, including aerodrome base maps and terrain and obstacle charts.

Temporary changes to infrastructure, procedures and equipment or changes having a permanent effect on operations and safety may be communicated to the airport community via airport safety information bulletins, safety campaigns, Local Runway Safety Teams, apron operations and safety meetings, or any other relevant meeting platforms.

### 4.2.4 Reduced RFF

When, because of reduced Rescue Fire Fighting (RFF) capacity at the airport, the operator cannot support the declared ICAO RFF category, appropriate measures need to be taken to reduce the capacity of that aerodrome. Aircraft operators need to be informed of the temporary reduced RFF category by means of NOTAM. When the reduced RFF category would last longer or become permanent, an AIP supplement or amendment must be published.

When there would be a potential conflict in relation to emergency response times of the airport RFF because of construction or maintenance works, alternative routings for RFF need to be studied; or, at least, clearly communicated drive-through action needs to be foreseen. It is recommended that emergency response time tests simulating the works be performed before final decisions on the work planning and schedules are taken. If drive-through routes would not be feasible, airport operators might consider temporarily installing sufficient RFF capacity at a satellite position, to be able to cover the affected movement or runway area.

### 4.2.5 Temporary Obstacles

A temporary obstacle, e.g. a crane in the take-off climb or approach or transitional area, is an obstacle that will be removed within a defined timeframe. It should also be considered as a temporary hazard. The term “temporary hazard” also refers to work in progress at the sides or ends of a runway related to airport construction or maintenance works. It may include, e.g., the construction site, cranes, machinery and equipment, building materials, vehicles or even immobilized aircraft near runways.

The effect of a temporary obstacle on aerodrome operational safety and the possible need for additional obstacle marking and lighting should be assessed by the competent authority. In determining the degree of hazard and the extent of any tolerable obstacle, the following factors should be taken into account:

- Runway width;
- Types of aircraft using the runway and distribution of traffic;
- Alternative runways;
- Crosswind components or any other prevailing wind information, such as seasonal wind variations;
- Prevailing weather conditions such as precipitation and visibility when significant, as these adversely affect the braking action of aircraft; and
- The possibility of compromise between a reduction in declared distances and some degree of approach surface infringement.

All information about such temporary obstacles and hazards to safe aircraft operations should be disseminated by means that are available, as described in ICAO Annex 15 (e.g. NOTAM and/or AIP SUPP), and marked and lighted in accordance with ICAO Annex 14. When unforeseeable circumstances would require, pilots must be informed by all means available and ATC must notify aircrew about the position of the hazard and the nature of it.

When restrictions would be required due to the nature and the position of the hazard, distinction has to be made regarding the type of runway which is affected. More specific guidance for restrictions applicable to non-instrument, non-precision approach and precision approach runways is available in ICAO Doc 9173 Aerodrome Services Manual Part 6 – Control of Obstacles.

### 4.2.6 ILS

Aerodrome operators should, together with their ANSPs, thoroughly investigate the impact of obstacles and fixed or mobile objects on adequate functioning of the ILS equipment. When investigation proves there is an impact on correct readings of the ILS equipment, aerodrome operators may degrade the ILS category accordingly. When circumstances such as (for example) adverse weather conditions or reduced visibility operations would require higher-level category precision approach guidance it is possible to introduce a "prior permission required – PPR" in order to clear the affected sensitive areas of obstacles and objects and upgrade the category of the ILS for that runway. Aerodrome operators need to consider the period of time in which runway construction and maintenance works may take place, in respect of ILS equipment functionalities and the required runway capacity for that period of time.

### 4.2.7 Runway Closure

When the outcome of hazard identification and risk assessments or aeronautical safety cases would be unsatisfactory and when residual risk cannot be mitigated effectively, runway closure during a defined period of time could be taken into consideration.

When closing a runway, relevant information needs to be provided to all aerodrome stakeholders via appropriate channels: NOTAM, AIP and AMDT of AIP SUPP when applicable.

Closing a runway does not automatically imply an end to the risk of hazards and risks for runway incursions and excursions on that runway. Aircraft operators may still accidentally take off from a closed runway or land on it when insufficient preventive measures are applied or when disseminated information in relation to the closure of the runway is incorrect, inconsistent or even unavailable. To avoid aircraft landing on or taking off from a closed runway, the following mitigating measures could be considered in addition to dissemination of information (discussion about which can be found in Chapter 3.2 and Chapter 4.2.3):

- During closure of a runway as a consequence of construction or maintenance works, information about the closure and the temporary work areas should be adequately disseminated and temporary signs and markings should be clearly visible, adequate and unambiguous in all operating conditions, in compliance with Annex 14 provisions;

- When practicable, entry taxiways to the closed runway should be physically closed by means of unambiguous, clearly visible, marked and lighted fencing, to prevent aircraft operators and vehicle drivers from taking a wrong entry to a closed runway;
- NAVAIDs in relation to the closed runway should be disabled to prevent aircraft from landing on the closed runway by wrongly or accidentally intercepting directional guidance;
- All obstacles, mobile or fixed, which may be present on the closed runway should be clearly marked and lighted; and
- Safety information bulletins should be disseminated to aircraft operators by all means available, e.g. via Operational Control Centres, airport safety websites, aircraft operators' safety meetings, Local Runway Safety Teams, Apron Safety Committees, posters and awareness campaigns (as well as other channels: this is a non-inclusive list).

## 4.3 Construction Safety

### 4.3.1 Planning Construction

Careful planning, scheduling, and coordination of construction activities can minimize disruption of normal aircraft operations and avoid situations that compromise the airport's operational safety. The airport operator must understand how construction activities and aircraft operations affect one another to be able to develop an effective plan to complete the project. The aerodrome operator should develop a **Construction Safety Plan (CSP)** that integrates and consolidates all of the planning efforts for the construction. Development of the CSP involves the following five steps:

- Identify the affected area. The aerodrome operator should determine the geographic areas on the airport affected by the construction project;
- Describe current operations. Identify the normal airport operations in each affected area for each phase of the project;
- Allow for temporary changes to operations. To the extent practical, current airport operations should be maintained during the construction. When the construction activities cannot be adjusted to safely maintain current operations, regardless of their importance, then the operations should be revised accordingly;
- Take required measures to revise operations. Once the level and type of aircraft operations to be maintained are identified, the aerodrome operator should determine the measures required to conduct the planned operations safely during the construction and
- Manage the safety risk. The aerodrome operator should coordinate the safety-risk management activities with appropriate stakeholders to the construction.

**Construction Safety Plan Requirements** should be included in the plan. These include:

- Coordination: Detail the proposed safety meetings between airport operator and contractor;
- Phasing: Construction schedule elements, including:
  - ✓ The duration of each phase;
  - ✓ Times of daily start and finish of construction, including 'night only' construction;
- The area and operations affected by the construction activity;
- Protection of NAVAIDs;
- Contractor access: Provide the following:
  - ✓ Details on how the contractor will maintain the integrity of the airport security fence (gate guards, daily log of construction personnel, and other measures);
  - ✓ Listing of individuals requiring driver training;
  - ✓ Details on how the contractor will escort material delivery vehicles;
- Radio communications:
  - ✓ Types of radios and backup capabilities used;
  - ✓ Who will be monitoring radio;
  - ✓ Who to contact if the ATC cannot reach the contractor's designated person by radio;
- Wildlife management. Provide the following:
  - ✓ Methods and procedures to prevent attracting wildlife;
  - ✓ Wildlife reporting procedures;
- Foreign Object Debris (FOD) management. Provide equipment and methods for control of FOD, including construction debris and dust;
- Hazardous material management. Provide equipment and methods for responding to hazardous spills;

- Notification of construction activities. Provide the following:
  - ✓ Contractor points of contact;
  - ✓ Contractor emergency contact;
  - ✓ Listing of tall or other requested equipment proposed for use on the airport and the timeframe and batch plant details;
- Inspection requirements. Daily (or more frequent) inspections and special inspection procedures;
- Underground utilities. Detail proposed methods of identifying and protecting underground utilities;
- Penalties. Penalties should be identified in the CSP;
- Special conditions. Detail proposed actions for each special condition identified in the CSP;
- Runway and taxiway visual aids, including marking, lighting, signs, and visual NAVAIDs. Detail proposed visual aids, including the following:
  - ✓ Equipment and methods for covering signage and airfield lights;
  - ✓ Equipment and methods for temporary closure markings (paint, fabric, other);
- Marking and signs for access routes. Detail proposed methods of demarcating access routes for vehicle drivers;
- Hazard marking and lighting. Detail proposed equipment and methods for identifying excavation areas; and
- Protection of runway and taxiway safety areas, including object free areas, obstacle free zones, and approach/departure surfaces. Discuss proposed methods of identifying, demarcating, and protecting airport surfaces, including:
  - ✓ Equipment and methods for maintaining Taxiway Safety Area standards; and
  - ✓ Equipment and methods for separation of construction operations from aircraft operations, including details of barricades.

**Dissemination of information:** Aerodrome operators should publish AIP AMDT/SUPP or issue a NOTAM. Detailed information can be found in Chapter 3.10.2 and Annex E.

### 4.3.2 Preventive Activities for Construction Area (Restricted Area)

As far as is practicable, working areas should be blocked off from the active movement areas by physical barriers. These barriers serve to warn pilots and to preclude work vehicles inadvertently straying on to each other's active movement areas. The barriers should be marked for day use and adequately lit for night use. The lighting on movement areas (such as taxiways, for instance) leading into working areas should be turned off during the work period. Multiple temporary gates with guards and flaggers should be prepared.

Lighting, markings and signs give pilots information on position at the aerodrome, directional information for taxiing to and from a runway and holding, the position of the threshold, declared distances, runway identification and designation and hazardous or NAVAID sensitive and critical areas. Maintenance or construction works should ensure integrity and perfect legibility of the information provided by the signs. Any change to runway lighting, taxiway system lighting, markings and signs should at a minimum comply with ICAO Annex 14 regulations and any change or deviation should be studied by means of hazard identification and risk assessment prior to the change or construction works. Take these relevant actions:

- Terminate or shut off electrical power to lightings leading to the construction site;
- Uninstall lightings leading to and in the construction site, or cover or mask with duct tape;
- Reconnect lighting circuits to maintain aircraft operations;
- Remove paint markings and uninstall or cover signs leading to the construction site;
- Install new markings and signs for prevention of incursion to the construction site; and
- Deactivate related NAVAIDs.

A checklist indicating what lighting, markings and signs are required and implemented on what areas of the aerodrome should be made available. Before bringing affected surfaces or infrastructure back into operation, a thorough inspection should be made to check the compliancy, consistency and operational ability of each lighting system, marking and sign.

At all times, specific attention and extreme care should be given when changing lighting, markings and signs for the purpose of prevention of runway incursions or excursions. Consistent and accurate information for aircraft operators and vehicle drivers is of primary importance in establishing and maintaining situational awareness.

### 4.3.3 Protection of Construction Area

It is most important that all personnel engaged in aerodrome works are made aware of, and be required to observe, the safety procedures under which the aerodrome works are conducted. A good way to ensure this is to include a safety highlight message in the briefing at the commencement of each day's work.

Access routes to and from the worksite should be carefully planned and signposted. Where vehicles are used to move excavated or backfill material, the loading and condition of the vehicles need to be checked to avoid any spillage. Where vehicles are allowed to travel on or across taxiways or runways, dedicated clean-up resources need to be made available to remove any spilled material from the pavement and adjacent areas. Additionally, vehicles should be cleaned before leaving the construction area when crossing taxiways.

If there are aircraft operations at night, the lights from vehicles engaged in night work must not cause confusion to pilots. Vehicle light fittings should be checked to ensure that the lights are not directed upwards unduly. Drivers must be told that, as a matter of course, high beam is not to be used. It is recommended to provide all drivers with a map and scenario in case of breakdown and a contact number to call when in need of assistance or when lost.

The parking and storage areas of vehicles, equipment and construction materials should be carefully chosen and identified to avoid infringement of the runway or taxiway strip or any of the OLS surfaces.

Excavation work along the runway or taxiway strips should be carefully planned, as the area needs to be restored before the next aircraft operation. There should be a contingency plan to cover equipment breakdown, rain stoppage and other occurrences which may disrupt the work.

Construction area protection planning and measures should include:

- Regular safety inspections;
- Coordination of fence changes and aircraft access with ATC;
- Escort by a qualified vehicle operator;
- Dedicated personnel for FOD; and
- In addition to FOD mitigation and removal measures, mitigation of dust/sand/earth which could be carried over to aircraft during construction works. Possible mitigations should be to keep an area wet or to cover the trucks when transporting earth or sand.

### 4.3.4 Closing Construction and Reopening Runway

Before reopening an area on the aircraft movement area that was affected by maintenance or construction works, the competent authority has to check the as-built situation against the aerodrome works plan and schedules and check that the area complies with all regulatory provisions.

The work area should be cleared of personnel, vehicles and related construction-site fencing in a safe and timely manner, to ensure the aerodrome is restored to full operational status.

The works-affected area is inspected for serviceability in accordance with workplace procedures and aircraft operating requirements. It is recommended that works-affected areas be reopened in daylight if possible, as any deficiencies left behind are much easier to find during daylight.

The aerodrome overall is inspected for serviceability in accordance with workplace procedures, standard operating procedures and aircraft operations requirements. All involved authorities and organisations have to be notified in accordance with workplace procedures, using suitable means of communication compliant with the provisions stated in ICAO Annex 15.

Relevant aeronautical charts, the aerodrome operations manual, standard operating procedures, aeronautical information publications and NOTAMs need to be amended and show accuracy and consistency with the newly constructed situation or amended layout of the aircraft movement areas and all other platforms used by aircraft operators.

The aerodrome operator has to make sure no foreign object debris has been left on the vacated construction sites or working areas, including on the routing to and from the affected areas. Stones, building materials and equipment may endanger aircraft operations, as will working tools used during the construction.

Before bringing affected surfaces or infrastructure back into operation, a thorough inspection should be made to check the compliancy, consistency and operational ability of each lighting system, marking and sign.

# ANNEXES

## Annex A Definitions

***Aeronautical Information Service (AIS).*** A service established within the defined area of coverage responsible for the provision of aeronautical information and/or data necessary for the safety, regularity and efficiency of air navigation.

***Aeronautical Information Publication (AIP).*** A publication issued by or with the authority of a State and containing aeronautical information of a lasting character essential to air navigation. AIP publications also include:

- ***AIP Amendment***. Contains permanent changes to the information contained in the AIP;
- ***AIP Supplement.*** Contains temporary changes to the information contained in the AIP, which are published by means of special pages.

***AIRAC.*** An acronym for Aeronautical Information Regulation And Control, which is a system aimed at advance notification, based on common effective dates, of circumstances that necessitate significant changes in operating practices.

***ATIS.*** The automatic provision of current, routine information to arriving and departing aircraft throughout a 24 hour-period or a specified portion thereof. ATIS information is broadcast via:

- Data link-Automatic Terminal Information Service (D-ATIS). The provision of ATIS via data link; or
- Voice-Automatic Terminal Information Service (Voice-ATIS). The provision of ATIS by means of continuous and repetitive voice broadcasts.

***Hot spot.*** A location on an aerodrome movement area with a history or potential risk of collision or runway incursion, and where heightened attention by pilots/drivers is necessary.

***Just culture.*** An atmosphere of trust in which people are encouraged (and on occasion even rewarded) for providing essential safety-related information, but in which they are also clear about where the line must be drawn between acceptable and unacceptable behaviour.

***Local Runway Safety Teams (LRST).*** A LRST is a team comprised of representatives from aerodrome operations, air traffic services providers, airlines or aircraft operators, pilot and air traffic controllers associations and any other group with a direct involvement in runway operations. It advises the appropriate management bodies on potential runway incursion issues and recommends mitigation strategies.

***Obstacle.*** All fixed (temporary or permanent) and mobile objects or parts thereof which are located on an area intended for the surface movement of aircraft, or which extend above a defined surface intended to protect aircraft in flight.

***Runway confusion.*** An error when an aircraft makes "unintentional use of a wrong runway or taxiway for landing or take-off".

***Runway End Safety Area (RESA).*** An area symmetrical about the extended runway centreline and adjacent to the end of the runway strip. It is primarily intended to reduce the risk of damage to an aircraft undershooting or overrunning the runway.

***Runway excursion.*** An event in which an aircraft veers off or overruns the runway surface during either take-off or landing.

***Runway incursion.*** Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take-off of aircraft.

# Annex B Acronyms

| | |
|---|---|
| ACI | Airports Council International |
| AIC | Aeronautical Information Circular |
| AIP | Aeronautical Information Publication |
| AIP AMDT | AIP Amendment |
| AIP SUPP | AIP Supplement |
| AIRAC | Aeronautical Information Regulation And Control |
| AIS | Aeronautical Information Service |
| ANSP | Air Navigation Service Provider |
| APEX | ACI Airport Excellence in Safety Programme |
| ASDA | Accelerate-Stop Distance Available |
| ASMGCS | Advanced Surface Movement Guidance and Control System |
| ATC | Air Traffic Control |
| ATIS | Automatic Terminal Information Service |
| CAA | Civil Aviation Authority |
| CAT | (ILS) Category |
| CCTV | Closed Circuit Television |
| CSP | Construction Safety Plan |
| EUROCONTROL | European Organization for the Safety of Air Navigation |
| FAA | Federal Aviation Administration |
| FOD | Foreign Object Debris |
| GSN | Global Safety Network (ACI) |
| HMI | Human Machine Interface |
| ICAO | International Civil Aviation Organization |
| ILS | Instrument Landing System |
| LCC | Life Cycle Cost |
| LDA | Landing Distance Available |
| LRST | Local Runway Safety Team |
| LVP | Low Visibility Procedures |
| NAVAIDs | Navigational Aids |
| NOTAM | Notice to Airmen |
| OLS | Obstacle Limitation Surfaces |
| PAPI | Precision Approach Path Indicator |
| PIB | Pre-flight Information Bulletin |
| PMI | Preventive Maintenance Inspection |
| REL | Runway Entrance Light |
| RESA | Runway End Safety Area |
| RFF | Rescue and Fire Fighting |
| RST | Runway Safety Team |
| RTF | Radio Telephony Frequency |
| RTO | Rejected Take Off |
| RWSL | Runway Status Light |
| RWY | Runway |
| SARPs | Standards and Recommended Practices |
| SMS | Safety Management System |
| STSC | Safety & Technical Standing Committee of ACI World |
| THL | Take-off Hold Lights |
| TODA | Take-Off Distance Available |
| TORA | Take-Off Run Available |
| TWY | Taxiway |
| VOR | VHF Omnidirectional Range |
| WHMH | Wildlife Hazards Management Handbook (ACI) |

# Annex C References

ACI Policies and Recommended Practices

ACI Airside Safety Handbook

ACI Runway Safety Team Guidance and Recommended Practices

ICAO Annex 4 - Aeronautical Charts

ICAO Annex 14 - Volume I Aerodrome Design and Operation

ICAO Annex 15 - Aeronautical Information Service

ICAO Annex 19 - Safety Management

ICAO Doc 8126 AIS Manual

ICAO Doc 8697 Amendment 3 Aeronautical Chart Manual

ICAO Doc 9137 Part 8 Airport Operational Services

ICAO Doc 9137 Part 9 Maintenance

ICAO Doc 9870 Runway Incursion Manual

FAA The Strategic Runway Safety Plan

FAA AC 150-5300-13A Airport Design

FAA AC 150-5370-2F Operational Safety on Airports during Construction

FAA Runway Incursion Avoidance

FAA Runway Safety Best Practices Brochure

Eurocontrol European Action Plan for the Prevention of Runway Excursions

Eurocontrol European Action Plan for the Prevention of Runway Incursions

UK CAA Safety Notice, RESA and Runway Excursion Guidance for Aerodromes

IFALPA Runway Safety Manual

# Annex D Frequently Asked Questions about RST

**Why establish an RST?**

- The RST constitutes a body of experienced Runway Safety professionals at the airport across all relevant aviation disciplines;
- It promotes a collaborative approach by:
  - Exchanging information; and
  - Jointly developing best practices to manage risks; and
- The RST improves runway safety outcomes at the airport.

**What does an RST do?**

- The RST assesses operational risks specific to the airport;
- Proposes mitigations to prevent runway events (incursions, excursions and others);
- Measures and monitors the effectiveness of the mitigations;
- Educates and promotes, raising awareness of operational risks among all stakeholders; and
- The RST is not a decision-making body, but provides recommendations to be implemented as appropriate by the participants.

**Who should the RST consist of?**

- At a minimum, the RST should include repre-sentatives from:
  - Airport Operator;
  - Air Traffic Services Provider;
  - Aircraft Operators (Airlines and general aviation);
  - Representatives of Pilot and ATC association;
- It may also include:
  - The State regulatory authority;
  - Military (if applicable);
  - Rescue and Fire Fighting Service;
  - Other airfield services (de-icing, ground handling, wildlife control, etc.); and
- On invitation , it may second:
  - Subject matter experts.

**Where should RST meetings be held?**

- Airport Operators generally host the meetings, at the airport.

**How should the RST be established? (Governance)**

- The RST should elect a chairman to coordinate meetings and other activities; and
- The chairmanship should not “belong” to any specific domain.
- The RST should be chaired by preference by the aerodrome operator

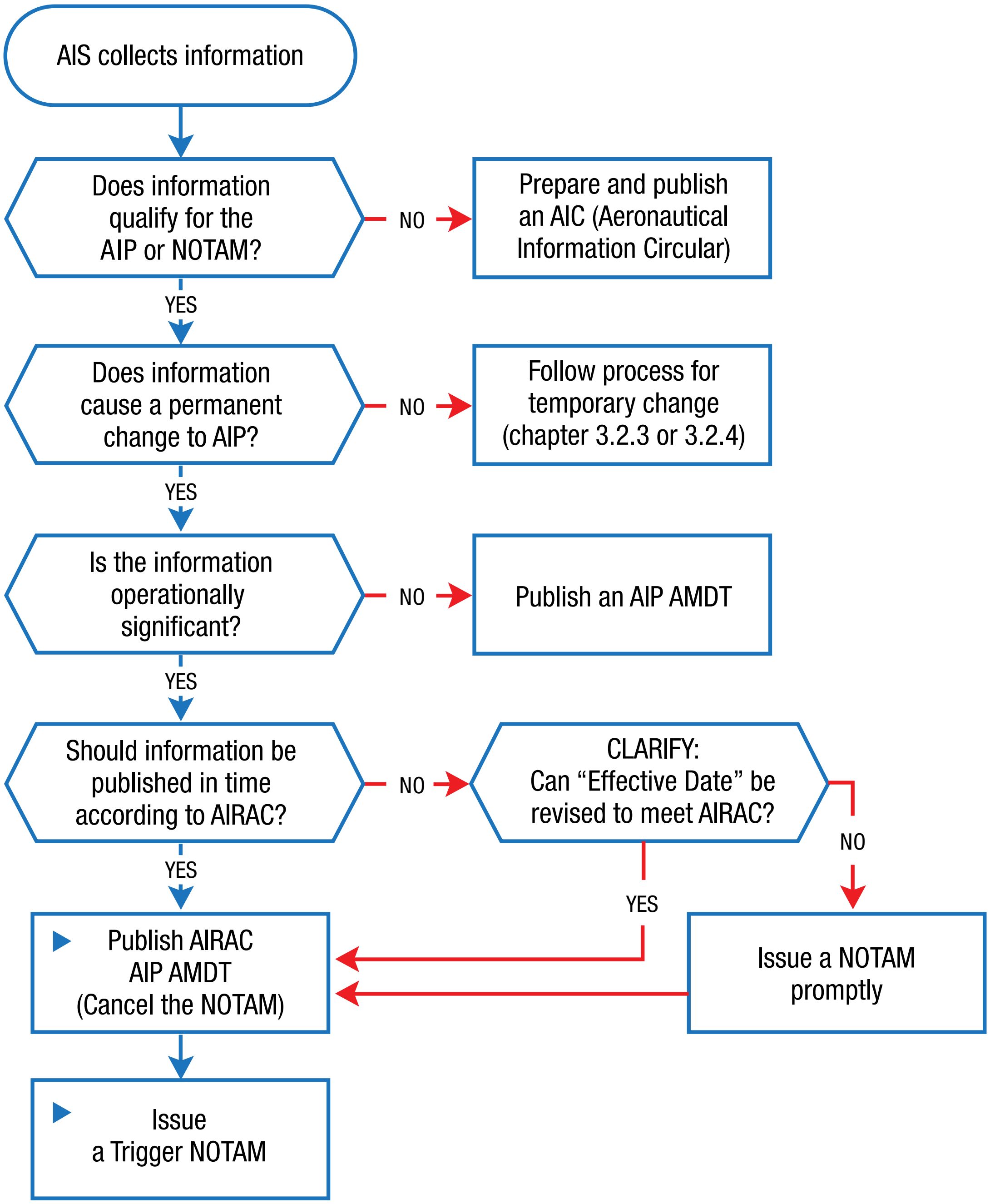
**How often should the RST meet?**

- It should meet regularly to review recurring safety issues and mitigations put in place;
- It may be called to address specific safety events or issues identified by RST participants;
- The RST should meet if there are any plans to alter the layout of the manoeuvring area; and
- If construction works are planned on the manoeuvring area (e.g. runway resurfacing).

# **Annex E** AIP & NOTAM Change Processes

## 1. Permanent change Process to AIP

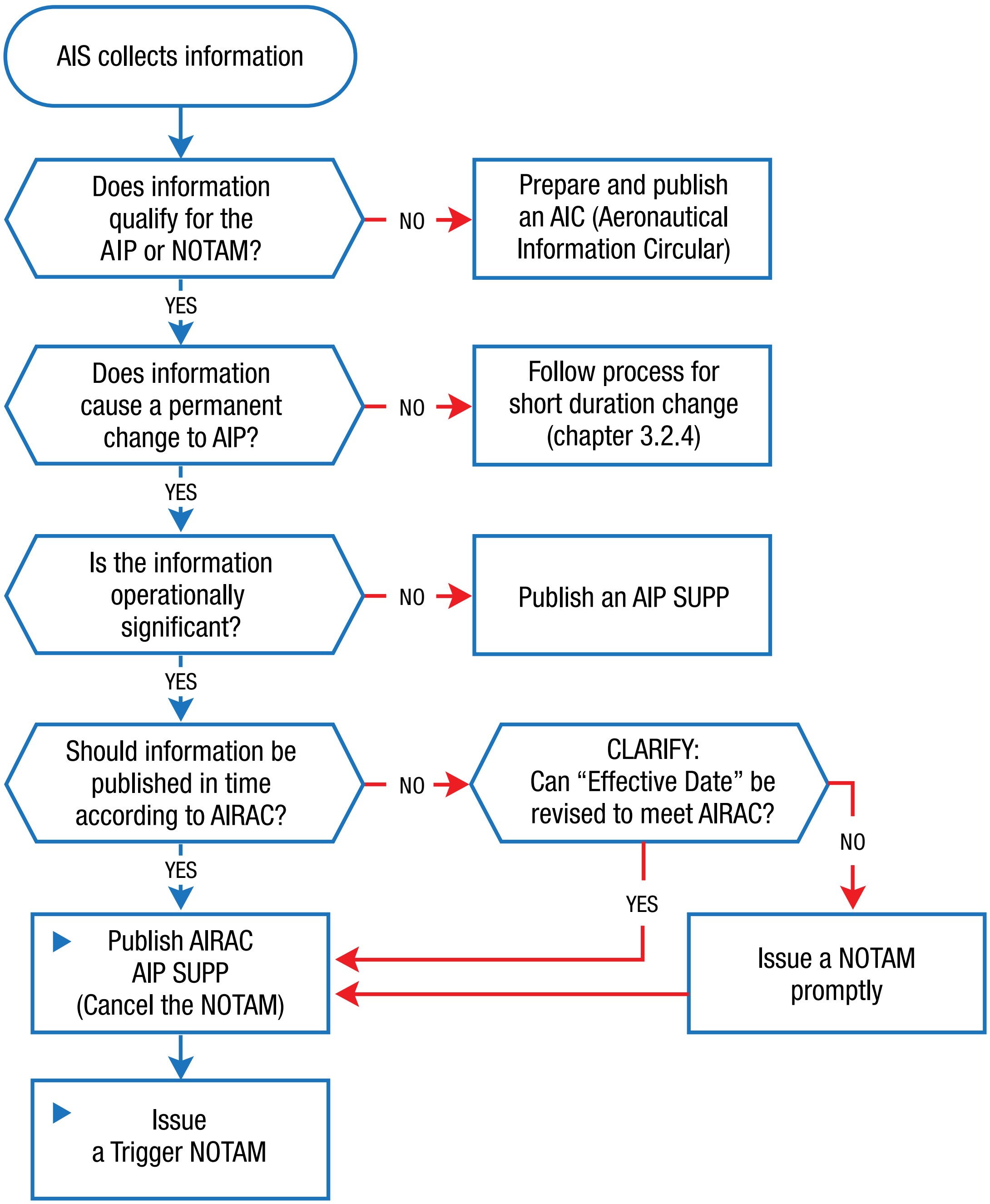
Permanent changes to the Aeronautical Information Publication (AIP) are published as AIP Amendments. When an AIP Amendment cannot be published at the established interval or publication date, a NOTAM should be issued promptly.



# Annex E AIP & NOTAM Change Processes

## 2. Temporary Change (Long Duration) Process to AIP

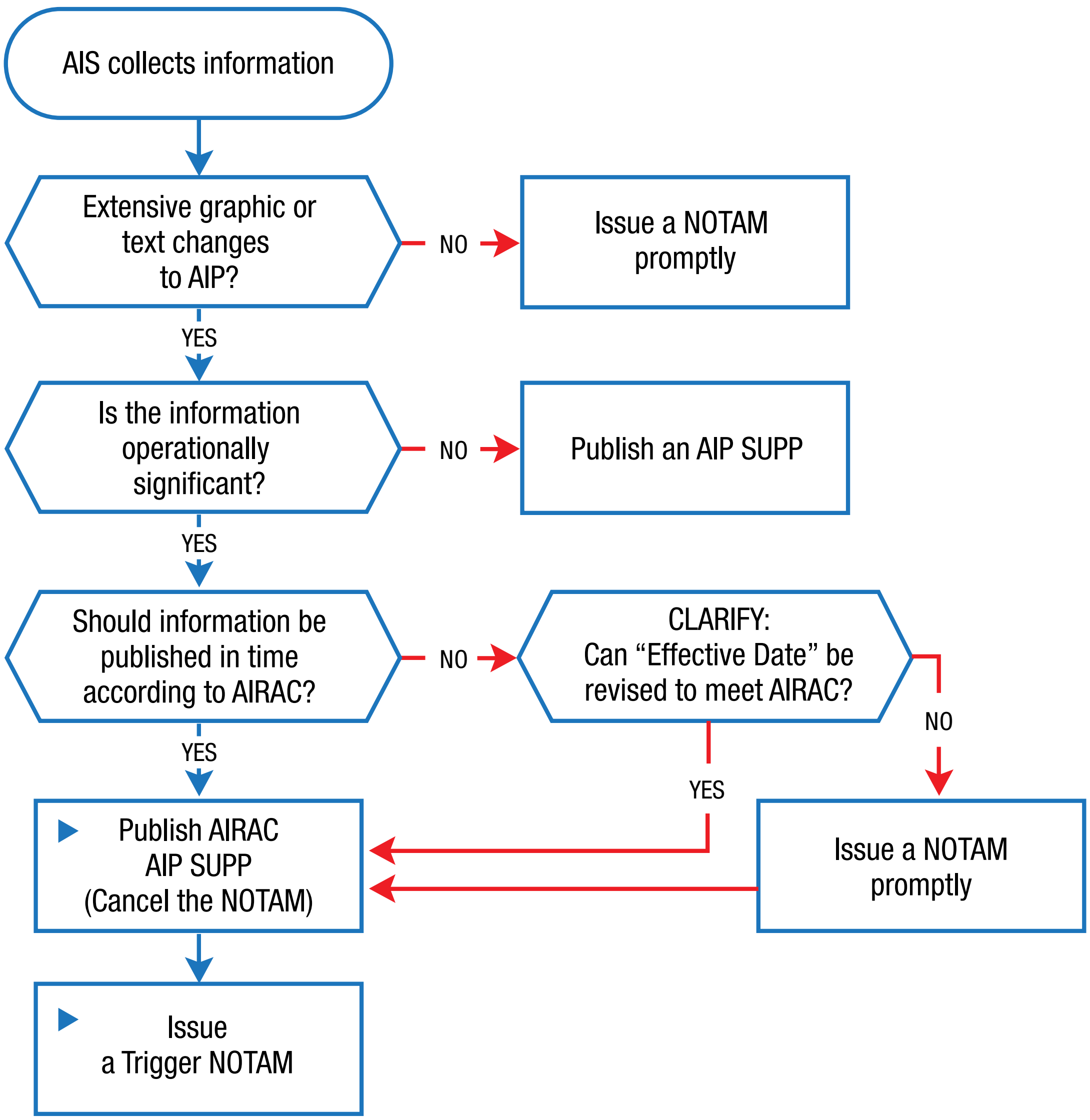
Temporary changes of long duration (three months or longer) are published as AIP Supplements.



# Annex E AIP & NOTAM Change Processes

## 3. Temporary Change (Short duration, extensive graphic or text change) process to AIP

Temporary changes of short duration which contain extensive text and/or graphics are published as AIP Supplements.



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