

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/335202921>

# AERODROME CONCEPT: IN-LINE RUNWAYS CONFIGURATION

Article · August 2019

CITATIONS

0

READS

74

1 author:



[Armand Brzosko](#)

HMJ Ltd.

6 PUBLICATIONS 0 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



Airport Systems [View project](#)



Material Science in Aviation [View project](#)

## AERODROME CONCEPT: IN-LINE RUNWAYS CONFIGURATION

*The concept of in-line runways , as an alternative to parallel configuration is presented as a way to decidedly shorten taxi times, improve safety of landing and takeoff, unload congested airspace and reduce emissions from aircraft engines. Consideration is given to present runways configurations, directions of aircraft development, fuel efficiency in various phases of flight, emissions, land use and regulatory issues.*

Large airports, as the hubs of mass public transport, find themselves in the middle of increasingly congested airspace. Landings and takeoffs as often as one every minute are already a daily routine in many airports, bringing the logistic capacity to the very extreme both in the air and on the ground, and forcing humans and systems to work without fault margin in very demanding environment. Comparing various means of public transport, a reflection comes to mind, that in certain phases of the journey margins of safety are by approximately an order of magnitude bigger in the land or sea transport than in the aviation. Only exceptionally good training and rigorous procedures maintain present excellent accidents' statistics intact.

With the growth of the air traffic , various configurations of runways were proposed. A crossed-runways configuration was devised quite early on, to diminish the influence of the cross wind. When the aircrafts got bigger and heavier , the airspace congestion factor came forward, which produced concept of parallel runways. Obviously, land lot limitations is a decisive factor , in particular close to large metropolies.

At the same time, airport buildings are growing in size to accomodate dozens of large aircrafts at once, to the extent that some terminals of today have lengths comparable with the length of yesterday's runways.

This article proposes a concept of in-line configuration for simultaneous operations of two runways, where the second is an immediate extention of the first, however

with own threshold, lights, own TORA/TODA&ASDA. It is in the fact one runway of double-length , where landings are done on the first part of it , and the takeoffs on the second. [Fig.1].

First feature which is produced by this configuration is decisive shortening of taxiways and taxi times. The landing aircrafts turn to the terminal , located conveniently near the central point of the connected runways. At the same time, departing aircraft taxi via short routes to the same central point where takeoff threshold is situated. A minimal time offset between runout of landing aircraft and lineup of a departing one is recommended, however not mandatory and grateful subject to automated control of runway occupation modes.

In order to understand why shortening of the taxi time is of value , the environmental and commercial factors are considered. Both are related to the fuel consumption in various phases of flights . Table 1 presents data collected per ICAO LTO-cycle averaged for standard transport aircrafts, courtesy of [1]. It shows, that although during taxiing the engines work with minimal power (approx. 7% on the broad average - [1] ) , the mean taxi time of 26 min makes it the most substantial contributor among all airport's vicinity manoeuvres, with respect to fuel consumption and emissions. For clarity , it has to be commented that majority of fuel consumption and related emissions are produced during cruise phase , which in turn depends on the distance.

Table 1. maneuvers duration, fuel consumption and emissions in the LTO cycle

Maneuver	Duration [s]	Fuel consumption [kg]	CO emission [g]	NO <sub>x</sub> emission [g]
Takeoff	42	103	21	2966
Climb	132	261	157	5872
Descent	240	162	259	1750
Taxiing	1560	353	6636	1659
Total	1974	879	7073	12247

The second, commercial aspect of the shortening of taxi time pertains both to the fuel consumption as well as to the idle time of the aircraft as the financial asset. Due to high value of the asset, each minute of unproductive time on the ground has quite a well defined cost, which may reach the hundreds of dollars range for the biggest aircrafts.

Initial computer simulations by the Author for the 4F-class double in-line runway show a possibility to shorten taxi time in the large airport down to 5 minutes for big transport aircraft, counted from vacating of the runway to docking at the gate; the same in opposite direction. However, the simulation strongly depends on the terminal architecture and taxiways layout, and therefore is not yet made public.[Fig2]

It should be noted that shortening of taxiways during aerodrome planning is clearly recommended by ICAO documents [5].

Considering next the flight safety aspects, two counteracting features have to be analysed.

First, that an extension of available touchdown distance is obviously positive. Under regular conditions, with all aircraft's systems operative and normal weather, the length of a typical runway is more than sufficient for safe landing manoeuvre. But, when only one of the involved factors such as human error, faulty instrument, windshear, poor visibility, etc. appear, all available runway length becomes critical.

Coincidence of just two negative factors, e.g. human error plus bad weather usually leads to some sort of aviation incident, with three or more being a strong premise for serious accident.

Possibility of using a second length of the runway under critical conditions, what may or may not be communicated in advance to the tower, could save lives in more situations met in the aircrafts operations than general public would like to know.

Contradictory factor under the aspect of flight safety is proximity of landing and departing aircrafts at separate thresholds on the same runway. Here, the solution is mentioned time offset, that is waiting until the aircraft touching down measurably slows down during runout before allowing the lineup of the next aircraft to the middle threshold.

It should be noted that location of 3 thresholds (2 in one direction, any) on one runway will require careful aligning to the requirements of present ICAO rules, as per [3];[4]. In the Author's opinion, the concept is not contradictory to actual regulations if the middle threshold is treated as a *displaced threshold*; therefore not requiring amendments to the said rules.

The land use is another significant factor while considering runways' configuration. Certainly, existing airports near big metropolitan cities may encounter problems with obtaining additional strips of land, and in any case the economy of costs becomes decisive. For the new airports, planning and acquiring of sufficient lengths of land for future development should already now envision possibility of presented runways configuration, which may be alternative or additional to currently prevailing parallel layout.

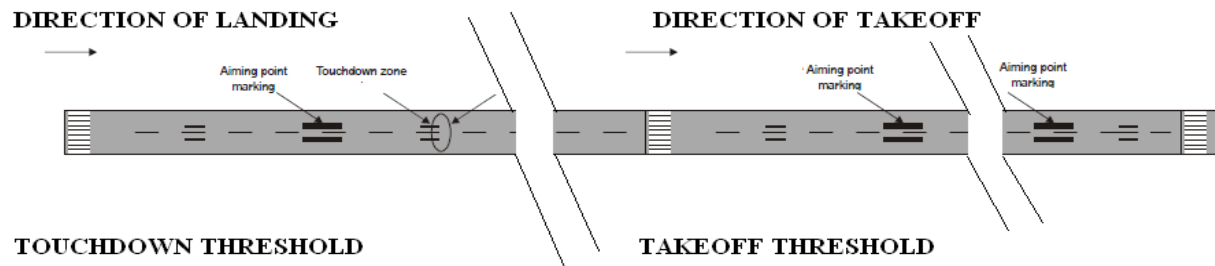
The last issue discussed in this paper is the future development of the aircrafts design. As the recent experiences with A380 have shown, very large constructions, although much appreciated

by the public, do not easily meet economical criteria. The Author is therefore of the opinion, that rather the speed of travel shall be explored in future than the size of individual plane. In such a case the landing speed, requiring longer runways may be a supportive factor for described aerodrome design. However, it

seems that for the next thirty years, a double in-line runway of total 5-7 km length should be sufficient to safely accommodate any commercial aircraft under most adverse conditions.

*The Author is a design engineer with over 25 years of industrial experience and a commercial pilot.*

**Fig.1. Inline thresholds on double-length runway**



**Fig.2. Ground traffic simulation**



- [1].Głowacki,P.;Kawalec,M.; Aircraft emissions during various flight phases.Combustion Engines,2015; 162(3),229-240 ISSN 2300-9896.
- [2].Annex 14 to the Convention on International Civil Aviation „Aerodromes” VIIth Edt.; 2016.
- [3].Airport Planning Manual. ICAO, Doc.9184,Part1. 2nd Edt.1987
- [4]Aerodrome Design Manual. ICAO Doc.9157,Part1. 3rd Edt.2006
- [5] Aerodrome Design Manual. ICAO Doc.9157,Part 2. 4thrd Edt.2005