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SKYbrary

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SKYbrary is also the place where you can access:

- all the documents of the **Flight Safety Foundation Operator's Guide to Human Factors in Aviation**
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This time, one of the over 800 SKYbrary articles summarising the Investigations carried out into Accidents and Serious Incidents has been selected. It deals with Runway Incursion and Airport Design.

RUNWAY INCURSION AND AIRPORT DESIGN

Introduction

Recommendation 1.2.12 from the European Action Plan for the Prevention of Runway Incursions states:

"new aerodrome infrastructure and changes to existing infrastructure should be designed to prevent runway incursions"

Poor infrastructure design has contributed to the quantity and severity of previous runway incursions. Good aerodrome design can directly reduce the potential for runway incursions whilst maintaining operating efficiency and aerodrome capacity.

The design principles suggested in this guidance material can be applied to new aerodrome infrastructure and changes to existing infrastructure. Enhancement to existing infrastructure may be especially effective at hot spots i.e. areas vulnerable to ground navigation errors which may lead to runway incursions, wrong runway selection, taxiways mistakenly used as runways.

Whatever the infrastructure, it should be easy to understand and so minimize the potential for pilot and manoeuvring area vehicle driver distraction or confusion.

Aerodrome Design Principles – Taxiways

Entry

Flight crews need an unobstructed view of the runway, in both directions, to confirm that the runway and approach is clear of conflicting traffic before proceeding to enter or line up. To achieve this clear view, runway entrances should be at right angles to a runway.

Where the aerodrome has more than one runway, ensure that runway ends are clearly identified as separated. This may be achieved through visual aids or taxiway design.

Use standard taxiway widths, suitable for a wide range of aircraft, including the largest type expected to use the aerodrome. Wide (non standard) taxiway entrances reduce the effectiveness of signs and markings as aids to prevent ground navigation error and wrong runway selection. Use islands or barriers to avoid disorientation at large expanses of pavement. In order to visually round or limit the runway surface, another solution is to apply green artificial turf to the surface pavement, which will blend in with surrounding grass areas.

Locating an elevated lighted X at the prethreshold area of the taxiway is a simple way to provide a clear signal to pilots on approach that the area is closed and is not safe for landing. In a situation where there is no room for an elevated lighted X, a lighted X can be imbedded in the pavement.

Crossing

Avoid designs that include crossing a runway to access a taxiway or another part of the aerodrome. Limiting the number of aircraft crossing an active runway can be achieved through the use of perimeter taxiways. Perimeter taxiways (that run around the runway ends) avoid aircraft having to cross a runway. perimeter taxiways can reduce runway occupancy times, taxi times and congestion on the manoeuvring area, as the time taken to cross a busy runway can be considerable.

Sufficient space is required between the landing threshold and the taxiway centreline where it crosses under the approach path, to enable the largest aircraft to pass under the approach without violating the approach surface. The requirement for Runway End Safety Areas, and possible interference with the ILS should also be taken into account. The perimeter taxiway should route traffic behind the localiser antenna, not between the localiser antenna and the runway, due to the potential for severe ILS disturbance, noting that this is harder to achieve as the distance between the localiser and the runway increases. Perimeter roads should also be provided for vehicles wherever possible.

Where perimeter taxiways and roadways are not possible, intersections used for crossing a runway, should be perpendicular to the runway. This will allow flight crew an unobstructed view of the runway, in both directions, to confirm that the runway and approach is clear of conflicting traffic before proceeding to cross that runway. Avoid using mid-runway (high energy) crossing points, because the departing aircraft has too much energy to stop, but not enough speed to take-off. Taxiway fillets should be used to allow the aircraft to be perpendicular to the runway, thereby assuring clear line of sight to the runway ends.

If runway crossing cannot be avoided then minimise the potential for runway entry at an unintended location by providing only essential entrances. It is important to have a consistent design of runway entrances and exits with the same ICAO compliant format for visual aids at each taxiway to ease navigation on the ground. Multiple taxiway entrances at one location, e.g. y-shaped connectors present opportunities for ground navigation errors such as runway incursions and for aircraft vacating one runway to enter a wrong taxiway or a different runway. Limiting the options available to pilots on each entrance or exit helps to avoid runway confusion.

Exit

Rapid exit taxiways (RET) are designed to be runway exits only. The geometry of the taxiway/runway intersection of a rapid exit taxiway does not allow the crew to see the runway is clear of conflicting or other traffic in both directions. No Entry signs should be used to avoid aircraft entering the runway via a rapid exit taxiway.

Where possible, do not mix high speed (RET) and taxi speed runway exits. If RETs are provided, have a series of RETs without interruption by other taxiway, entrances or exits. Avoid a crossing runway in between exit taxiways. RETs should be of sufficient length to be effective in allowing the aircraft to slow to an appropriate taxi speed and should terminate onto a parallel taxiway. RETs should not terminate directly on to a parallel runway. Runway/taxiway separations must be sufficient to permit space for effective RETs.

Exit taxiways should be long enough to assure an aircraft has adequately vacated the runway according to the category of operations and is clear of the ILS.

Other

The use of runways as taxiways should be avoided. If necessary, design out runway incursion hot spots.

When practicable, permanently disused taxiways and roadways should be removed to prevent ground navigation error. If left in place, the taxiway must be closed with ICAO compliant markings, signs and lighting and correctly shown and identified for navigation purposes on the aerodrome map/chart.

The air traffic Control tower should be located such that it has good visibility of surface movements of aircraft and vehicles, without any visual restrictions.

Avoid designs that lead to backtrack operations for aircraft prior to take-off or after landing. Taxiways that are parallel to the runway minimize the time aircraft (and also vehicles) stay on the runway, so are a key element for safety and efficiency.

Aerodrome Infrastructure Naming Convention

Where possible, taxiways should be designated in a logical manner that is instinctive to pilots and manoeuvring area vehicle drivers. Different taxiways on the same aerodrome should not have the same or similar designations.

Connecting taxiways (links between major traffic routes) should be designated in such a way that they cannot be mistaken as taxiways that connect to a runway. Those

taxiways that connect to the runway should be clearly designated. The naming of taxiways should follow ICAO recommendations.

Aerodrome Signs, Marking And Lighting

Ensure signs, marking and lighting, conform to ICAO Annex 14. The visual aids must be clear, in good condition and correctly located. All visual aids must be visible to the pilot and driver from their respective aircraft type and vehicle type, from the angle of their approach to the visual aid in question e.g. stop bars that protect the runway.

Consider the benefits of using technology as a safety net to provide immediate and simultaneous runway and traffic proximity alerts for pilots, air traffic controllers and manoeuvring area vehicles to help to protect the runway.

Stop bars and runway guard lights that protect the runway should be ICAO compliant. Consider using stop bars and runway guard lights at all runway/taxiway intersections under all weather conditions (24 hours a day) to help prevent runway incursions. Manage the length of time the stop bar is extinguished to ensure that aircraft and vehicles have crossed them prior to their re-illumination.

Manage the length of time stop bars are extinguished when conditional clearances are in use to avoid the incorrect presence of a second aircraft or other traffic on the runway.

Consider the use of LED lighting as they give superior luminance.

Lighting systems that provide taxiway routing guidance are considered beneficial to navigating on the ground by pilots.

The installation of omnidirectional runway end identifier lights (REILs) and replacement of unidirectional REILs would be an additional enhancement for the runway environment.

Aerodrome Operations

Flight crews and manoeuvring area vehicle drivers should not be instructed to cross illuminated red stop bars. In the event of stop bars failing in the illuminated state, appropriate contingency procedures are required, such as the use of alternative runway entry or crossing points, etc.

Stop bars that protect the runway should be individually selectable by the runway controller and co-located with the working position.

All access to a runway requires a specific ATC clearance to enter or cross the runway, regardless of whether the runway is active or not. An extinguished stop bar, or any other red light, is not a clearance to enter or cross a runway.

When warning systems can be installed, such as within a surface movement guidance control system (A-SMGCS),

they should provide aural (word) warnings, not just sounds, when practicable. All staff working on the manoeuvring area should carry an up-to-date airport map/chart, including hot spots, to ensure awareness of areas that may be difficult to navigate correctly.

Work in Progress

When planning and carrying out work in progress on the manoeuvring area the aerodrome operator should:

Ensure in the design stage that the changed layout does not increase the likelihood of runway incursions;

Ensure that the layout changes are published in the AIP, NOTAMs or ATIS and local airfield notices in a timely fashion as appropriate;

Ensure that the airfield signs, lights and markings are altered to reflect the changed layout;

Ensure that air traffic control are aware of the changes;

Ensure that the ground lighting and any associated control software are altered to reflect the new layout e.g. availability of green taxiway centre line lights linked to an unserviceable stop bar should not occur.

Related Articles

- Parallel Runway Operation
- Surface Movement Radar
- Taxi-in Runway Incursions
- Runway Status Lights (RWSL)

Further Reading

- European Action Plan for the Prevention of Runway Incursions (Edition 2.0). Appendix K: "Aerodrome Design Guidance for the Prevention of Runway Incursions"
- An example of a clearly written and unambiguous Aerodrome Manual: Manchester UK – 2013 Aerodrome Manual, version 3
- FAA Engineering Brief No. 89 Taxiway Nomenclature Convention, 2012
- UK CAA CAP 1069 'Preventing runway incursions at small aerodromes'
- Identification Techniques to Reduce Confusion Between Taxiways and Adjacent Runways, J. W. Patterson, Jr., R. N. Frierson, September 2007.
- Engineering Brief No. 72A – Positive Identification Of Runways For Landing, FAA, November 2007.