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IFALPA

POSITION PAPER

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LOC-I and Aircraft Trim Systems

NOTE

This paper supersedes 19POS03, of the same name.

BACKGROUND

Loss of Control In-flight (LOC-I) events are accidents or incidents in which the control of the aircraft in flight is lost, resulting in major deviations from the intended flight path. In the decade 2019-2024, LOC-I airplane accidents have overtaken CFIT, Controlled Flight into Terrain-related ones as the first contributor to fatalities in commercial aviation[1]. They have remained one of the major causes of fatal accidents in aviation.

PRELIMINARY ANALYSIS

Trim system

Historically, an aircraft trim system was needed to reduce control loads on the three axes: pitch, roll, and yaw. With the development of flight control systems as well as Fly-By-Wire (FBW) designs, pilots are now fully assisted in trimming the aircraft throughout the entire flight envelope. Therefore, depending on aircraft type, trim can be partially or completely transparent to flight crews.

Loss of Control related to trim system

Some occurrences involving trim issues have happened in all phases of flight. The out-of-trim conditions resulted principally from:

- Unsafe automatic trimming due to previous system failures (trim runaway, auto trim beyond normal limits up to mechanical or electrical stops, trim failure or trim degraded modes).

- Normal automatic trimming for a specific phase of flight immediately followed by large aerodynamics and thrust modification. Under-speed high-nose-up trimmed approach followed by a go-around maneuver is a typical example, and there is currently rulemaking activity happening on this specific subject[2].

[1] IATA, (2016). *2010-2014 LOC-I Accident Analysis Report*, 1st edition.
[2] EASA, (2018). *European Decision 2018/005 CS25*, Amendment 21.

- Improper manual trim (switch confusion, spatial disorientation).

In most cases, and regardless of the initial scenario, the maximum out-of-trim condition happened quickly (less than one minute) and was reached before, or at the very beginning of, the overall event. It was often not recognized as such by crews. Typical subsequent warnings included auto-pilot disconnection alarms (manual or consequently to failures), stick shaker and/or bank angle warnings with or without flight law reconfiguration and protections activation.

Most of the time, crews have only indirect cues and are not fully aware of the trim setting. In other words, they don't know the position of some of the main flight control surfaces in terms of authority (i.e. rudder or trimmable horizontal stabilizer). There have been numerous accidents and incidents in recent years where flight crews did not even try to operate the trim switches at all. If they did so, it was only after 1 or 2 minutes.

Moreover, some occurrence reports have considered an out-of-trim condition as the initial failure rather than a contributing factor. There is often a lack of full data on trim position (on the three axes), and stress is preferentially put on the controls and thrust inputs and not on trim dynamics.

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Prevention objectives

In order to mitigate such trim-related risks, IFALPA recommends the following actions:

- To provide flight crews with tools allowing them to detect and recognize immediately dangerous out-of-trim conditions as well as trim degraded mode operation or failures.

- To enable the flight crew to manually override an automatic trim system input.

- To enhance and maintain flight crew proficiency and skills to deal with full or partial out-of-trim conditions.

- To enhance knowledge and awareness of this type of accident by systematically including and analyzing trim data as part of the occurrence reporting process.

Display of trim information, alerts, and warnings

While the display of trim information and/or associated alerts can be designed in various ways, any detected or predicted abnormal trim conditions should trigger, in a

timely manner, clear visual/aural alerts or warnings with as much information as relevant to understand the situation.

Since the trim system can be faulty by itself (i.e. trim overrun) or in degraded mode (i.e. icing), the monitoring should be as simple as possible and could rely, for example, on direct surface sensing. Priority of alerts and warnings should be considered, since most trim upsets lead to multiple alarm conditions. Particular attention should be paid to the avoidance of false positive alarms.

Additionally, IFALPA would welcome the introduction of any display designed to help pilots recognize an impeding excursion outside the flight envelope as an additional tool to avoid out-of-trim conditions.

Out-of-Trim detection and recovery training[3]

Even if trimming is now simplified in modern FBW aircraft, trim-related training is important during initial and operational and recurrent training. The following elements should be included in the training:

- Manual flying skills, in non-normal flight laws when manual trimming is required. This should include all trimmable axes.

- Stalls or Upset recovery from partial or full out-of-trim conditions on different axes. (i.e. "trimmed stalls") in order to mitigate the startle effect. Training should include increased awareness of the possibility of an out-of-trim condition upon autopilot disconnection.

- Review of normal, abnormal, and emergency manoeuvres or conditions where trim may be required as per SOP.

- Flight controls characteristics, specificity of the trim system design, elevators or ailerons authority limitations (if they exist) and thrust pitch moment management.

[3] ICAO, (2014). *Doc 10011 - Manual on Aeroplane Upset Prevention and Recovery Training*.