

Flight inspection periodicity considerations for radio navigation aids during the COVID-19 pandemic and related recovery phase

Introduction

The present note discusses issues related to flight inspection that could arise during the COVID-19 pandemic and during the recovery phase, with particular regard to periodicity. The main purpose of the document is to ensure that flight inspection will be able to maintain safe operation of navigation aids during the pandemic and will not be on the critical path to aviation recovery after the pandemic.

To this end the document stresses the need to maintain regular ground and flight checks of navaids to ensure that they are available during recovery (delaying implementation of new facilities if necessary). It provides information on flight inspection experiences and best practice currently adopted in several ICAO States, including recommendations on how to deal with periodicity intervals when delays are experienced.

ICAO requirements on flight inspection periodicity

The fundamental ICAO provision addressing flight inspection in general is the Standard in Annex 10, Volume I, Chapter 2, 2.2.1 (reproduced in Appendix).

Guidance on flight inspection, including periodicity, is given in the ICAO *Manual on Testing of Radio Navigation Aids* (Doc 8071). The general aspects of periodicity requirements are addressed in section 1.15 of the document (reproduced in Appendix), whereas *suggested*¹ periodicities for specific navigation aids are given in the chapters corresponding to each aid. States may have determined their periodicity requirements based on local circumstances and as such the recovery should consider these periodicities.

Relationship between ground testing and flight inspection

This document focuses on flight inspection periodicity. However, Doc 8071 also specifies a number of ground tests with an associated periodicity. Normal practice is to ensure that a navigation facility passes all of its ground tests prior to conducting a flight inspection. Local maintenance staff normally accomplish this. This document assumes that such ground testing can be carried out as required and in accordance with the local COVID-related health precautions. Some of the measures discussed herein can also be applied to ground maintenance staff. The document focuses on flight inspection due to its often international dimension (cross-border operations).

¹ It should be noted that “suggested” is the term used in Doc 8071, as opposed to “required”. See for instance Doc 8071, 1.5.2: “This document contains suggested schedules for each radio navigation aid, which should be considered (and modified, if necessary), based on the conditions relevant to each State and each site.”

Flight inspection practices during the pandemic

The ICAO Secretariat and EUROCONTROL have conducted an informal survey of flight inspection practices during the pandemic in twenty-seven States.

The survey results show that the majority of States surveyed are maintaining a regular or near-regular flight inspection schedule during the pandemic. This is consistent with the general recognition of ATC as an essential public service and the related need for reliable system performance of radio navigation aids. However, it should also be noted that the majority of the responses came from States that operate their own flight inspection aircraft. So the survey may not fully reflect the situation in States where issues may exist due to delays or suspended flight inspection operations, especially if they rely on cross-border flights by flight inspection providers (see below).

Special measures

In order to sustain the flight inspection schedule notwithstanding the pandemic-related difficulties, the majority of the States surveyed have adopted special health safety procedures and operational measures, as discussed below.

Health safety procedures

Some or all of the following health safety procedures have been put in place:

- daily sanitization of aircraft² and equipment;
- daily supply of personal protection devices to crew, with detailed instructions on usage;
- flight inspection crew segregation from ground support personnel (ground maintenance, dispatch, refuel etc);
- flight inspection crew segregation from engineering personnel responsible for the navaids under test (telephone coordination only);
- segregation between the flight inspection crews themselves (fixed crew staffing); and
- implementation of alternate on/off crew rotation rosters taking into account potential incubation period.

Operational measures

While flight inspection operations have been to some extent facilitated by the low air traffic levels currently prevailing, overall significant operational restrictions are being experienced, calling for special measures to mitigate them.

A common approach adopted for flight inspection operations during pandemic is to keep individual missions within a single day, returning to base at the end of the day and thus avoiding overnight stays at the destination.

² See for example EASA “Safety Directive under Article 76(6)(b) of Regulation (EU) No 2018/1139 - SD No.: 2020-01”

The impact of the associated reduction in efficiency could be mitigated by prioritizing regular flight inspection missions over new implementation projects (new facilities and procedures).

Furthermore, among regular missions, those addressing facilities that are approaching the flight inspection due date, particularly in the case of ILS Category III facilities, should be prioritized.

In some cases however, reductions in aerodrome operating hours may limit the number of working hours available in a day. In such cases and in other cases when overnight stays are necessary (e.g. to avoid exceeding flight duty time limitations), particular care should be given to assessing the chosen accommodation to ensure compliance with pandemic sanitation provisions and minimize the need for external contacts.

Specific issues with cross border flights.

In some cases in which flight inspection services are supported by cross border flights (international flight service operations), a number of specific issues have been encountered:

- requirements for special authorization to access aerodromes that would otherwise be closed to all traffic;
- requirements for special authorization for crew access to country;
- requirements for quarantine on crew arrival to destination and return to base;
- difficulties in ensuring avoidance of contact between crew and ground personnel at destination (eg due to custom/immigration controls); and
- suspension of ground maintenance activities.

These issues were largely unexpected, due to the situation being effectively unprecedented, and were not taken into account in the original inspection schedules. They have required ad-hoc adjustments, negotiated bilaterally on a case-by-case basis by the entities involved. This has typically led to scheduling delays. However, notwithstanding the delays, cross border flights have remained largely feasible, if less efficient, thanks to the commitment of all the parties to the flight inspection requirements.

In the process, the need for international recognition in pandemic situations of the special status and needs of flight inspection as a key element of the safety-critical air navigation infrastructure has been highlighted. Future work by ICAO will address the development of guidance to States on facilitating cross-border flight inspection operations in pandemic situations, including development of an advisory health safety protocol to minimize interaction between crew and ground personnel.

Dealing with potential periodicity issues during and after the pandemic

The informal survey results suggest that in principle flight inspection should be feasible even in COVID-19 times, possibly with some restrictions requiring prioritization/rearranging of schedule as discussed above.

As a result, periodicity of flight inspection should not be affected substantially, and it should be possible to limit any potential deviations from the nominal intervals to within the time window of extension mentioned

in Doc 8071, 1.15.15. While Doc 8071 makes no recommendations on the length of such time windows, the extension window needs to be a reasonable fraction of the nominal interval. For example, some States use a maximum delay of 1 month for nominal inspection periodicities of 6 months.

In cases in which nominal periodicity cannot be maintained and the appropriate extension time window is exceeded (e.g. because of initial set-up issues with cross-border operations, as discussed above), Doc 8071, 1.15.15 offers a choice of actions that may be considered:

- allowing for further extension time, after engineering evaluation and/or ground maintenance reinforcement;
- downgrading of ILS (Category III down to Category I or II); and
- temporarily removing the navigation aid from service.

In choosing among those actions, the responsible entities should take into account the exceptionality of the current situation, in which aviation has suffered an unprecedented setback and is facing what can be expected to be a very difficult recovery phase. In this context, the navigation infrastructure must remain operational both to support the reduced level of traffic during containment measures (including flights meeting critical pandemic-related needs, such as delivery of medical supplies) and to facilitate the resumption of regular flight operations. Therefore, in cases where timely flight inspection cannot be ensured, the preferred method for maintaining safe signals in space is to either take advantage of the (short) periodicity extension window, or, if a longer extension is required, to grant an extension of periodicity intervals in line with the principles described in Doc 8071. Furthermore, in cases where flight inspection operations were suspended and periodicity intervals extended, careful planning should ensure that navigation aid availability of service can be ensured to support the recovery.

At the same time, no compromise on operational safety due to non-standard performance of navigation aids should be accepted. Instead, potential extensions of nominal inspection intervals should be considered only in the presence of appropriate mitigations maintaining nominal safety levels. To this end, the provisions of Doc 8071, 1.15 should be taken into account.

Doc 8071, 1.15.2 recognizes that the suggested periodicities are given as general guidance and may be modified based on the manufacturer's recommendation or operational experience. Subsequent sections (1.15.4 – 1.15.6) discuss the factors influencing the inspection intervals, including reliability and stability of operation of the equipment, extent of ground monitoring, degree of correlation between ground and flight measurements, changes in the operating environment, manufacturer recommendations, and quality of maintenance. In many cases, modern ground facilities using current technology provide highly stable and reliable signals. A point of particular practical interest in the current context is given in 1.15.6 with the observation that equipment reliability may be adversely affected by too frequently scheduled major maintenance activities, which should therefore be limited to essential needs if extended periodicity is desired.

Further sections of Doc 8071, (1.15.7 – 1.15.8 and 1.15.10- 1.15.14) discuss the type of technical analysis that would need to be performed to extend nominal ground and flight inspection periodicities in a normal situation. While performing such detailed analysis may be unpractical in a pandemic situation, it should be noted that the most important item to ensure safe facility performance is the verification of the proper

functioning of executive monitor shutdown capabilities. Special attention should also be given to site safeguarding, especially if aircraft or other large equipment is being parked near a navigation aid.

While the guidance in Doc 8071 does not explicitly address the current situation, it does indicate that, in situations in which maintaining nominal flight inspection periodicity is effectively impossible, case-by-case extensions can legitimately be considered on an exceptional basis when the relevant enabling factors are present. In other words, in the unprecedented situation now being faced by aviation, a reliable system running in a stable configuration with a history of nominal performance, undergoing regular ground checks consistent with manufacturer recommendations which indicate normal functioning, and in the absence of anomaly reports, should normally qualify for an extension of the periodicity interval.

Special considerations apply to the specific case of Category III ILS. Because of the particularly demanding requirements, rigorous testing is essential. For that reason, during the current pandemic several States are prioritizing flight inspection of Category III ILS. Should it nevertheless occur that flight inspection intervals for a Category III ILS are significantly exceeded, as mentioned above a potential option would be downgrading of the facility from Category III to Category II or Category I.

Appendix

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

[...]

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).

[...]

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.

[...]