

PREVENTING RUNWAY INCURSIONS WITH ENHANCED AIRFIELD GEOMETRY

by Gaël Le Bris

As advanced systems for preventing runway incursions and collisions have been introduced in the past few years such as the Runway Status Lights (RWSL)¹, we should not forget the fundamentals. A proper configuration of the taxiways in the vicinity of the runway, a simple and clear taxiway naming system and effective aerodrome signage are all key elements in reducing the likelihood of one aircraft entering a runway which could already be occupied by another². As stated in Recommendation 1.2.12 in the European Action Plan for the Prevention of Runway Incursions (EAPPRI)³, "new aerodrome infrastructure and changes to existing infrastructure should be designed to prevent runway incursions".

A fatal accident at Paris-CDG in May 2000 led to major infrastructure improvements. A MD83 on its takeoff roll on runway 27 at night collided with a Shorts 330 that had entered the same runway from a 09 Rapid Exit Taxiway (RET)⁴,⁵.

The MD83 was cleared to taxi along taxiway 19 (current taxiway Q4) to make a full length takeoff on runway 27 (since re-designated as runway 27L) while at the same time, a Shorts 330 was cleared to taxi to taxiway 16 (since re-designated as Y5). At this time, Rapid Exit Taxiways (RETs) were also used as intermediate access taxiways - 90° access taxiways were only introduced a few months after

this accident, when the outer runways 09L/27R and then 08R/26L were opened.

The MD83 was cleared to line up and takeoff and the Shorts 330 to line up and wait "number two". The investigation found that the controller thought both aircraft were taking off from the full length when clearing them to line up in turn. As the MD83 began to accelerate, the Shorts 330 entered the runway further along having assumed that the aircraft which had just passed them was the "No 1" taking off when in fact it was a landing aircraft. As the MD83 approached the taxiway 16 intersection and its crew saw the other aircraft, it was already beyond V1

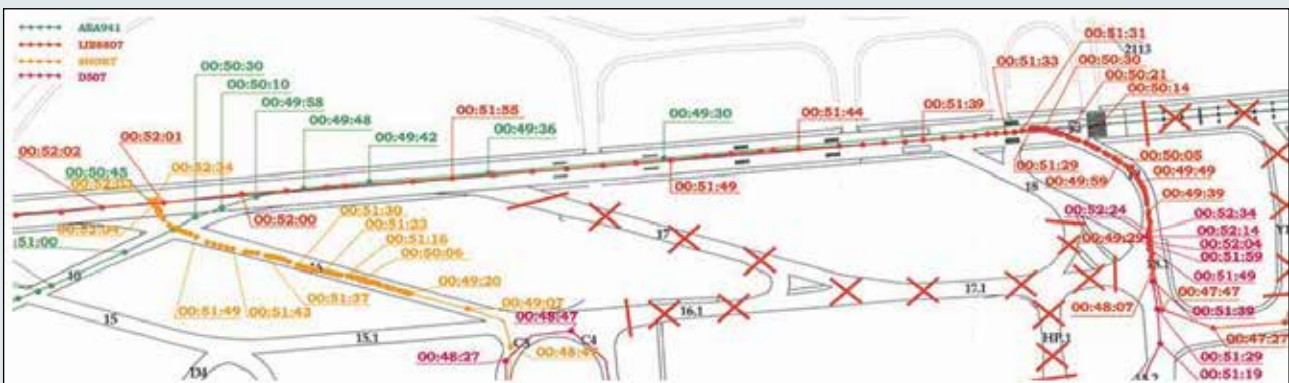


Figure 1 – Tracks of the two aircraft which collided on 25 May 2000

1- [http://www.skybrary.aero/index.php/Runway_Status_Lights_\(RWSL\)](http://www.skybrary.aero/index.php/Runway_Status_Lights_(RWSL))
 2- http://www.skybrary.aero/index.php/Runway_Incursion_and_Airport_Design
 3- <http://www.skybrary.aero/bookshelf/books/151.pdf>
 4- http://www.skybrary.aero/index.php/SH33_-_MD83,_Paris,_CDG,_France,_2000
 5- Runway Incursion, HindSight Magazine No 1, January 2005, EUROCONTROL pp. 7-9, <http://www.skybrary.aero/bookshelf/books/23.pdf>

and impossible to stop their aircraft before reaching the Shorts 330. The MD83 left wingtip went through the flight deck of the Shorts 330, killing the Co-pilot and seriously injuring the Pilot.

The Final Investigation Report of the BEA (the French Accident and Incident Investigation Board), gave the 'Probable Causes' of the accident as the TWR controller's erroneous perception of the position of the aircraft (reinforced by the prevailing context and working methods) which led him to clear the Shorts 330 to line up, the inadequacy of systematic verification procedures which made impossible for the error to be corrected and the crew of the Shorts not dispelling any doubts they had as to the position of the "number one" aircraft before entering the runway. One of six 'Contributory Factors' also identified was "the angle between access taxiway 16 and the runway which made it impossible for the Shorts 330 crew to perform a visual check before entering the runway".

After the accident, the Air Traffic Control Tower (ATCT) decided to ban line ups from any RET⁶.

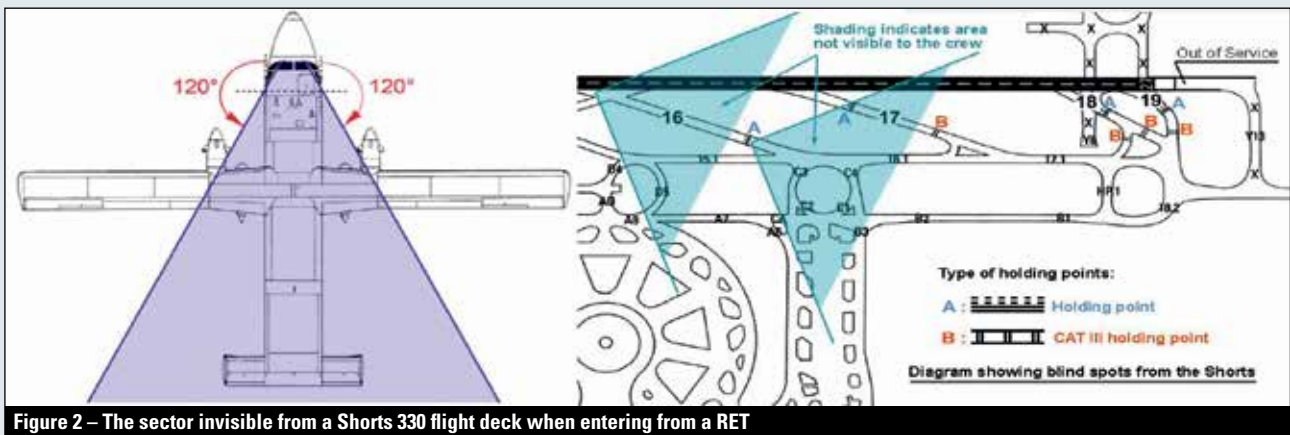


Figure 2 – The sector invisible from a Shorts 330 flight deck when entering from a RET

This rule is since then strictly applied by both the airport operator (Groupe ADP) and the ATCT, even during construction projects where an alleviation could help maintain runway capacity.

This accident was also one of the influences on a large scale taxiway reconfiguration project around Threshold 08L. Between 2011 and 2014, more than 3 hectares of taxiways were reconfigured. While this work was not wholly motivated by runway safety concerns, one of its objectives was to help prevent an accident similar to the collision of May 2000. The threshold area of southern runway 08L was the only one not reconfigured with 90° access taxiways at that time. Taxiways W1 (now T1), WB (now T2), W1 (no longer exists) and the original W2 (now W1) all retained an acute angle recognised as conducive to hazardous runway entry.

Improving an existing airfield infrastructure

These four access taxiways were historically used to queue aircraft near to runway access points to maximise outbound traffic during peak times because of uncertainty about the time it would take aircraft to get from pushback clearance to 'ready-to-line-up'. This uncertainty has now been mostly resolved by the Collaborative Pre-Departure Sequencer (CPDS), component of the local A-CDM (Airport Collaborative Decision Making) in place "CDM@CDG"⁷,⁸. This system reliably estimates taxi times so that departing aircraft can hold on their stand instead of consuming fuel waiting in a queue near the runway threshold.



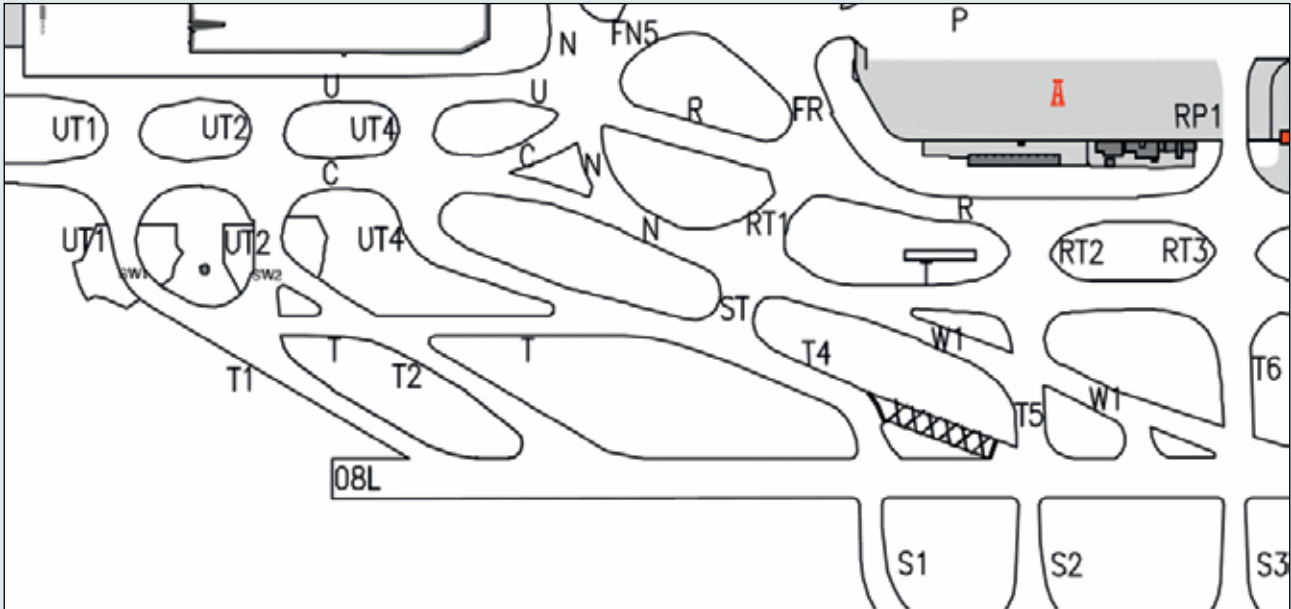
Figure 3 – Taxiway configuration around the runway 08L threshold circa 2005

6- With the exceptions of the Spiral Rapid Exit Taxiways (S-RET) V2, V7, Z2 and Z7 on the outer runways 09L/27R and 08R/26L. These taxiways are the second from the threshold, their layout is a non-standard spiral and it is still possible to see the first taxiway entrance until arriving on the runway itself.

7- [http://www.skybrary.aero/index.php/Airport_Collaborative_Decision_Making_\(A-CDM\)](http://www.skybrary.aero/index.php/Airport_Collaborative_Decision_Making_(A-CDM))

8- <https://www.cdmparis.net/Pages/CONCEPT.aspx>

It was therefore decided to redesign this area. The changes took place over a 4 year period and introduced a new 90° access (T3) and made the other main access taxiways (current T2 to T6) straight or straighter. They also improved the intersections around the former "KILO loop", preventing confusions between taxiways W1 (ex-W2) and TANGO when turning counter clockwise on the loop.



**Figure 4 – Configuration of Threshold 08L in 2011 before the construction works
Note the closure of the angled access between T4 and T5 (ex-W1)**

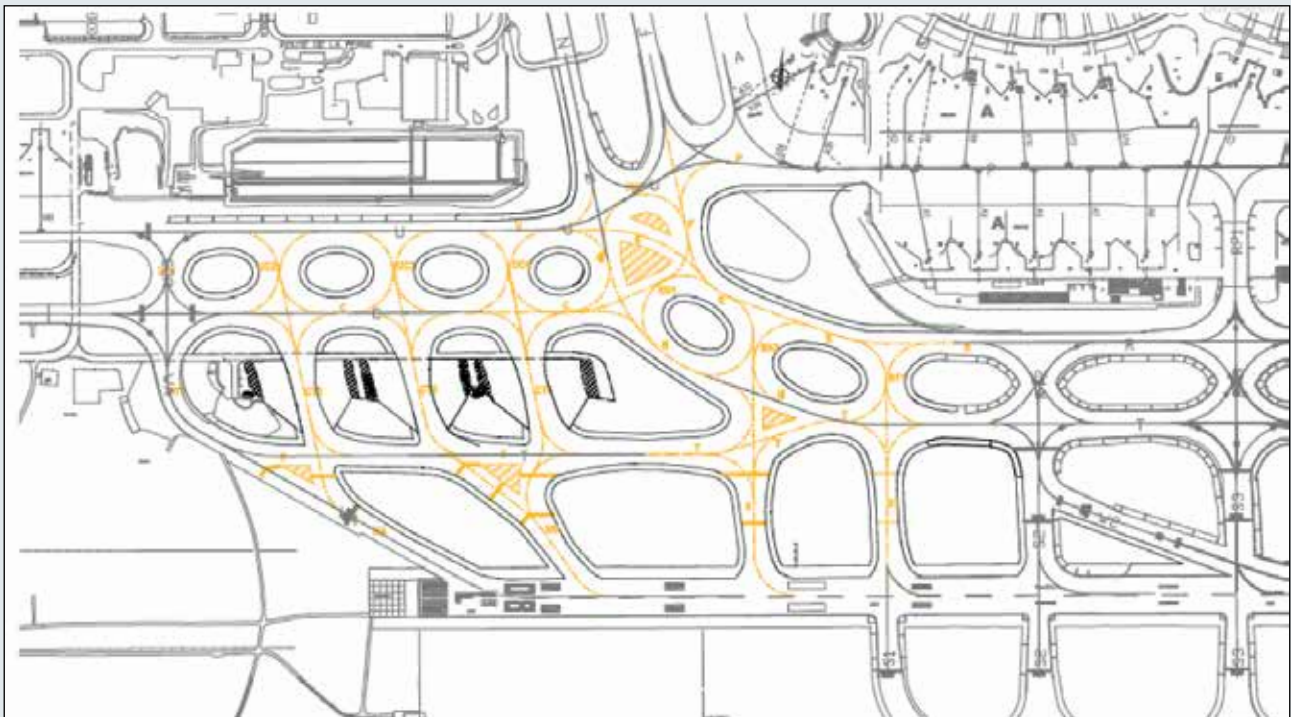


Figure 5 – Configuration of Threshold 08L in 2014 after the construction works

Due to the topography, it was decided that it was not practical to make taxiway T2 a 90° access without compromising the longitudinal slope and the connections from de-icing pads SW1 and SW2. But it was realigned to increase its angle to the runway from 30° to approximately 55° to make a pre-entry visual check of the 08L approach by pilots practicable.

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The final configuration of these access taxiways left 'islands' between taxiway TANGO and taxiways T1 and T2. The main concern was reduce the risk of an aircraft taxiing in the middle not seeing the CAT III stop bar or misunderstanding of the switching off of the entire bar if two aircraft were holding the CAT III holding position at the same time. After considering and consulting on different options with the airside community (e.g. LRST), it was decided to remove the marking and lighting of the holding position between the two entries to T1 and T2 and in both cases to extend the unavailable area markings (yellow hatching) as far as practicable (option N°2). The paths were delineated with blue taxiway edge lights. This final configuration is similar to FAA practices for islands between multiple runway entrances⁹.

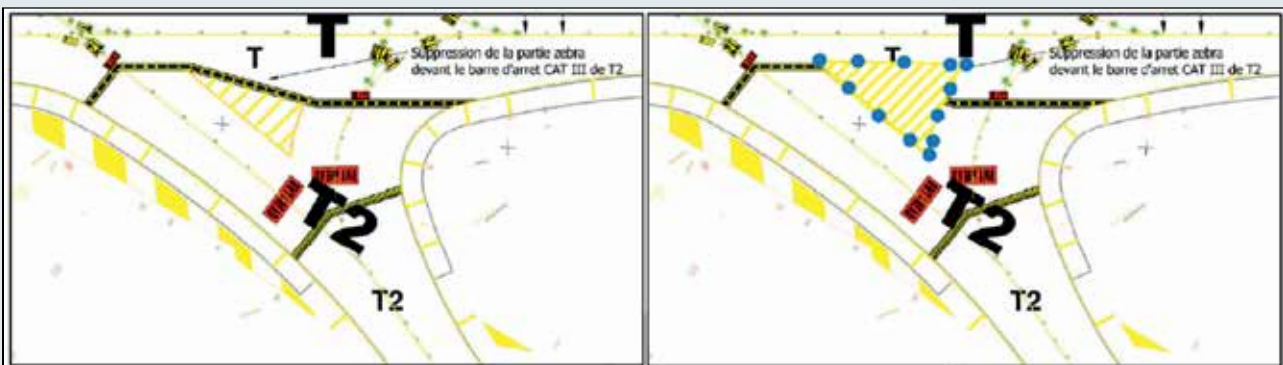


Figure 6 – Project for taxiway T2 (option n°1 on the left / option n°2 on the right)

Simple is beautiful...

Taxiway designations can either reduce runway incursion risks in an existing infrastructure, or they can contribute to the efficiency of a brand new runway. Simple aerodrome layout must be supported by a simple taxiway naming system which is effective in terms of both safety and operational efficiency. The ICAO, FAA and IFALPA have produced guidance and recommendations on this matter and a case study on their application at Paris-CDG was published in HindSight N°21¹⁰.

The most important rules for taxiway naming relevant to the prevention of runway incursions are to:

- use a different set of letters for 90° runway access taxiways and RETs,
- avoid including the number of the closest runway threshold in the designation of access taxiways,
- use different letters for the taxiways on each side of a runway,
- use different numbers (and letters) when a taxiway crosses a runway.

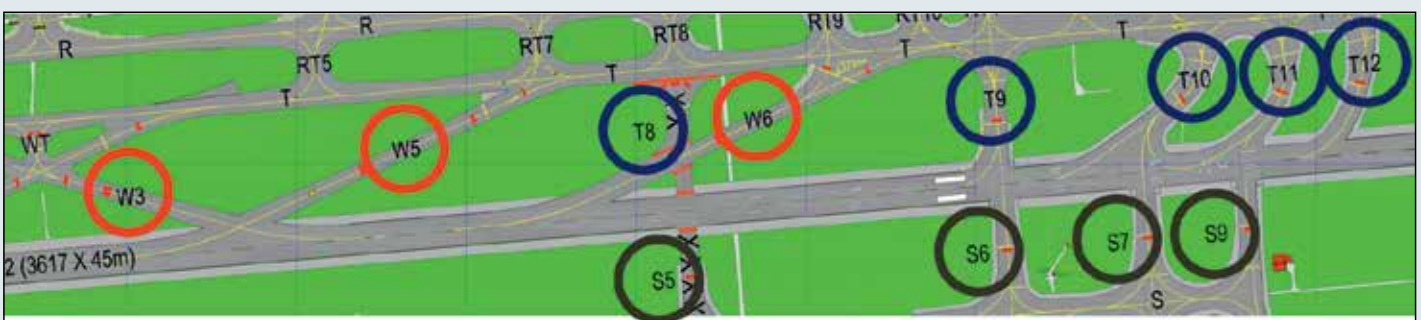


Figure 7 – Taxiway naming system around runway 08L/26R

9- Airport Design, Advisory Circular 150/5300-13A, Section 410, FAA, September 2012, p. 148

10- Le Bris G. and Kintzler M., How to design a simple, safe and efficient taxiway designation system, HindSight Magazine N°21, EUROCONTROL, Summer 2015, pps. 84-88
<http://www.skybrary.aero/bookshelf/books/3088.pdf>



Figure 8 – Temporary information signage at Paris-CDG and Paris-Orly

Mind the gap... Construction Ahead!

From a pilot and air traffic controller perspective, aerodrome layout should be carefully considered when preparing for a construction project which will modify taxi routings and may increase existing runway incursion and collision risks or create new ones. At Paris-CDG, the rehabilitation of taxiway ROMEO south of apron CHARLIE during the autumn of 2015 raised concerns about the potential for runway incursion via RET W2 by aircraft taxiing east around the closed section of the taxiway on taxiway TANGO (see the illustrations above) Controllers were informed about this risk and the Orange Construction Signage (OCS) jointly developed by the FAA and Paris-CDG for this purpose¹¹ was used to increase pilots' situational awareness. Since 2014, this signage has been deployed at various airports in both the United States and Europe.

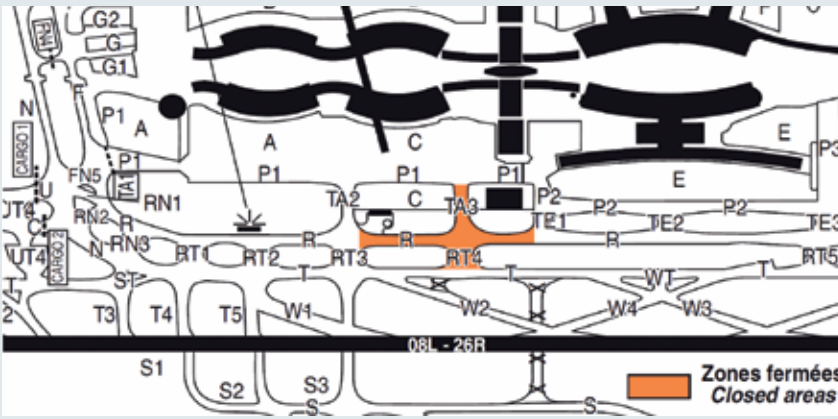


Figure 9 – Rehabilitation of taxiway ROMEO in 2015

The concern about this risk had been founded on a previous incident in October 2007 when a Boeing 747 which had just landed on runway 09L and crossed runway 09R then turned onto RET Y6 from taxiway Q2 instead of continuing as cleared on taxiway QUEBEC.

Usual routing
Modified routing
Risk of mirrouting

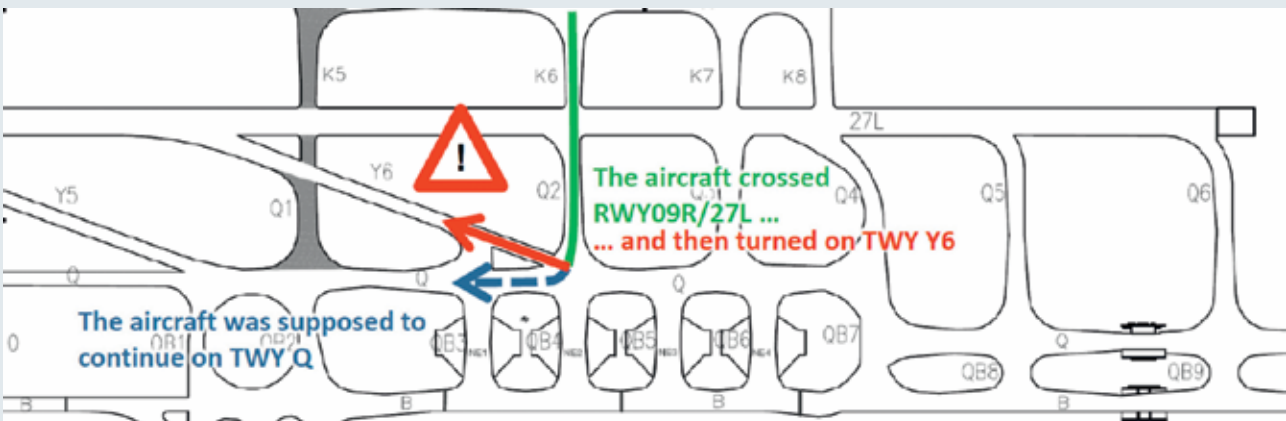


Figure 10 – The erroneous routing which led to a RET incursion in 2007

11- Le Bris G., Siewert D. and Berlucchi R., Enhanced airfield signage to improve situational awareness in the vicinity of aerodrome construction works, HindSight Magazine N°23, EUROCONTROL, Summer 2016, <http://www.skybrary.aero/bookshelf/books/3470.pdf>