New aspects in FIS installation and certification

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ABSTRACT

FIS integration and certification is mandatory for legal operations of Flight Inspection Systems. This presentation highlights new regulations and their consequences.

A new regulation is in place at EASA dealing with the training and familiarization of personnel working with and dispatch conditions of new equipment on board. The EASA CS-FCD (Certification Specification Flight Crew Data) requires detailed analysis about requirement of additional pilot training, while CS-MMEL (Minimum Equipment List) regulates the dispatch condition of an aircraft with additional equipment installed. Especially after two major accidents with passenger aircraft with manufacturers decision not to train pilots on these new systems, this discussion is mandatory and under special emphasis for all installations.

Numerous questions for the operation and certification of Flight Inspection Aircraft have to be taken into consideration:

Who is allowed to physically work/modify the FIS equipment, change of boxes, calibrate with connecting and disconnecting wiring for calibration and conduct hardware upgrades?
How do new mandatory systems like TAWS/GPWS with permanent warnings or TCAS systems designed for normal enroute separation affect the flight in special Flight Inspection procedures?
How can modern compact fully digital and closed avionics systems be combined with the FIS installation?
Is it legal to install temporary/mobile test equipment in any aircraft and operate it in commercial Flight Inspection role without individual certification?
How do current regulations about High Intensity Radiated Fields (HIRF) from outside effect certification?
How can Personal Elctronic Devices (PEDs) safely be operated in the aircraft?
All these items need to be addressed prior to writing a specification for a new Flight Inspection Aircraft to avoid any impact in operation by the authorities later.

Different local regulations and special focus of the certification agencies may apply.

INTRODUCTION

Within certification and maintenance aspects the regulations change/increase constantly and include current topics, typically gained from mishaps, accidents in the past or new technologies.

An installation of a Flight Inspection System has to cover several aspects:

- Regarding airwortiness:
    - Operation must be safe for aircrew and environment
    - All installations must be certified for operation in flight
- Regarding operation:
    - It must be built in high quality in order to operate reliable
    - Must work with high accuracy

The following Airworthiness aspects are discussed

- Flight Crew Training
- Cabin Crew Training
- Maintenance Crew Training
- Master Minimum Equipment List (MMEL)
- Disabling of standard equipment
- FIS Maintenance
- Wireless Local Area network (WiFi)
- Personal Electronic Devices (PEDs)
- Lithium Batteries
- Temporary Test Equipment
- High Intensity Radiated Fields (HIRF)
- LASER

The following topics are required to cover when changes to the aircraft certification is made and the aircraft is registered in the European Union.

Other (non EASA) authorities have similar, but not necessary identical discussions going on.

FLIGHT CREW TRAINING

The FIS installation changes the standard cockpit. The pilots have to be fully aware of all modifications and their functions.

Therefore, the agencies have issued a new set of certification specifications.

Figure 1 EASA Title CS-FCD

As part of the certification process, it has to be decided, whether and which kind of additional training for the pilots is required.

Examples:

- New Limitations (published in the Flight manual supplement). The limitations published are based on a safety assessment for the complex system integration. If not followed by the pilots, the safety concept may be undermined.
- Unusual Flight procedures have to be flown in flight inspection missions. One example if flying below glide path or below MSA (minimum safe altitude) in orbits. This is unusual for standard pilots and limitations (e.g. alternative navigation sources or weather minima) must be observed.
- Cockpit flight guidance can use the FIS as a source. Cockpit crew must be aware, that these signals may be different to the expectations of the pilots. Crew coordination and "safe track observation" must be established in the cockpit.
- Complex intercom and additional audio. The audio system in the aircraft is typically enhanced by audio signals from the FIS or additional navigation/communication equipment in the cockpit (e.g. FIS VHF, FIS UHF, TACAN, SATCOM…). Pilots must be aware how to use this systems to avoid confusion or high workload in the cockpit.
- Disabling of standard safety systems may be a feature of the system integration. This can be TAWS/GPWS disabling to avoid permanent call-outs of theses warning systems in low-level flight inspection procedures. Therefore, these (mandatory) systems can be disabled and must be enabled in normal flight. Wrong operation may have negative safety impact on the aircraft operation.

What happens if you do not train pilots: See 737 MAX accidents, where complex systems not completely known to the pilots took control of the aircraft, not clearly indicated to the cockpit crew.

Establishing of new cockpit crew data is required if the initial aircraft has published OS-FCDs and the aircraft is registered in the European Union.

CABIN CREW TRAINING

In larger aircraft the cabin crew is part of the safety concept. They are trained to ensure cabin safety, support passengers in case of emergencies and are trained for fire fighting as first responder.

If any changes to the cabin are made (e.g. installation of a FIS console, blocking of emergency exits, change of oxygen masks, relocating of fire fighting equipment…), it must be verified, that no impact to the safety of the cabin is caused by the new installations.

Establishing of new cabin crew data is required, if the initial aircraft has published OSD-CCDs and the aircraft is registered in the European Union.

A small aircraft, where no cabin crew is required, can be operated without new cabin crew procedures. In this case, the pilot is solely responsible for cabin safety.

Figure 2 EASA Title CS-CCD

MAINTENANCE CREW TRAINING

The FIS installation may change the maintenance procedures of the aircraft.

Therefore, the agencies have issued a new set of certification requirements.

As part of the process it has to be decided, whether and which additional training for the maintenance staff is required.

Examples:

- Installations on non-metal surfaces or complex structures
- Shared use of primary equipment
- Change of maintenance intervals or additional tests

What happens if you do not train maintenance staff: Safety concept of the aircraft may be undermined

Figure 3 EASA Title CS-MSCD

In a small aircraft, it is not likely to issue new MCSD, but it has to be addressed in the certification program.

MASTER MINIMUM EQUIPMENT LIST (MMEL)

The FIS installation adds new equipment to the aircraft. As a general rule, all equipment on board must be serviceable for dispatch, if not otherwise excluded.

As part of the certification process, it can be decided to allow dispatch with certain FIS equipment not installed or not serviceable. Then a partly serviceable FIS can still legally be used.

Examples:

- FIS equipment not installed which is not required this flight. This may be e.g. ADF, second NAV, TACAN, UHF COM, FIS XPDR or other equipment not required for this flight. This condition must be taken into account in the FIS flight planning. The crew must be aware of this limited operation capability and any effect to aircraft data, e.g. weight and balance changes must be available to the pilots.
- Some equipment may not be transported or used outside a certain region due to export regulations. To enable flight in those foreign countries this special equipment has to be taken out and must stay e.g. at the home base. Typical affected systems are military type like TACAN and UHF or special data links, when no license for the foreign country is available.
- Some other aircraft installed equipment can be excluded as required operationally by the MMEL. An example is SATCOM, if not required by ATC procedures, or some indicators or equipment which is for crew comfort only, e.g. power supply for active noise reduction headsets. Each equipment or function, which shall allow dispatch with a non-serviceable unit, must be explicitly listed in the MMEL and repair or re-installation schedule must be published.

Figure 4 EASA Title CS-MSCD

The preparation of a new MMEL is not mandatory with an EASA certification, but is very handy for the operator to reduce possible down time of the aircraft and clearly point out the legal status for dispatch. The maintenance organization may not sign an aircraft serviceable with equipment unserviceable, unless allowed by aircraft MEL or MMEL

A standard aircraft has already a Minimum equipment list (MEL) by the aircraft manufacturer. This may not be undermined by the new MMEL

DISABLING OF STANDARD EQUIPMENT

Some equipment in the aircraft is mandatory for flights in special areas or under special operations.

Examples:

- Mode S Transponder with or without ADS-B
- Terrain Avoidance Warning System TAWS/GPWS

Disabling or altering such equipment is not permitted without a dedicated certification and permission by the authorities.

Technical installations for disabling these units while some flight inspection mission flights can be installed. Operation and limitations must be described in the AFM supplement and pilots must be aware of missing safety functions.

In many countries a serviceable Mode S transponder is mandatory for any powered flight. It is assumed, that the data sent from this equipment is correct and can be used for ATC, e.g. a correct altitude indication or valid ADS-B data. If a special test for flight inspection is required, e.g. a low altitude transponder indication with the aircraft operating in a safe height to check ATC alarms is performed, special permission of ATC or authorities may be required. Wrong indications may otherwise confuse ATC and other aircraft´s TCAS and initiate unnecessary collision avoidance maneuvers.

To avoid permanent alarms of a GPWS/TAWS installation, in some flight inspection procedures (e.g. low level run with gear up) it is very convenient to switch off these alarms. This procedure must be certified with the authorities and will be published in the airplane flight manual supplement.

FIS MAINTENANCE

The FIS needs regular maintenance, but is part of the aircraft and therefore only certified maintenance organizations may work on it. The detailed technical knowledge of the FIS is often only available at specialists, which are not aircraft certified personnel.

It has to be agreed with the authorities, who may work on the FIS and who can release the aircraft to service after FIS maintenance. This will be an agreement between the aircraft operator and local authorities, not directly related to the initial FIS installation certification.

What happens if you do not follow standard aircraft maintenance practices? Aircraft may not be released to service after FIS maintenance or a release to service is issued illegally.

WIRELESS LOCAL AREA NETWORK (WIFI)

Modern mobile computer and tablets are designed to connect to a wireless network. Passengers or crew may bring such equipment on board. Operation, especially with connection to an aircraft wireless network, is only permitted, if the aircraft is certified for using theses network in flight or on pilot´s decision.

With the FIS there may be an additional mobile computer or tablet, connected to a FIS-internal wireless network to show flight inspection results or start parallel measurement procedures without dedicated action of the flight inspector. This may be configuring result pages or operation of non-standard equipment like a spectrum analyzer or direction finder.

In the certification process, it has to be demonstrated, how it can be assured, that the operation of a local wireless network is creating no safety effect to the aircraft. Several approaches are possible; a standard procedure is very complicated due to unknown types and specification of future personal electronic devices, being no aircraft- but standard Commercial of the shelf (COTS) consumer equipment.

Operation of the wireless network may be permitted in some flight phases only, e.g. only in enroute above a certain height. Take off and landing may be excluded.

No standard document is available, how to permit this Wifi operation and an individual approach has to be agreed with the authorities. This requires typically an individual CRI-process (certification review item).

PERSONAL ELECTRONIC DEVICES (PEDS

Personal Electronic Devices (PED) get more and more common in aircraft. This includes operation in FIS aircraft of this equipment designed to operate in cockpit and cabin.

Many papers of the agencies show up to this topic, one approach is shown below.

Figure 5 EASA Title CM ES-003 PED tolerance

PEDs may create hazards to the aircraft. The main concerns are electromagnetic interference with aircraft systems and fire related issues caused by the PED batteries.

Therefore, before an operator may permit the use of any kind of PED on-board, it should be ensured, that these PEDs have no impact on the safe operation of the aircraft. The operator should demonstrate that PEDs do not interfere with on-board electronic systems and equipment, especially with the aircraft's navigation and communication systems.

Operation may be permitted in some flight phases only.

Fire hazards caused by Lithium batteries are discussed in the following chapter.

LITHIUM BATTERIES

Lithium Batteries in Personal Electronic Devices and other supporting equipment are more and more used on board.

Alerted by an increasing numbers of in-flight fires, the agencies are preparing guidance material defining how this equipment can be safely used in the aircraft.

The main concern is a battery fire, which can:

- Not be detected by the crew in the initial phase caused by non visible storage locations of the equipment
- No fire fighting is possible because no special equipment is available
- Ignition of other equipment due to high temperatures
- Create dangerous or toxic smoke to the crew or passengers

While the certification process, equipment with lithium batteries has to be identified and operational and fire fighting procedures have to be published to the operator and crew. One part of it can be dedicated storage compartments.

Limitations to battery size and flight phases may apply.

A current example, issued March 2022, pointed to the risk of a potential PED fire related to the stowage location:

EASA
European Union Aviation Safety Agency

Airworthiness Directive
AD No.: 2022-0050
Issued: 22 March 2022

Reason:
EASA issued Continuing Airworthiness Review Item (CARI) 25-09 requesting Type Certificate Holders to investigate the potential risk of in-flight fire of lithium batteries installed in Personal Electronic Devices (PED). PED stowage locations in the flight deck may be located in the proximity of oxygen lines, oxygen mask boxes and/or other critical system components.

TEMPORARY TEST EQUIPMENT

From time to time requests show up, to install new test equipment in a temporary way at the FIS to make a feasibility study and gather some data.

Is this legal?

No. Not according to EASA rules. Any modifications at the installed systems are not legal, unless they are certified again.

This typical requires a new Supplemental Type Certificate (STC) or a minor change approval. This is often more costly than the additional equipment.

HIGH INTENSITY RADIATED FIELDS (HIRF)

The ceretification § CS23.1308 staest, that “Each electrical and electronic system that performs a function whose failure would prevent the continued safe flight and landing of the aeroplane must be designed and installed so that……

..the functions are not affected during the exposition and automatically recover”.

HIRF only occurs when passing a very strong electromagnetic transmission beam. This can be very powerful communication transmitters or RADAR stations.

The certification must show that no negative effect to the airplane of these strong fields arises caused by the FIS installation.

What happens if you do not follow the rules, examples:

- Engine control (FADEC) may shut down
- Audio system decodes pulses (common problem), e.g. RADAR

Figure 6 EASA Title HIRF

HIRF studies can be by comparison to already certified installations or by a full HIRF test in a test laboratory.

LASER

In a flight inspection aircraft in some configurations an airborne LASER system may be installed.

Typical applications are height reference system to compare with the radio altimeter or height determination for a camera system. Both applications may radiate powerful light pulses, which could cause harm people or installations on ground.

To avoid any negative effect to external people, a safety assessment has to be performed to determine any risk. The risk depends on, but not limited to:

- Radiated energy
- Color spectrum
- Beam characteristics
- Location of operation
- Eye-safe status with or without optical instruments.

An overview of the process is presented in an EASA certification memorandum.

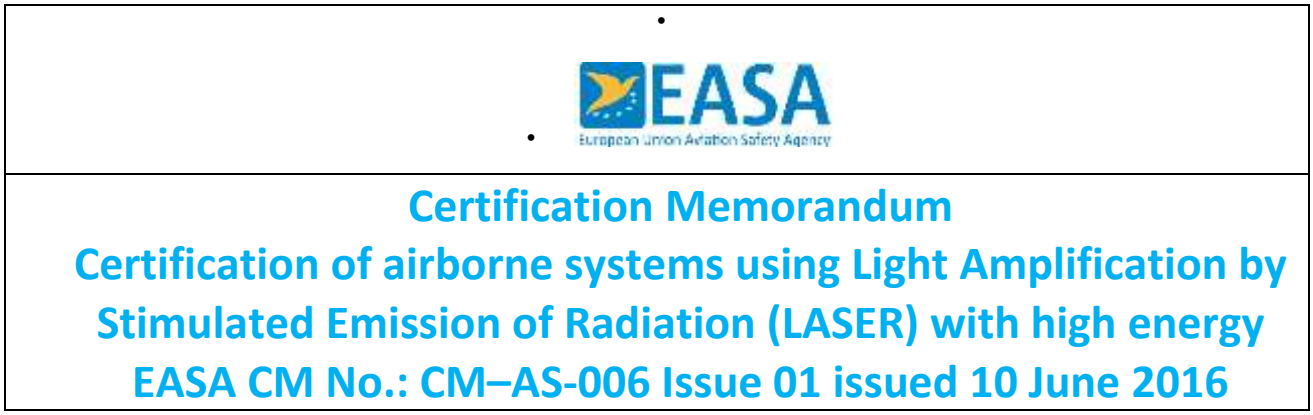

Figure 7 EASA Title LASER

The best way to overcome a complex certification process is to select a LASER with little output power, which is safe by design and has a dedicated safety assessment available by the manufacturer.

CONCLUSION

The certification requirements given by the regulators are constantly increasing. New aspects of airworthiness topics, resulting from mishaps, accidents or new technologies make the certification process more complex. At least a statement concerning a topic has to be presented, but sometimes a complete report. Each of these elements can be a show stopper for a timely certification process if not taken into account at the very beginning of an installation project.

A continuous monitoring of new regulations and appropriate training for the involved staff is required.

This makes certification now and in the future not easier, but hopefully safer.