FIS Data Integrity

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ABSTRACT
This paper aims at discussing the various aspects of data integrity in a flight inspection environment. The various elements constituting the data integrity realm in this respect are shown and discussed. Methods and concept to work with and handle data integrity are discussed.

INTRODUCTION
In a modern flight inspection system, data is collected and computed with almost no human intervention. The final report of the navaid facility under inspection may be printed and ready for the inspector to sign with only a few keystrokes.
Although the level of automation is high, one must not forget all the essential parameters and factors that contribute to making the final result. There are many pitfalls that may lead to erroneous results.
Potentially, the increased automation may make the inspector less aware of the process, and the importance and influence of the various parameters. This may lead to problems going undetected, or at least causing extra efforts to understand where the problem lies.
Ironically, it is this same increased automation that may provide increased control, understanding and data integrity – when used the correct way. To do this, one has to understand the actual elements making up the data integrity in a flight inspection system and organization.

FLIGHT INSPECTION DATA INTEGRITY ELEMENTS
What elements are actually of interest when speaking of data integrity in flight inspection? Let us look at a typical system and organization, and see where such elements occur.

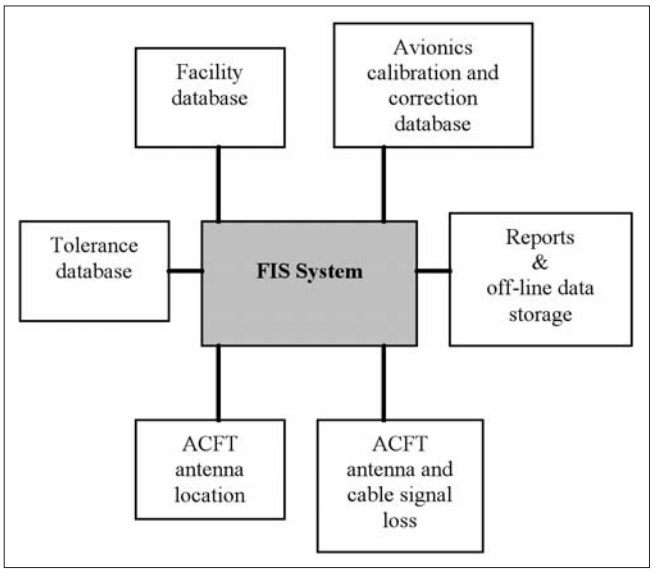


Figure 1 - Typical data integrity elements

There are many various forms for information required by a flight inspection system to be able to perform its tasks successfully with the expected quality of the result. Let us look a bit more in detail on some of these items.

Facility Database
The facility database holds the vital information about the navaid under inspection. When inspecting a localizer, the exact location of the localizer must be known to the FIS system.

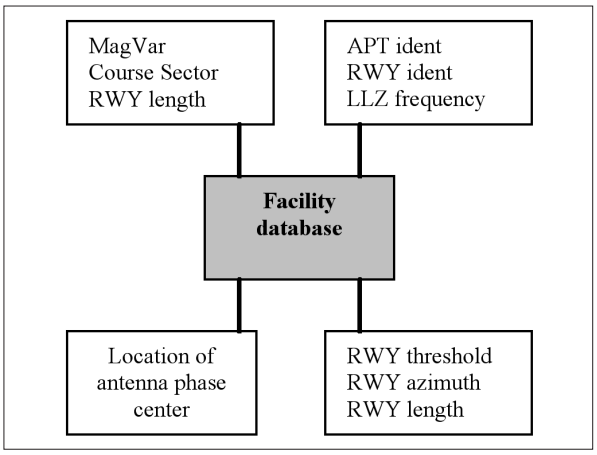


Figure 2 – Typical LLZ facility information

In addition parameters such as runway heading, runway length, course sector and magnetic deviation are necessary to perform the calculations required.
The actual detailed information of the various facility parameters requires very high accuracy. Site surveys of such accuracy may not have been performed until the flight inspection organization requests it. This is yet another factor in the data integrity realm. The correctness and integrity of such measurement data must be handled properly by the responsible organization.
Without this information and its correctness, no valid flight inspection parameters may be calculated.

ACFT Antenna Database
The location of the various antennas on the ACFT body is vital to be able to correct the measurements for antenna offsets. The position reference of the flight inspection system normally has its measurement origo in the phase center of a GPS antenna, or perhaps in the Inertial Reference Unit origo. When comparing to signals received at a LLZ antenna, as an example, the offsets between the antennas must be taken into consideration.
The distance between the antennas may be several meters. Using input from highly accurate aircraft attitude sensors, the flight inspection system is able to correct for these offsets. The offset measurements of the various aircraft antennas are therefore vital parameters of the system, and their correct quality and integrity must be ensured.

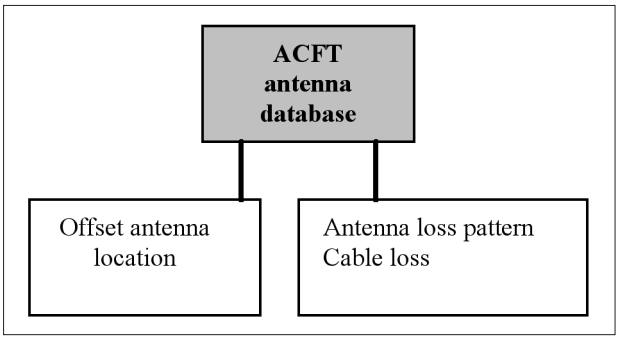
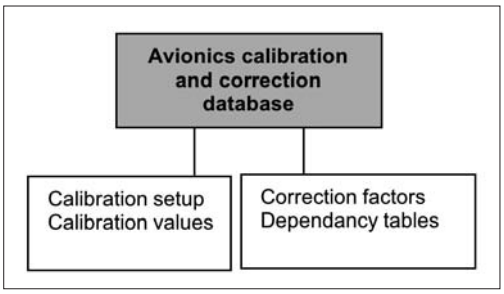


Figure 3 - ACFT antenna database

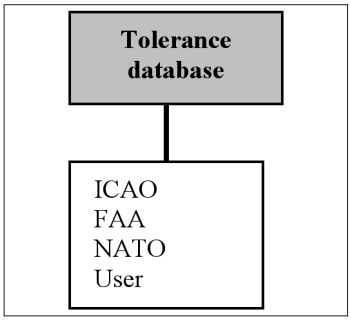
In addition, signal loss in the antennas and antenna cables must be known to precisely calculate field strength. Such values are typically measured during installation, and should be repeated at intervals to ensure their correct values.
Some users utilize a full 3D antenna pattern to perform corrections for signals from any given angle. Such databases again raise the question of external data integrity – how do we ensure the data is transferred and interpreted correctly by the flight inspection system.

Avionics Calibration and Correction Database
Each sensor has, or may have, calibration and correction factors applied to provide the desired accuracy under various circumstances. The actual calibration values used are directly affecting the final results. This again may produce different results if a wrong set of calibration values are used.



As with the other data integrity issues, the organization should have a way of quality assuring the calibration routines, and keep track of all information relevant to the calibration. This includes also such information as calibration date of signal generators etc.

Tolerance Database
When performing flight inspection, certain criteria applies to the actual tolerances. If the measured values are outside these tolerances, the facility under inspection may require further investigation.
The tolerances may be based on ICAO, FAA, NATO or other requirements, and may vary between different operations. However, the correctness of this database is vital for the flight inspector to be able to judge the results of the facility under inspection.



Reports and organization data handling
The final reports are normally based on the results of several flight inspection runs. The reports must clearly state which runs they are generated from to ensure their traceability and integrity.
The safe storage of all runs relevant for the final reports is another crucial element where the organization must ensure the proper routines are in place.
The actual offline handling and storing of the flight inspection data is highly dependant on the infrastructure available in the organization.

WAYS TO ENSURE DATA INTEGRITY

There are two vital elements in ensuring data integrity:
- The organization elements – ensuring proper handling and quality assurance of the data
- The technical elements – providing tools and methods to mark quality checked data and ensure they are not tampered or modified unintentionally.

The organization elements
Most of the databases in use by a flight inspection system require input from the flight inspection organization using the system.
The organization must ensure the correct quality and integrity of these databases. Only approved personnel should be allowed to modify the databases. This is a feature that the flight inspection system may aid, by only allowing certain users editing access to these databases.
The organization should also keep all databases under version control, to be able to view all historical changes made to the databases. This also allows the organization to recreate any previous version of the databases.

The technical elements
The flight inspection business is not alone in facing the challenge of data integrity – this problem is faced by most, if not all, industries. There are several methods for handling the technical elements, a couple of the most common will be discussed here.
Checksum (CRC or similar) are some of the most common methods for ensuring data integrity on a technical level. When a database, let's say the facility database, has been modified and quality assured, a programmed routine may calculate the database checksum or CRC. This value should then be known to the flight inspection system, which would confirm the correct checksum/CRC every time the various databases are in use.
Most of the databases do not change very frequently. The flight inspection system may keep track of the current valid version of all different databases, and notify or alert the flight inspector if any databases have changed in an unexpected way.
Whenever an updated, official, quality assured database is introduced to the system, routines in the flight inspection system will handle these updates and at the same time note the checksum. Thereby, the system may keep a list of valid databases as well as invalid ones. Whenever any invalid databases are tried used, a notification is issued.
The actual printout reports of any flight inspection mission may provide information about version, date and checksum of all databases used for the relevant flight.
When the flight inspection data is archived, all belonging databases must go with it into the archive. This ensures full traceability and provides essential data for later studies or analysis.
Digital Signatures could be used to provide user authentication related to the actual database selections and all stored data. This will allow the flight inspector to digitally sign all the flight data and relevant databases such that any tampering with the data without the flight inspector's knowledge is impossible. The data may still be available for other users, but any modifications to the data will also automatically change the signature.

CONCLUSION

The large amount of digital data generated by new flight inspection systems are only as accurate as the input from the databases the flight inspection system depend upon.
The organization must be very careful to proper handle such files and databases to ensure the desired quality and data integrity.
Routines to aid in such handling must be provided by the flight inspection system manufacturer. The manufacturer should work closely with the end user to make sure backup, editing and version control of these databases are taken care of.