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Methods of runway overrun prevention

An analysis is made of the existing methods of preventing the aircraft from rolling out beyond the runway.

Hazards associated with runway overruns.

In order to develop risk mitigation strategies and tools, it is important to identify hazards associated with runway overruns:

Weather

- Heavy Showers/Thunderstorms make the runway wet and slippery, making it difficult for the pilot to control the aircraft during landing
- Winds also play a factor due to strong cross or tail winds making it difficult to control the aircraft
- Inaccurate weather information passed by ATC to the pilot due to slow updating of weather devices paint a wrong and misleading picture to pilots causing them to miscalculate their landing techniques

Pilot Error (Human Factors)

- Incorrect judgment in prevailing weather/runway conditions leading to the aircraft landing too long or too fast on the runway
- Incorrect Braking Techniques applied upon landing resulting in insufficient braking force applied rendering the aircraft unable to stop in time
- Incorrect flare technique upon landing
- Failure to arm spoilers prior to landing
- “Missionitis” Mindset making the pilot want to accomplish the mission of landing the aircraft even in adverse weather conditions/ high stress situation when diverting is more appropriate

Aircraft

- Brakes malfunction
- Anti-skid system malfunction
- Hydroplaning

Organization

- Money making especially with the poor economy is of primary importance and the airline company would like all aircraft to land and take off on time and not to divert even in bad weather as it would result in delays and loss of money. [1]

Ways to minimize risk of runway overruns.

From the above, we can conclude that most of the measures currently being developed and being used to reduce the risk of rolling out are organizational and training, as follows:

- *Strict adherence to aircraft SOPs*

If due to prevailing weather conditions SOPs recommend a diversion, it should be followed

- *Knowledge of meteorological conditions*

A good knowledge of the movement of weather, up to date and accurate reports of impending weather would enable the pilot to make informed decisions on whether it is viable and safe to proceed/continue with the flight

- *Sound understanding of aircraft performance and systems*

This would enable pilots to know the capabilities and limitations of the aircraft in bad weather and to select the correct landing configuration in adverse situations

- *Communications and teamwork*

Good two way communications and teamwork between the pilots are important as there can be occasions when a senior pilot might want to press on to land even though the junior pilot feels otherwise leading to poor teamwork and coordination prior to a probable difficult landing

- *Organization/ Company mission*

The mission of an organization should encourage flights to be completed safely at all times instead of a flight HAS to be completed at all times because of profits; this will not put adverse pressure on the pilots to complete the flight at all costs even in bad situations

- *Training*

Only with proper training comes the experience and expertise to mentally prepare the pilot for a safe landing in bad conditions

In addition to organizational measures to prevent the rolling out of the aircraft beyond the runway, there are technical methods that can be divided into ground and airborne. [2] The most effective for today methods to minimize risk of runway overruns are Engineered Material Arresting System and Runway Overrun Prevention System.

Engineered Material Arresting System (EMAS)

An Engineered Materials Arresting System uses a specially installed surface which quickly stops any aircraft that moves onto it. EMAS may be installed at the end of some runways to reduce the extent, and associated risks, of any overrun off the end of the runway compared to the equivalent soft ground distance. As such it may be an alternative to a RESA where the topography precludes the full recommended length of a RESA or it may be used in addition to a full length RESA where precipitous terrain immediately follows the end of the RESA.

The design of the Zodiac Aerospace EMAS product is predicated on being able to cope with the overrun speeds that have occurred in the past and the aircraft sizes which may use particular runways. Each installation is adapted to the prevailing environmental circumstances and a maximum EMAS entry speed by aircraft type. It meets all the requirements of the applicable FAA guidance.

The Zodiac EMAS is a bed of cellular cement blocks encased in a protective cover positioned after a ‘setback distance’ which begins immediately after the end of the paved runway surface. The blocks crush reliably and predictably under the weight of an aircraft and thus facilitate a rapid but nevertheless gentle and consistent deceleration. Each lightweight block is secured to the EMAS base with hot asphalt and the seams between blocks are then taped at their upper surface to prevent water penetration. The depth of the EMAS bed gradually increases with increasing distance from the runway, typically from around 25cm up to 75cm.

An FAA-approved computer model of the wheel / compacted cellular cement interface is used to determine the required arrestor bed configuration according to aircraft weight and EMAS entry speed. The heaviest aircraft will usually be the 'critical aircraft' but, since landing gear configuration and tyre pressures are also relevant, this does not hold universally.

Each system is also designed to take account of runway length / width, elevation, and the length and slope of the available installation area. Performance usually takes account of aircraft types which have more than 500 movements per year and assumes that these aircraft will be operating at 100% of runway MTOM or 80% of runway MLW. Most installations to date have used a maximum 70 knots bed-entry speed. [3].

Runway Overrun Prevention System (ROPS)

ROPS is an Airbus system designed to continuously calculate whether the aircraft can safely stop in the runway length remaining ahead of the aircraft. If at any point the system detects there is a risk of a runway overrun, flight deck alerts are generated to help the crew in their decision making. ROPS is hosted in the aircraft avionics. The system has access to the parameters which affect an aircraft's stop distance, such as:

- Aircraft position
- Aircraft & engine type
- Aircraft weight
- Ground speed
- Outside air temperature
- Slat/Flap configuration
- True and calibrated airspeed
- Wind
- CG

ROPS is also connected to a runway database. The source of the runway database may be the Terrain Avoidance and Warning System (TAWS) or the Onboard Airport Navigation System (OANS). ROPS automatically detects the current landing runway using the runway database.

ROPS is made up of two sub-functions, Runway Overrun Warning (ROW) and Runway Overrun Protection (ROP). The ROW function generates alerts which incite the flight crew to perform a Go-Around whereas the ROP function generates alerts which incite the flight crew to apply available deceleration means.

ROW becomes active at 500ft and remains active throughout short-final, the flare and touchdown until transition to ROP. ROW stopping distances are based on the same principles as the Airbus In-Flight Landing Distances.

On Airbus A380, A330 and AIRBUS A-320 family, ROW continuously calculates two stopping distances, the stopping distance on a DRY runway and the stopping distance on a WET runway. If the stopping distance on a WET runway becomes longer than the available runway length, the system triggers an amber message on the PFD "IF WET: RWY TOO SHORT". If the stopping distance on a DRY runway becomes longer than the available runway length, the system triggers a red message on the PFD “RWY TOO SHORT” and a below 200ft an aural message “RUNWAY TOO SHORT”. On the Airbus A350, the flight crew has a runway state selector knob on the instrument panel. Consequently, ROW predicted stop distance is based on the runway state selected by the crew and thus ROW alerts are directly “RWY TOO SHORT” corresponding to the flight crew selection. At entry-into-service of the A350, the runway states DRY and WET are available for pilot selection. Extension to contaminated runway states is planned.

ROP becomes active on-ground after transition from ROW and remains active until taxiing speed. ROP uses the aircraft’s current deceleration and aircraft characteristics to determine where the aircraft can safely stop on the runway. If ROP detects a risk of runway overrun, aural and visual alerts are triggered. On the PFD the red visual alert “MAX BRAKING, MAX REVERSE” is displayed. Aural alerts are prioritized: “BRAKE, MAX BRAKING, MAX BRAKING” aural alert is triggered until pilot application of pedal braking, then aural alert “SET MAX REVERSE” if maximum reverse thrust has not been selected. If overrun condition still exists at 70kt, the aural alert “KEEP MAX REVERSE” will trigger to remind the flight crew to keep maximum reverse thrust.

ROP is reversible and alerts are cancelled when overrun risk is no longer present. On the Airbus A380 and A350, if an Autobrake mode is engaged, ROP will automatically apply maximum braking in case of runway overrun risk. ROPS and Navigation Display

On the Airbus A380 and A350, ROPS is integrated with the aircraft flight management and navigation systems and provides pilots with a real-time, constantly updated picture on the navigation display of where the aircraft will stop on the runway in WET or DRY conditions (or pilot selected runway condition for A350).[4][5].

Conclusion

Runway excursions continue to be the most common type of accident in business aviation. The first step in mitigating risk is to raise the level of awareness and developed runway overrun prevention system

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