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RESEARCH ARTICLE

The dynamic concept of runway slots by type of operation

Concepto dinámico de franjas de pista según tipo de operación

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Abstract

The purpose of this paper is to show practical application criteria for the concept of operational runway strips. The need to optimize the use of airport infrastructures is of particular interest from various points of view, including operational, environmental and economic ones. Naturally, runways do not escape this reality. The operational demands imposed by the traffic mix, according to the combination of aircraft, propeller type and operational weights, requested for the origins/destinations by the airlines' business plans, demand a "required" runway while the airport offers, through its existing infrastructure, an "available" runway.

Resumen

El objeto del presente trabajo es mostrar criterios de aplicación práctica para el concepto de franjas de pista operativas. La necesidad de optimizar el aprovechamiento de las infraestructuras en los aeropuertos despierta especial interés desde varios puntos de vista: entre otros, operacionales, ambientales o económicos. Naturalmente, las pistas no escapan a esta realidad. Las demandas operacionales impuestas por la mezcla de tráfico, según combinación de aeronave, tipo de propulsor y pesos operacionales, solicitadas para los orígenes/destinos por los planes de negocios de las aerolíneas, demandan una pista "requerida" mientras que el aeropuerto ofrece, a través de su infraestructura existente, una pista "disponible".

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Introduction

For the objective of optimizing the airport system, the ability to make the most of the available infrastructure through an examination of its declared distances is crucial.

To accomplish this, it is necessary to adhere strictly to the written regulations in place, keeping in mind that all operations on runways must be carried out in accordance with the required safety specifications.

In this context, is a single runway the only suitable physically determined by the existing infrastructure? or is there any possibility to determine different runways strips for each type of operation? Thus, the concepts of an "operative runway" and a "dynamic runway" become relevant.

The purpose of this article is to show practical application approaches to the concept of "operative" runways in line with a more dynamic idea, taking advantage of the existing airport infrastructures, considering that paragraph 3.4 – Runways, Annex 14 to the Agreement on Convention on International Civil Aviation of the International Civil Aviation Organization (ICAO) makes reference to strips in plural and to a runway in singular, thus making room for a supplementary interpretation differing from the habitual customs and usages.

The scope of this article is focused on the analysis of the application pursuant to the definitions and characteristics of a runway set out in Annex 14, 8th Edition, 2018.

Development and discussion

Strips are areas surrounding a runway and its staging areas, if any, that must have characteristics such as to reduce damage to aircraft transiting the runway in the event of a possible runway departure and must provide an obstacle-free area in order to protect the aircraft flying over them during takeoff and landing operations.This brief document is intended to illustrate options for the safe implementation of runway strips according to their definitions, without overlooking the type of operation conducted there, with the view to avoid penalties imposed on account of the infrastructure and to allow for a more flexible implementation.

Under international regulations, the following definitions of a strip are associated to a runway and its staging area. (Annex 14, 2018).

Runway strip. A defined surface including the runway and its staging area, if any, intended to:

a) minimize the risk of damage to aircraft running off strip limits; and to

b) protect any overflying aircraft during takeoff or landing operations.

Runway. A rectangular area defined in a ground aerodrome, prepared for aircraft takeoffs and landings.

Precision Approach Runway. See "Instrument Flight Runway".

Takeoff Runway. A runway exclusively reserved for takeoffs.

Instrument Flight Runway. One of the following runway types reserved for aircraft operations using instrument approach procedures:

a) Non-precision approach runway: A runway supported by visual and non visual aids reserved for landings after a Type A instrument approach operation and with a visibility of not less than 1000 m.

b) Category I Precision Approach Runway. A runway supported by visual and non visual aids, reserved for landings after a Type B instrument approach operation with a decision height (DH) not lower than 60 m (200 ft) and with a visibility of not less than 800 m or a visual range on the runway of not less than 550 m.

c) Category II Precision Approach Runway. A runway supported by visual and non visual aids, reserved for landings after a Type B instrument approach operation with a decision height (DH) lower than 60 m (200 ft) but not lower than 30 m (100 ft) and with a visual range on the runway of not less than 300 m.

d) Category III Precision Approach Runway. A runway supported by visual and non visual aids, reserved for landings after a Type B instrument approach operation up to the runway surface and along the same, and

A — used for operations with a decision height (DH) lower than 30 m (100 ft), or with no decision height and with a visual range on the runway not lower than 175 m.

B — used for operations with a decision height (DH) lower than 15 m (50 ft), or with no decision height, and with a visual range on the runway lower than 175 m but not lower than 50 m.

C — used for operations with no decision height (DH) and no visual range restrictions on the runway.

Note 1.— Visual aids must not necesssarily adjust to the scale characterizing the non visual aids provided. Visual aids are selected on the basis of the relevant operational conditions.

Note 2.— Go to Annex 6 — Aircraft operation for instrument approach operation types.

Visual Runway. A runway reserved for aircraft operations using either non-instrument procedures or an instrument approach procedure at a point beyond which the approach may continue under weather conditions fit for non-instrument flights.

As can be seen, the definition of strip is associated with the runway and the stopping zone, and the definition of runway is associated with the runway according to the type of operation in which it is carried out.

> ***"Strips are areas surrounding a runway and its staging areas, if any, that must have characteristics such as to reduce damage to aircraft transiting the runway."***

Case Studies

According to the parameters described above, runway strip dimensions are determined as follows:

Case A: An airport with 2 runways

A generic airport with two parallel runways of identical dimensions and segregated operations (simultaneous operations where one of them is to be exclusively reserved for landings and the other one, for takeoffs). In both cases, the airport reference code shall be "4E," and the runways shall have neither a SWY (staging area) nor a CWY (obstacle-clear zone). Besides, the landing runway shall be reserved for CAT I precision approach operations. (Note: in the following charts, the aircraft represents the runway use direction).

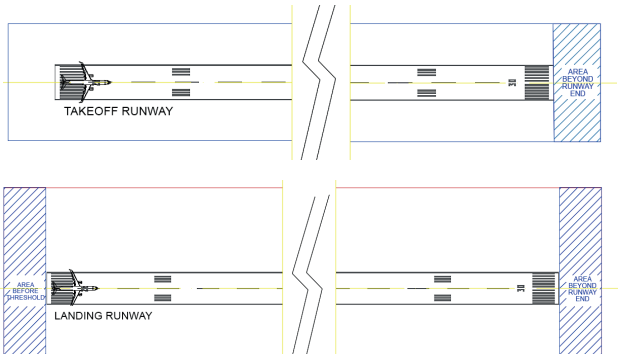
The length of a strip is defined by:

> 3.4.2 Every runway strip shall extend before the threshold and beyond its end (or beyond the parking area end), up to a distance of at least:
>
> — 60 m when the code number is 2, 3, or 4;
>
> — 60 m when the code number is 1 and the runway is used for instrument flights; and
>
> — 30 m when the code number is 1 and the runway is used for visual flights.

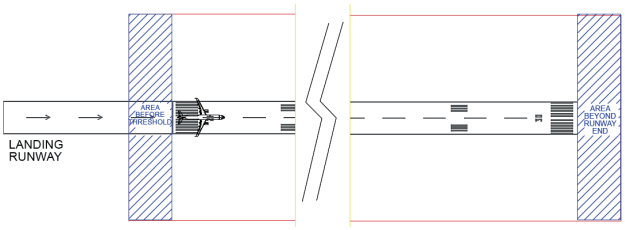
In 1.1. of Annex 14, a definition may be found of the strip threshold, though not of its end:

> **Threshold.** Commencement of such part of the runway as may be used for landing purposes.

An area before the runway threshold and beyond the runway end is thus determined, in the understanding that such end is a limit opposed to the threshold, that is, the end of both takeoff roll and landing rollout operations; in other words, no area is defined before the runway outer edge coinciding with the commencement of the takeoff-roll runway. The next chart illustrates these concepts:



A runway with displaced threshold would look as follows:

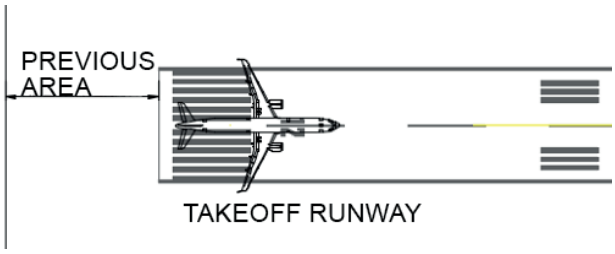


The runway width is determined according to the approach category and the airport reference code.

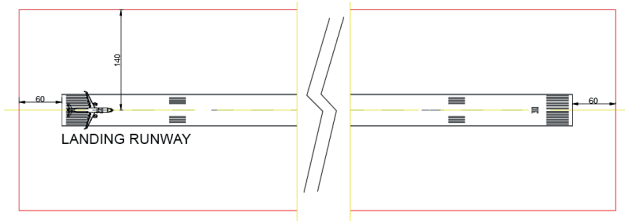
> **Runway Strip Width**
>
> 3.4.3 Where possible, every runway strip including a precision approach runway shall extend sideways up to a distance of at least:
>
> — 150 m when the code number is 3 or 4; and
> — 75 m when the code number is 1 or 2;
> on each side of the runway centerline and of its extension along the strip.
>
> 3.4.4 Recommendation — Every strip including a non-precision approach runway should extend sideways up to a distance of at least:
>
> — 150 m when the code number is 3 or 4, and
> — 75 m when the code number is 1 or 2;
> on each side of the runway and of its extension along the strip.
>
> 3.4.5 Recommendation.— Every strip including a visual flight runway should extend on both sides of the runway centerline and its extension along the strip, up to a distance of at least:
>
> — 75 m when the code number is 3 or 4;
> — 40 m when the code number is 2; and
> — 30 m when the code number is 1.

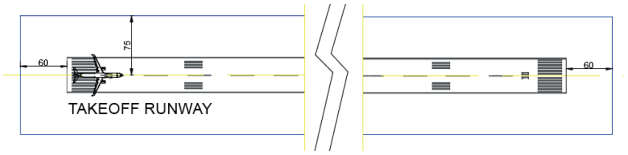
For landing runways, you might ask why is it that a runway strip which is only used for landings is determined according to its code number? [being that the latter is directly related to the field length reference (LCR), that is, to the length required by an aircraft to take off under certain conditions]. In other words, why is it that some characteristics of a strip are defined in accordance with a specific type of operation, with no direct reference to takeoffs?

Furthermore, in the case of takeoff runways, why should there be a strip portion or area before the commencement of the threshold if the runway is used for takeoffs only?



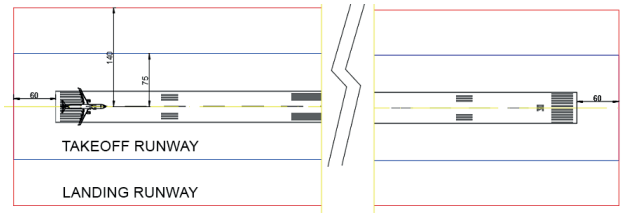
Depending on the type of operation involved, the strips would look as follows:





Case B. An airport with a runway deriving from Case A

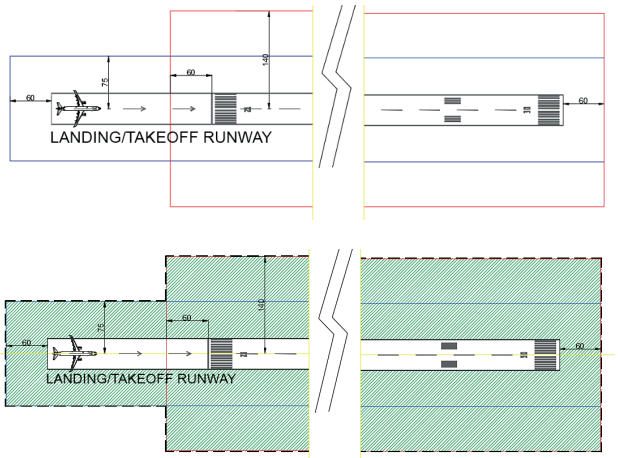
Based on the previous case, what would happen if, due to specific requirements, one of the runways must be closed and the operations moved to the remaining operative runway? The next following chart illustrates this scenario:



Logically, being that there is only one strip, we would have the wider (red) one available, since the other one is contained there.

Case C. An airport with a runway deriving from Case A and with a displaced threshold

Following the previous line of thought, the next chart illustrates the case of airports with only one runway, but with a threshold displaced at a certain distance:



The strip would no longer have a fixed width; part of it would be determined by the requirements of the type of operation to be performed there.

Furthermore,

Strip Leveling Off

3.4.8 Recommendation — The part of a strip comprising an instrument flight runway should provide, from the runway centerline and its extension and up to a distance of at least:

— 75 m when the code number is 3 or 4; and of at least
— 40 m when the code number is 1 or 2;

a leveled off area taking into account the aircrafts for which the runway is reserved, in the event of landings off strip limits.

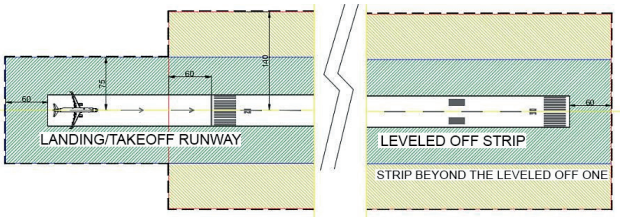
Note.— Appendix A, Section 9, provides several guidelines for the leveling off of an area wider than a strip, comprising a runway for precision approaches, when the code number is 3 or 4.

3.4.9 Recommendation.— The part of a strip for a non-instrument flights should provide from the runway centerline and its extension and up to a distance of at least:

— 75 m when the code number is 3 or 4;
— 40 m when the code number is 2; and
— 30 m when the code number is 1;

a leveled off area for the aircrafts for which the runway is reserved, in the event of an aircraft runway extrusion.

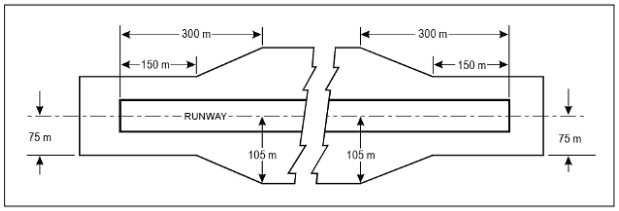
The areas to be leveled off are associated not to a type of approach but to a type of (instrument or visual) flight for which runways are reserved, and, of course, to the type of aircraft through the pertinent code.



In addition to the abovementioned provisions, Appendix A, Section 9 states the following:

> 9.3 A strip leveling off for precision approaches.
>
> Chapter 3, 3.4.8 recommends that the part of a strip comprising an instrument flight runway identified by a 3 or 4 code number be leveled off up to at least 75 m from the runway centerline. If runways reserved for precision approaches are involved, it would be advisable to
>
> adopt a greater width if the code number is 3 or 4. Chart A-4 illustrates the form and dimensions of a wider strip that could be considered for such runways. A strip of these characteristics has been projected according to data on aircrafts that run off its limits. The part to be leveled off extends sideways up to 105 m from the runway centerline, but such distance is gradually reduced to 75 m on both ends of the strip, along 150 m distance from the runway end.

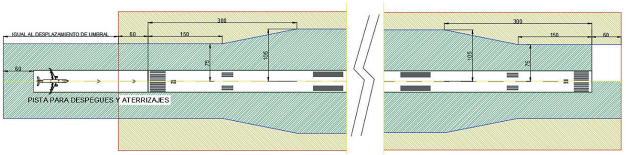
Chart A 4: Leveled off part of a strip for 3 or 4 code precision approaches.



The abovementioned chapter states that in the event of a recommendation, it should have a wider scope, thus indicating that there could be a recommendation within another more convenient one (paragraphs 3.4.8 – 3.4.9 and section 9 of Appendix A) always refers to a lateral distance; however, in connection with a longitudinal distance, reference is always made to the extension of the runway centerline.

It is also mentioned that such recommendation considers that aircrafts may run off strip limits, so that reference is made to events known as overrun (exit at runway end when landing or taking off) veer off (lateral exits when landing or taking off) and undershoot (when landing).

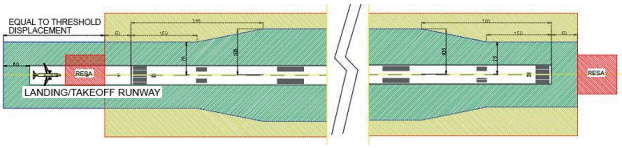
Thus, if runway thresholds coincide with runway ends, no problems would be encountered. However, if runways with a displaced threshold are involved, the following situation could take place:



Even if we apply the runway end safety area (RESA) definition:

> **Runway End Safety Area (RESA).** An area adjacent to the runway end that is symmetric with respect to the extension of the runway centerline, the area's main function being to reduce the chance of an aircraft being damaged in the event of an undershoot or a strip end overrun.

The chart would be the following:



CONCLUSIONS

The possibility to determine "dynamic" strips in line with the type of operation conducted there, considering, in all cases, the available declared distances, clearly stems from the three case studies described above and their respective notes and remarks.

This concept clearly deviates from the traditional, commonly used approach regarding wraparound, static strips, which does not take operational requirements into consideration.

The difference between a traditional concept and the dynamic one proposed here may solve the usual problems arising at many airports where the available spaces must be optimized in order to declare strip dimensions in full agreement with Annex 14, but with a differentiating operational approach.

The ideas described above entail a greater flexibility and a possibility to take advantage of available infrastructures, being the decision to adjust and adequate them to international regulations in the hands of upper management levels.