RUNWAY END SAFETY AREA

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Abstract: *Statistics indicates that most aircraft incidents and accidents happen on the runway and its surroundings. International Civil Aviation Organization (ICAO) defines an area in extension of the runway end to reduce the risk of death or injury of passengers and damage to the aircraft as a runway end safety area. The paper presents international standards and a recommended practice related to runway end safety area and shows the application of runway end safety area for the Rijeka Airport case through several possible solutions to reduce the consequences of aircraft accidents.*

Keywords: *runway end safety area, airport, safety*

1. INTRODUCTION

Aviation accidents are very rare, but sometimes they occur and can cause loss of human lives and heavy material damage.

The distribution of runway excursions indicates that over 70% of all aviation accidents happen during take off and landing, the phases of flight related to the airport. During the period from 1980 to 2008, there were 1,732 runway excursions recorded [1]. This is the most common type of incidents/accidents in commercial aviation in the world.

A runway excursion represents an event in which aircraft veers off from the runway or overruns the runway. In these cases the consequences could be the damage to aircraft structure, the destruction of facilities on the ground and loss of human lives. Runway excursions cost airline industry about 900 million euro per year [1]. Table 1 shows two types of runway excursions depending on the type of aircraft operations (landing, take-off).

Region	Runway excursion type	Phase of flight	Number of occurrences	Percentage
Worldwide excl. Europe	Overrun	Landing	499	37.1%
	Overrun	Takeoff	144	10.7%
	Veeroff	Landing	535	39.8%
	Veeroff	Takeoff	166	12.4%
Europe	Overrun	Landing	162	41.8%
	Overrun	Takeoff	49	12.6%
	Veeroff	Landing	139	35.8%
	Veeroff	Takeoff	38	9.8%

Table 1 Landing and take off overrun and veer-off

Table 1 shows that over 50% of all aircraft excursions in the world are caused by runway overrun. Separate analysis of European airports confirmed the previous conclusion.

International Civil Aviation Organization (ICAO) has divided runways [2] depending on the equipment for landing (non-instrument and instrument ones) and physical characteristics of the aircraft (wing span and outer main gear wheel span) and runway (aerodrome reference code).

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Non–instrument runways are used for VFR (Visual flight rules) aircraft operations, while the instrument runways are used by aircraft for IFR (Instrument flight rules) operations. Instrument runways are classified into: runways for non–precision approach and runways for precision approach category I, II, IIIA, IIIB and IIIC.

ICAO prescribes a number of safety areas on the ground to reduce the consequences of aircraft accidents in the vicinity of the runway. One of these safety areas is the runway end safety area (RESA), the space behind the end of the runway strip. RESA is flat and in most cases grass field without objects whose purpose is to mitigate the consequences of overrun incidents and accidents. Annex 14 to the Convention on International Civil Aviation – Aerodromes, defines RESA as an area that shall be provided at each end of runway strip where: the code number is 3 or 4 and if the code number is 1 or 2 it is an instrument one. RESA for aerodromes of reference code 3 or 4 must have a length of 90m, as well as for reference code 1 or 2 if runway is an instrument one. ICAO recommends RESA length of 240m for runways of reference code 3 or 4 and 120m for reference code 1 or 2.

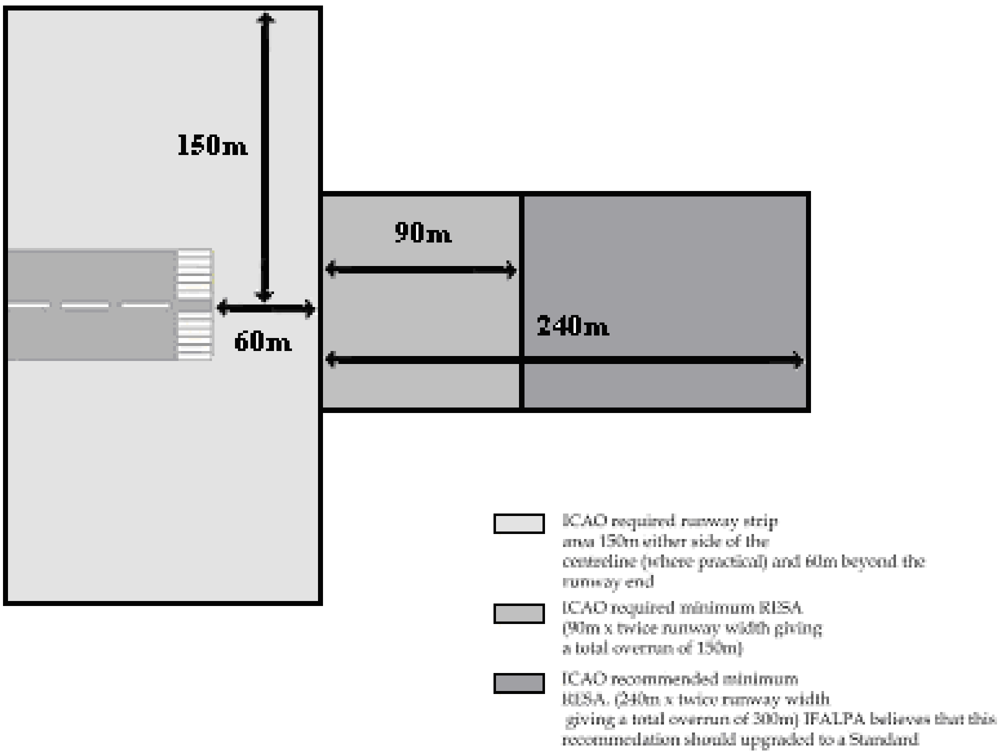

Figure 1 Standards and recommended size of RESA defined by ICAO [2]

2. EXAMPLES OF AIRPORTS IN THE WORLD WITHOUT RECCOMENDED DIMENSIONS OF RESA

The implementation of standards and recommended practices prescribed by ICAO are sometimes faced with difficulties. The application of RESA at some airports is not possible due to physical or other conditions of specific location. These conditions occur in the form of unfavorable terrain, water surfaces (sea, rivers, lakes), roads, parking lots, railroads, buildings, populated areas, fences, etc. which are located behind the end of runway strip. These barriers are located in an area that should be flat and without obstacles. Analysis shows that in some cases restrictions and physical barriers are only some dozens of meters beyond the end of runway. In those cases, which are relatively rare, it is not possible to use either standard or recommended RESA dimension.

Figures 2 and 3 show cases where it is not possible to use the recommended size of RESA because of physical limitations beyond the runway. In both cases the dimensions of RESA are 240m of length and 90m of width.

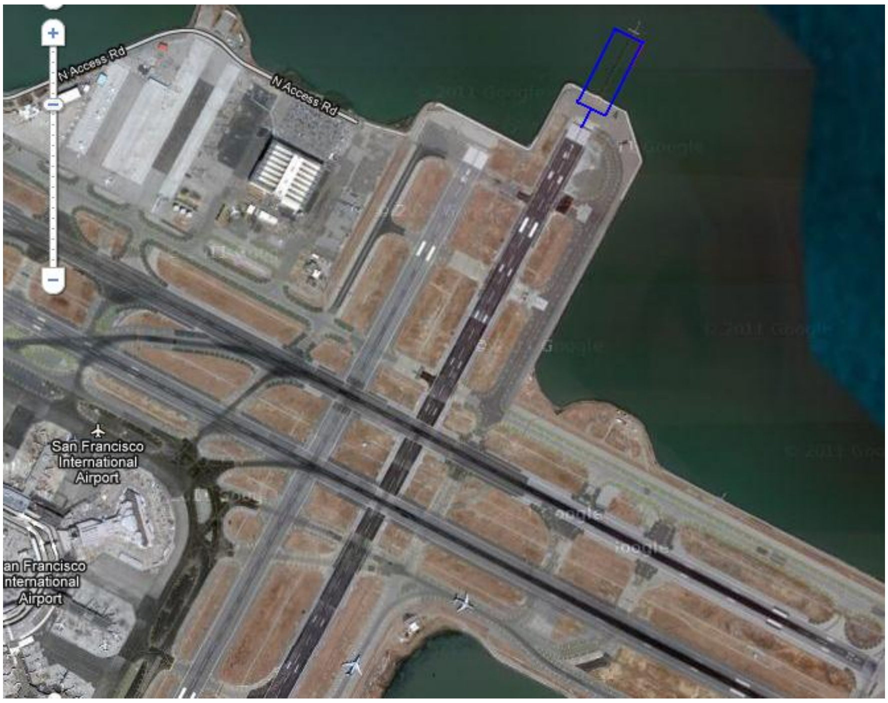

Figure 2 RESA according to Annex 14 at the threshold 19 at San Francisco Airport

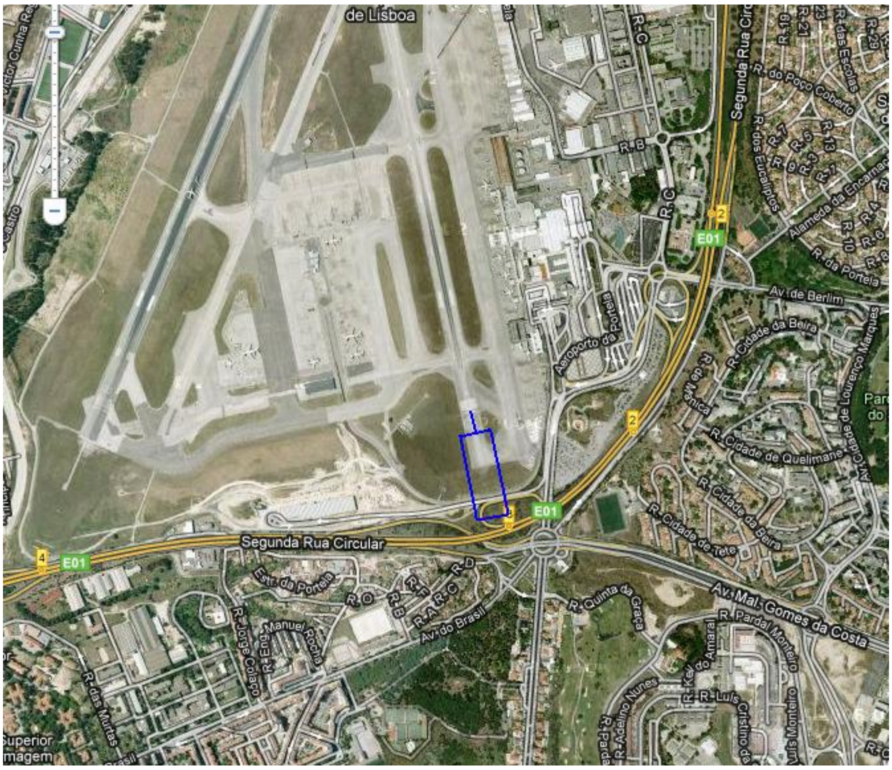

Figure 3 RESA according to Annex 14 at the threshold 19 at Lisbon Airport

Figure 2 shows that RESA is not implemented at San Francisco Airport. Figure 3 shows that at Lisbon airport RESA has not been applied. Possible solutions for the implementation of RESA are described in the next chapter.

3. POSSIBLE SOLUTIONS FOR APPLICATION OF RESA

Possible solutions for the application of RESA are:

1.) Shortening of the runway for full application of the recommended RESA is one of the simplest and cheapest technical solutions used in cases in which there is not enough space behind the runway end;
2.) In cases in which it is not acceptable to shorten the length of the runway, there is a possible solution of buying the surrounding land in order to implement the recommended dimension of RESA;
3.) One of the technical solutions that should be mentioned is a filling terrain in the cases where after the runway end there are bodies of water surfaces or big declines of field;
4.) Construction of an underpass is also one of the possible technical solutions in case of roads, railway lines, or others;
5.) An efficient technical solution is the use of so-called Engineered Material Arresting System and similar systems that reliably stop most of the aircraft that exceeded the length available for landing
6.) Assessment of aircraft accidents occurrence depending on the number operation, weather conditions, etc.

4. POTENTIAL SOLUTIONS OF RESA SHOWN FOR THE RIJEKA AIRPORT-CASE

The Rijeka Airport on both sides of runway does not have enough space within the fence for the application of the recommended dimensions of RESA (see Figure 4). The simplest solution that could be applied to Rijeka Airport is shortening of the length of runway. However, the implementation of this solution should take into account the critical airplane that operationally use Rijeka Airport which requires the maximum length of runway, Boeing 757 – 300. The results suggest that shortening of the runway may cause that aircraft flying at distances of over 2,000NM in particular configuration of the engine and certain atmospheric conditions potentially require the length of runway that exceeds the length of the reduced runway.

Filling up the terrain is also one of the possible solutions in order to implement the recommended dimensions of RESA at the Rijeka Airport. This technical solution is applied on the threshold 32 on the way to purchase land and flatten the terrain behind the paved runway that the longitudinal slope would not exceed 5%. On the threshold 14 it is necessary to build a road underpass which is located 300 meters behind the end of the runway that could be applied for the recommended dimensions of RESA.

Technically sophisticated, but also the most expensive solution is the use of the Engineering Material Arresting System or similar system. The advantage of this system is that it effectively stops almost all types of aircraft at speeds of up to 130 km/h. The price of several millions of USD is the major disadvantage of this system.

Alongside these potential solutions it is necessary to make an assessment of the probability of aircraft incidents/accidents considering that Rijeka Airport recorded only about 2,000 IFR operations. Yearly, compared with other airports, which recorded more than two hundred thousand operations, this number is negligible.

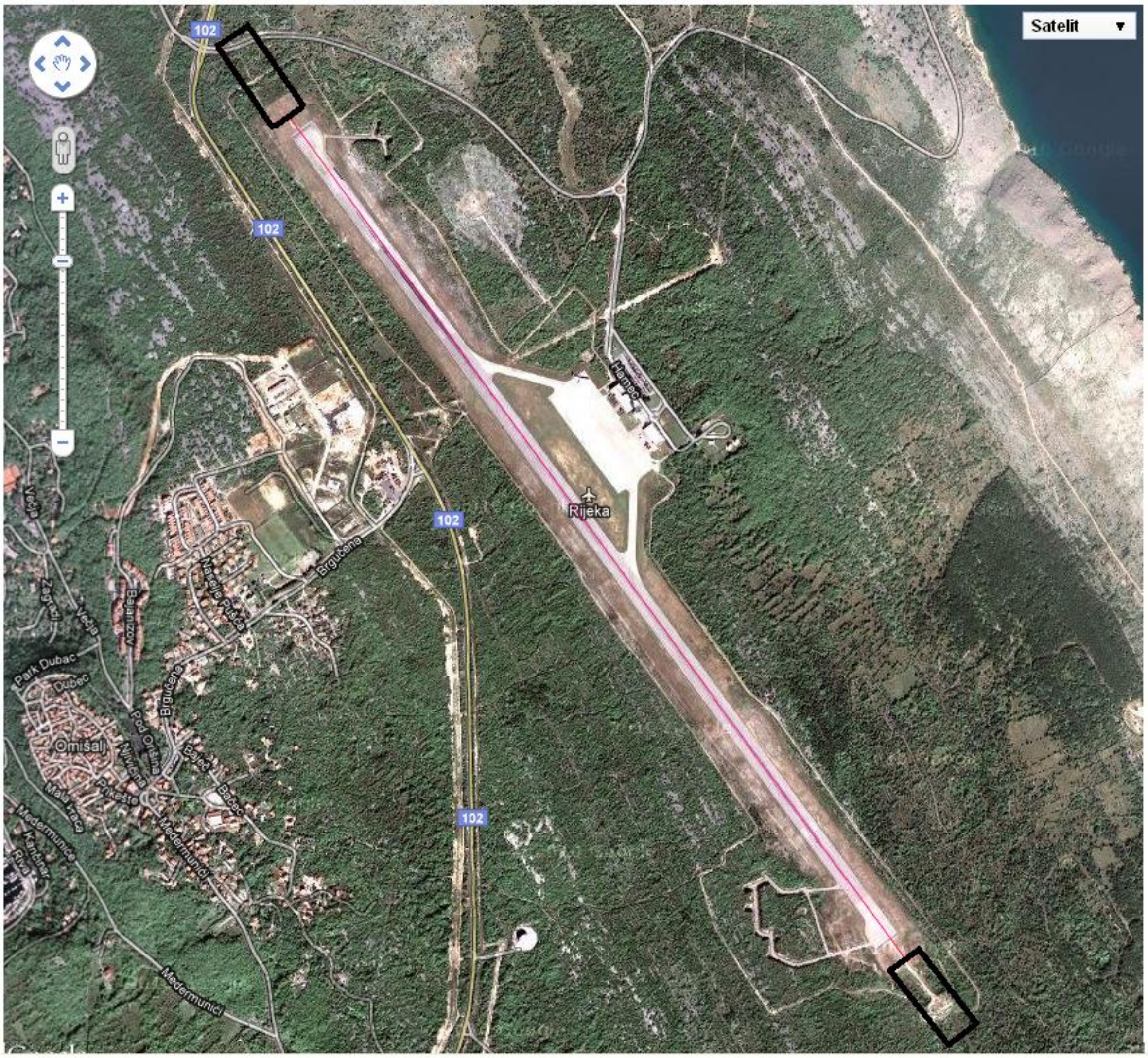

Figure 4 RESA according to Annex 14 at both ends of Rijeka Airport

5. CONCLUSION

In spite of ICAO standards and recommended practices some airports in the world have not implemented RESA. The implementation of RESA is possible by shortening of the runway which is the simplest solution. Acquisition of land and extension of the runway, filling in the terrain or putting road construction or railroad in underpasses or implementing some of the engineering systems which enable short stopping of airplane may represent other solutions. Finally, the assessment of aircraft accident occurrence rate is recommended. For runways with very low number of operations in good weather conditions may-be RESA would not be standard.

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