Review of Annex 10 Technical Criteria

Pertaining to ILS (LOC) Annex 10 Vol 1 Ch 3

- 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
- The localizer and glide path components specified in 3.1.2.1 a) and b) which form part of a Facility Performance Category I — ILS shall comply at least with the Standards in 3.1.3 and 3.1.5 respectively, excepting those in which application to Facility Performance Category II — ILS is prescribed
- The mean Loc course line shall be adjusted and maintained within limits equivalent to the following displacements from the runway centre line at the ILS reference datum
- a) for Facility Performance Category I localizers: plus or minus 10.5 m (35 ft), or the linear equivalent of 0.015 DDM, whichever is less;
- b) for Facility Performance Category II localizers: plus or minus 7.5 m (25 ft)

Review of Annex 10 Technical Criteria

Pertaining to ILS (LOC) Annex 10 Vol 1 Ch 3

- For Facility Performance Category I localizers, bends in the course line shall not have amplitudes which exceed the following:
- ILS Point “A” to 0.031 at ILS Point “A” (Amplitude DDM 95% probability)
- ILS Point “B” decreasing at a linear rate to 0.015 at ILS Point “B”
- For Facility Performance Category II localizers;
- ILS Point “A” to 0.031 at ILS Point “A”
- ILS Point “B” decreasing at a linear rate to 0.005 at ILS Point “B”
- ILS Point “B” to the ILS reference datum 0.005

Review of Annex 10 Technical Criteria

Pertaining to Glidepath Annex 10 Vol 1 Ch 3

- The ILS glide path angle should be 3 degrees. ILS glide path angles in excess of 3 degrees should not be used except where alternative means of satisfying obstruction clearance requirements are impracticable.
- The glide path angle shall be adjusted and maintained within
- a) 0.075 θ from θ for Categories I and II — ILS glide paths
- The downward extended straight portion of the ILS glide path shall pass through the ILS reference datum at a height ensuring safe guidance over obstructions and also safe and efficient use of the runway served
- The height of the ILS reference datum for Facility Performance Categories II and III — ILS shall be 15 m (50 ft). A tolerance of plus 3 m (10 ft) is permitted

Review of Annex 10 Technical Criteria

Pertaining to Glidepath Annex 10 Vol 1 Ch 3

- Glidepath structure, for Facility Performance Category I — ILS glide paths, bends in the glide path shall not have amplitudes which exceed the following
- Outer limit of coverage to ILS Point “C” 0.035 (DDM 95% probability)
- For Facility Performance Category II
- ILS Point “A” to 0.035 at ILS Point “A”
- ILS Point “B” decreasing at a linear rate to 0.023 at ILS Point “B”
- ILS Point “B” to the ILS reference datum 0.023
- TCH remaining at 50’ (tolerance +/- 10’)

Review of Annex 10 Technical Criteria

Pertaining to VOR Annex 10 Vol 1 Ch 3

- The accuracy of the bearing information conveyed by the horizontally polarized radiation from the VOR at a distance of approximately four wavelengths for all elevation angles between 0 and 40 degrees, measured from the centre of the VOR antenna system, shall be within plus or minus 2 degrees
- The VOR shall provide signals such as to permit satisfactory operation of a typical aircraft installation at the levels and distances required for operational reasons, and up to an elevation angle of 40 degrees

Review of Annex 10 Technical Criteria

Pertaining to DME Annex 10 Vol 1 Ch 3

- *Range.* The system shall provide a means of measurement of slant range distance from an aircraft to a selected transponder to the limit of coverage prescribed by the operational requirements for the selected transponder
- When associated with a VOR, DME/N coverage shall be at least that of the VOR to the extent practicable
- When associated with either an ILS, DME/N coverage shall be at least that of the respective ILS
- *System accuracy.* The accuracy standards specified herein shall be met on a 95 per cent probability basis

Review of Annex 10 Technical Criteria

Pertaining to GNSS Annex 10 Vol 1 Ch 3

- *Space reference*. The position information provided by the GNSS to the user shall be expressed in terms of the World Geodetic System — 1984 (WGS-84) geodetic reference datum
- *SARPs for WGS-84 are contained in Annex 4, Chapter 2, Annex 11, Chapter 2, Annex 14, Volumes I and II,Chapter 2 and Annex 15, Chapter 3.*
- *Positioning accuracy*. The GPS SPS position errors shall not exceed the following limits
- Horizontal position error 13m (43ft)
- Vertical position error 22 m (72 ft)

Review of Annex 10 Technical Criteria

Pertaining to GNSS Annex 10 Vol 1 Ch 3

- *Availability*. The GPS SPS availability shall be as follows:
- ≥99 per cent horizontal service availability, average location (36 m 95 per cent threshold)
- ≥99 per cent vertical service availability, average location (77 m 95 per cent threshold)
- ≥90 per cent horizontal service availability, worst-case location (36 m 95 per cent threshold)
- ≥90 per cent vertical service availability, worst-case location (77 m 95 per cent threshold)

Review of Annex 10 Technical Criteria

Pertaining to GNSS Annex 10 Vol 1 Ch 3

- *Reliability*. The GPS SPS reliability shall be within the following limits:
- a) frequency of a major service failure — not more than three per year for the constellation (global average);
- b) reliability — at least 99.94 per cent (global average); and
- c) reliability — at least 99.79 per cent (single point average).
- *Coverage.* The GPS SPS shall cover the surface of the earth up to an altitude of 3 000 kilometres.
- *Further guidance material on GPS accuracy, availability, reliability and coverage is given in Vol 1 Attachment D, 4.1.*

Review of Annex 10 Technical Criteria

Pertaining to GBAS Annex 10 Vol 1 Ch 3

- *Performance*. GBAS combined with one or more of the other GNSS elements and a fault-free GNSS receiver shall meet the requirements for system accuracy, continuity, availability and integrity for the intended operation as stated in 3.7.2.4.
- GBAS shall perform the following functions:
- a) provide locally relevant pseudo-range corrections;
- b) provide GBAS-related data;
- c) provide final approach segment data when supporting precision approach;
- d) provide predicted ranging source availability data; and
- e) provide integrity monitoring for GNSS ranging sources.

Review of Annex 10 Technical Criteria

Pertaining to GBAS Annex 10 Vol 1 Ch 3

- The GBAS coverage to support each Category I precision approach or approach with vertical guidance shall be as follows, except where topographical features dictate and operational requirements permit:
- laterally, beginning at 140 m (450 ft) each side of the landing threshold point/fictitious threshold point (LTP/FTP) and projecting out ±35 degrees either side of the final approach path to 28 km (15 NM) and ±10 degrees either side of the final approach path to 37 km (20 NM); and
- vertically, within the lateral region, up to the greater of 7 degrees or 1.75 promulgated glide path angle (GPA) above the horizontal with an origin at the glide path interception point (GPIP) and 0.45 GPA above the horizontal or to such lower angle, down to 0.30 GPA, as required, to safeguard the promulgated glide path intercept procedure. This coverage applies between 30 m (100 ft) and 3 000 m (10 000 ft) height above threshold (HAT).

Review of Annex 10 Technical Criteria

Pertaining to SSR in Annex 10 Vol 4 CH 3

- Systems having Mode S capabilities;
- The carrier frequency of all interrogations (uplink transmissions) from ground facilities with Mode S capabilities shall be 1 030 plus or minus 0.01 MHz, except during the phase reversal, while maintaining the spectrum requirements of 3.1.2.1.2.
- The short (16.25-microsecond) and long (30.25-microsecond) *P*6 pulses of 3.1.2.1.4.1 shall have internal binary differential phase modulation consisting of 180-degree phase reversals of the carrier at a 4 megabit per second rate
- This interrogation shall consist of three pulses: *P*1, *P*3, and the long *P*4 as shown in Figure 3-3. One or two control pulses (*P*2 alone, or *P*1 and *P*2) shall be transmitted using a separate antenna pattern to suppress responses from aircraft in the side lobes of the interrogator antenna
- Mode A/C/S all-call interrogations shall not be used on or after 1 January 2020

Review of Annex 10 Technical Criteria

Pertaining to ADS-B in Annex 10 Vol 4 CH 7

- Airborne surveillance applications are based on aircraft receiving and using ADS-B message information transmitted by other aircraft/vehicles or ground stations. The capability of an aircraft to receive and use ADS-B/TIS-B message information is referred to as ADS-B/TIS-B IN
- Initial airborne surveillance applications use ADS-B messages on 1 090 MHz extended squitter to provide airborne traffic situational awareness (ATSA) and are expected to include “In-trail procedures” and “Enhanced visual separation on approach”
- Detailed description of aforementioned applications can be found in RTCA/DO-289 and DO-312

Review of Annex 10 Technical Criteria

Pertaining to ADS-B in Annex 10 Vol 4 CH 7

- The system shall display only one track for each distinct aircraft on a given display
- Where a track generated by ADS-B/TIS-B IN and a track generated by ACAS have been determined to belong to the same aircraft, the track generated by ADS-B/TIS-B IN shall be displayed
- At close distances, it is possible that the track generated by ACAS provides better accuracy than the track generated by ADS-B/TIS-B IN. The requirement above ensures the continuity of the display
- The display of the tracks shall comply with the requirements of ACAS traffic display

Review of Annex 10 Technical Criteria

Pertaining to Multilateration Systems (MLAT) in Annex 10 Vol 4 CH 6

- *Multilateration (MLAT) systems use the time difference of arrival (TDOA) of the transmissions of an SSR transponder (or the extended squitter transmissions of a non-transponder device) between several ground receivers to determine the position of the aircraft (or ground vehicle). A multilateration system can be:*
- *a) passive, using transponder replies to other interrogations or spontaneous squitter transmissions;*
- *b) active, in which case the system itself interrogates aircraft in the coverage area; or*
- *c) a combination of a) and b).*

Review of Annex 10 Technical Criteria

Pertaining to Multilateration Systems (MLAT) in Annex 10 Vol 4 CH 6

- Radio frequency characteristics, structure and data contents of signals used in 1 090 MHz MLAT systems shall conform to the provisions of Chapter 3.
- An MLAT system used for air traffic surveillance shall be capable of determining aircraft position and identity
- Where an MLAT system is equipped to decode additional position information contained in transmissions, it shall report such information separately from the aircraft position calculated based on TDOA
- Aircraft identity may be determined from:
- a) Mode A code contained in Mode A or Mode S replies; or
- b) Aircraft identification contained in Mode S replies or extended squitter identity and category message.

End of Annex 10 review

Review of Doc 8071 and Flight Inspection procedures.

DOC 8071 FLIGHT INSPECTION PROCEDURES

General procedures for VOR

- An orbit should be flown at a height and range that allows the position reference system to accurately determine the position of the aircraft
- The orbit should have sufficient overlap to ensure that the measurement covers the complete 360°
- Modulation levels can be determined during the orbit
- Average alignment must be within +/- 2 degs
- Station ident to be check for correctness and modulation level not exceeding tolerance
- Reading and measurements can be referenced to the Commissioning levels

DOC 8071 FLIGHT INSPECTION PROCEDURES

General procedures for DME

- The accuracy can be checked on both VOR orbital and radial flights.
- DME associated with ILS can be checked coincidental with an ILS inspection
- The pulse transmission rate contains replies from interrogations, identification pulses and squitter, which can be checked during orbit and radial flight
- The identification signal should be checked for correctness and clarity. DME associated with an ILS localizer or VOR should be checked for correct synchronization of the two identification signals
- Throughout the flight inspection, the reply efficiency should be monitored and recorded
- Areas where persistent unlocks occur should be investigated

DOC 8071 FLIGHT INSPECTION PROCEDURES

General procedures for ILS Localizer

- On course alignment accuracy and analysis of roughness is performed according to the ILS Category tolerances
- Displacement sensitivity is checked on periodic inspections
- Modulation levels of 150 Hz and 90 Hz is verified for correct tolerance
- RF power is checked on the inbound alignment/structure run at the appropriate distance from threshold according to the Category
- Station Ident is verified for correctness and modulation level
- Off course clearance is checked at a specified altitude and range to ensure correct +/- 35 deg clearances and normal cockpit CDI off course indication

DOC 8071 FLIGHT INSPECTION PROCEDURES

General procedures for ILS Glidepath

- Alignment of glidepath angle is assessed for correct tolerance applicable to the ILS Category
- Course structure is evaluated for roughness that must be within tolerance such that it would not contribute to the potential for auto-pilot disconnect
- Displacement sensitivity is checked for correct tolerance on periodic inspections
- Modulation levels of 150 Hz and 90Hz are verified for correct tolerance
- Below path clearance is checked to ensure adequate fly-up indication in unusual below path flight situations

Review of Chapter 8

Flight Validation in respect to PBN

- The use of VOR in PBN is limited to VOR/DME supporting RNAV5. While multi-sensor avionics are normally capable of using VOR/DME for an RNAV solution
- The main role of DME/DME in PBN is to support RNAV1 and RNAV5 as a complementary terrestrial infrastructure alongside GNSS
- Flight Validation of an RNAV procedure may be required under certain circumstances to ensure facility technical coverage within the procedure area
- An assessment of the procedure would determine if the facilities are being used outside of the areas where they would normally be flight inspected on a routine basis

Review of Chapter 8

Flight Validation in respect to PBN

- Determination if a procedural flight validation is required or not
- Evaluation of procedure area to see if the facilities are being used in areas outside where they are periodically flight inspected, then;
- Evaluation of VOR or DME facilities are able to support PBN
- Assessment of both coverage and accuracy in the PBN service area
- Successful assessment of the procedure to be retained in the RNAV infrastructure database for future reference
- Periodic assessment or evaluations of the PBN procedure are normally not required, unless there are changes in the facilities, or in the procedure design

Potential future Flight Inspection technologies

- The basis of airborne Flight Inspection has evolved over the last 35 years
- Considering the availability and use of very high quality avionics, antenna designs, computer generated signal analysis and practical IFR aircraft platforms all contribute to efficiency of flight inspection operations
- Avionics technologies themselves continue to advance in design and miniaturisation; for example, portable ADS-B transponders for drones
- RPAS definitely have a useful purpose and capability in flight inspection
- Many of the current restrictions to flight inspection operations could be addressed using certain categories of RPAS
- Correlation of ground and airborne measurements using RPAS deserves further evaluation

Potential future Flight Inspection technologies

- Certain categories of RPAS could fulfill a non-traditional role of airborne signal in space technical analysis
- RPAS have the capability to further evolve and support the requirements for flight inspection
- RPAS should be foreseen as a potential valuable extension to the way airborne measurements are performed and accomplished today
- RPAS could fulfill very specific role in supporting areas of airborne measurement that would normally be impractical or inefficient for the flight inspection aircraft to be deployed
- One RPAS category that deserves further evaluation is the 50kg Octocopter category that has payload capacity and full capability to position accurately and hover at programmed GNSS spot locations

SUMMARY

- In this session we have done a general overview of Doc 8071 procedures pertaining to ILS Localizer, Glidepath, DME and VOR, also Ch 8 and future technologies in flight inspection
- This brings us an understanding of the relationships of flight inspection, procedures, technical tolerances with the requirement for safety oversight and regulation using ICAO SARP's and Docs as the standards
- In the end, the overall emphasis is on supporting a safe and efficient aviation industry infrastructure by adhering to Standards, established procedures and safety management practices