Appendix

1. Excerpt from Annex 10, Volume I, Chapter 2:

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2.2 Ground and flight testing

2.2.1 Radio navigation aids of the types covered by the specifications in Chapter 3 and available for use by aircraft engaged in international air navigation shall be the subject of periodic ground and flight tests.

Note.— Guidance on the ground and flight testing of ICAO standard facilities, including the periodicity of the testing, is contained in Attachment C and in the Manual on Testing of Radio Navigation Aids *(Doc 8071).*

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2. Excerpt from the *Manual on Testing of Radio Navigation Aids* (Doc 8071), Chapter 1

[…]

1.15 GROUND AND FLIGHT INSPECTION PERIODICITY

General

1.15.1 This document includes suggested periodicities for various ground and flight tests that should be considered in the light of conditions relevant to each State and each site.

1.15.2 The suggested periodicities are given as general guidance and may be modified based on the manufacturer's recommendation or operational experience. In some cases, it may be necessary to carry out more frequent inspections, e.g. following initial installation. It may also be reasonable to extend the inspection intervals in some circumstances, if the factors outlined in this section have been taken into account. It is recommended that States have a documented procedure for determining and changing the test/inspection interval.

1.15.3 The manufacturer's equipment manual usually contains recommendations which are also useful in this regard.

Determination of test/inspection intervals

1.15.4 Many factors influence the choice of appropriate intervals for both ground and flight tests. These include the reliability and stability of operation of the equipment, the extent of ground monitoring, the degree of correlation between ground and flight measurements, changes in the operating environment, manufacturer recommendations, and the quality of maintenance. The complete programme of ground and flight inspections should be considered when determining test intervals.

1.15.5 Reliability and stability of equipment is related to age, design technology, and the operational environment. Stability of operation may also be affected by excessive maintenance adjustments attributable to either human factors or variation in test equipment performance. This is particularly true with some older test equipment where the accuracy and stability of the test equipment is not significantly better than the equipment under test. A major contribution to the demonstration of stability of navigation aids is the design of modern flight inspection systems and ground facility test equipment, where the standard resolution and accuracy are very high.

1.15.6 Ground maintenance activity and its frequency is dependent upon the design, reliability and stability of a particular equipment and the quality of the ground test equipment employed as a transfer standard. It has been shown that equipment reliability may be adversely affected by frequently scheduled major maintenance activity. It is, therefore, desirable to limit such activity to essential testing only, particularly for tests that require the disconnection of cables. There is a requirement for additional supplementary flight inspection when some engineering activities, such as glide path antenna changes or adjustments are made. Further investigation may be initiated if the independent monitor calibration indicates any adjustments are required.

Example of criteria to be considered for the modification of ILS flight inspection intervals

1.15.7 The correlation of air and ground measurement records and historic demonstration of equipment stability have allowed some States to extend the intervals between flight inspections. This is supported by the use of routine monitor readings, strict environmental safeguarding and closer tolerances on flight inspection results to ensure operational stability is maintained. Example criteria for the extension of ILS flight inspection intervals are given in 1.15.8 and 1.15.9.

1.15.8 This section gives an example of criteria applied to extend the nominal interval between flight inspections of selected facilities. The procedure requires:

a) an initial demonstration of stability over four consecutive periodic flight inspections with no transmitter adjustments;

b) good correlation between concurrent ground and airborne results;

c) a record of independent monitor test results;

d) a record of equipment monitor readings taken at regular intervals not to exceed 50 per cent of the extended flight inspection interval;

Note.— A shorter interval between monitor readings is suggested for ILS Facility Performance Categories II and III.

e) evidence that the quality of the maintenance is high and that the recorded test result and monitor readings of critical parameters indicate that the equipment consistently meets

performance requirements;

f) that the facility is adequately safeguarded against changes in the operational environment, e.g. building development; and

g) a recommended decrease in tolerances applied to the flight inspection results for critical parameters to 75 per cent of the normal acceptance standards. Examples of critical parameter(s) include:

1) localizer alignment and displacement sensitivity;

2) glide path angle and displacement sensitivity; and

3) VOR approach radial alignment and structure.

1.15.9 Examples of cases in which the flight inspection interval should be decreased include:

a) if the above criteria are no longer met; or

b) if a facility fails to meet the same performance requirement on successive inspections; or

c) if several requirements are not met on any one inspection.

Correlation as the basis for extending periodicity

1.15.10 A typical basis for extending the interval between required measurements without degrading ILS integrity is correlation. Any individual measurement is normally expected to be repeatable over time without adjustments to the equipment. Correlation between ILS measurements made both on the ground and in the air at the same or nearly the same time is also expected. This places equal responsibility on ground and airborne personnel and helps identify common-mode measurement errors. An additional requirement to extend flight inspection intervals is the influence of near- and far-field environments on the signals. These effects can be determined with a flight inspection aircraft. The following paragraphs give illustrations of the correlation technique.

1.15.11 *Preliminary requirements.* Certain fundamental requirements should be met prior to any measurement activity if correlation between ground and airborne measurements over time can be expected. Typical requirements include functionally similar training for personnel, appropriate calibrated test equipment, completion of all prescribed ground maintenance tasks, availability of commissioning reports and recent periodic inspection reports, and frequent use of measurement skills by both ground and airborne personnel.

1.15.12 *Techniques.* Achieving good correlation places the same or similar weight on both ground and airborne testing, and demands that both be conducted with great care. Initial or commissioning-type flight measurements should be made with special care, as the corresponding ground measurements will be used as references for ground maintenance personnel. The portable maintenance receiver is readily used in the far-field for localizer facilities, while glide path facilities may require measurements in the near- or mid-field with an auxiliary antenna placed near the transmitting antennas.

1.15.13 *Tolerances.* New tolerances may be developed to define acceptable correlation between measurements. A rigorous application of correlation principles might include the following types:

a) Setting tolerance — defines the exact value for a parameter, which should be achieved (within the measurement uncertainty) when adjustment is required.

b) Adjustment/maintenance tolerance — defines the limit within which a parameter may vary without requiring adjustment.

c) Operational tolerance — defines the ICAO Standard for a parameter.

d) Discrepancy tolerance — defines, for certain parameters only, the limits of divergence between various measurements:

1) Ground/ground discrepancy — applies to a divergence over time, or between different methods of measuring the same parameter (e.g. alignment monitor, portable ILS receiver, and far-field monitor).

2) Ground/air discrepancy — applies to a divergence between measurements of the same parameter at the same or nearly the same time by ground and airborne testing personnel.

1.15.14 *Activities during flight inspection.* Typical correlation activities begin with a confirmation that airborne and ground test equipment is operating within tolerances. This may be achieved by comparing ground and flight test generators and receivers. (If the tolerances are not met, the flight inspection is delayed until the cause of the problem is eliminated.) If the ground or airborne results are out of discrepancy tolerances during the flight inspection and the cause cannot be determined, then the ground monitor alarm limits should be tightened, the facility declassified appropriately or removed from service. The successful completion of the flight inspection (all tolerances are met) establishes that the ground maintenance activities are effective and the interval between inspections may be maintained at the optimum periodicity.

Expiration of nominal intervals

1.15.15 To account for operational restrictions, States may permit the completion of a recurrent test/inspection within a certain time window following the nominal recommended interval. This extension is not to be intended as a means to systematically extend the test/inspection interval.

1.15.16 If a test/inspection is not conducted prior to the expiration of the appropriate time window, various actions may be considered:

a) extension of the expiration after engineering evaluation and/or ground maintenance reinforcement;

b) degrading of the category of ILS (Category III down to Category I) in cases where intervals vary according to the category of ILS; and

c) temporarily removing the navigation aid from service.

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