Update of ICAO DOC 8071 Volume 1

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Overview

- Motivation for update and process summary
- Volume 1 in context of other related documents
- Doc 8071 Status
- Editorial Principles
- Chapter by Chapter Novelties
- Some dedicated examples
- Conclusion

Motivation and Context

- Amendment 84 to Annex 10 (2008) implemented changes due to a general review of Standards and Recommended Practices (SARPS) of conventional radio navigation aids
  - Delete obsolete and clarify ambiguous provisions
  - Only ILS CSA part of Amendment 84 was rejected
  - Amendment 91 implements new CSA without impact on Doc 8071 (applicable in Nov 2018)
- Take into account move of flight validation material to Doc 9906 Vol. 5, IFP Quality Manual under IFPP responsibility
- Maintain 2 Volumes (Ground-Based and Space-Based) to minimize editorial effort in subsequent transposition into national languages and contract documents
- New Fifth Edition (EN) published **Summer 2018**

The Neighbours of Vol I

- Vol II: GNSS
  - Conventional Navigation *AND TESTING* WG of NSP currently updating Vol II in coop with other WG's on GBAS, GNSS SARPS, Spectrum
  - Some delay due to focus on large new GNSS SARPs package
    - introducing Dual Frequency Multi Constellation (DFMC) GNSS including GPS, GLONASS, Galileo, BDS and DFMC SBAS
  - Doc 9849 GNSS Manual, Doc 9613 PBN Manual
- Vol III: Surveillance Radar Systems
  - SUR Panel minimum update, link to Doc 9924 SUR Manual
  - MLS remains unpublished at ICAO NSP Secretariat
- Doc 9906 Vol 5, Instrument Flight Procedure Quality Manual
  - Flight Inspection = verify compliance of signals with Annex 10
  - Flight Validation = verify quality of Instrument Flight Procedure
  - Any notion of flight validation moved out of Doc 8071
  - *Nothing prevents a suitable flight inspection aircraft with a suitable flight validation crew from conducting flight validation*

Doc 8071 Status

- Only SARPS and PANS have official status, rest is **guidance material only**, including ALL of Doc 8071
  - Standard: “shall” statement in an ICAO Annex
  - Recommended practice: marked “recommendation” in Annex
  - Attachments in Annex (“green pages”): also guidance
- ICAO Annex 10, Chapter 2, Section 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 refers to Doc 8071 to explain how it can be done, based on best practices established in some States experienced with the provision of radio navigation aid services
- To ensure continued compliance to Annex 10 during operational service life; **NOT for design assurance testing**

“Guidance” in Doc 8071 Context

- Some States make 8071 guidance mandatory through national regulation: OK but difficult to manage
  - Guidance documents have much reduced validation requirements
  - Represents a best effort by available experts
  - Cannot spell out every detail
  - Responsive to requests from users which may not be a common need for all users
  - Never intended to lead to excessive effort
  - Difficult to predict consequences of too strict interpretation
- ICAO insists that sound engineering practice and common sense must be applied
  - Only high level objective is to ensure facility compliance with Annex 10 shall’s in installed environment
  - 8071 is one acceptable means which never excludes smarter ways of meeting the same objective

Doc 8071 Editorial Principles

- Guidance Doc may never contradict the Annex
- Annex 10 Vol 1 is quoted only for convenience
  - Newer, amended versions of Annex 10 automatically supersede outdated text in Doc 8071
- Test procedure describes process and measurement aspects

- **Tables summarize!**
  - For quick and easy reference
  - Not meant to describe perfectly the requirements; that is what Annex 10 is for
  - Not meant to describe perfectly the test procedures; that is what the main body of Doc 8071 is for

Volume I Structure and Summary

Structure remains essentially intact:

1. General:
   - Update to align with current practice
   - Quality processes
   - Inspection Intervals
   - New section on use of RPAS
2. VOR
3. DME
4. ILS

5/6/7. NDB, MB, PAR

8. New: Flight Validation is move to Doc 9906 and replaced by Navigation Aids Supporting PBN, like DME-DME for RNAV

Appendix: Deletion of copies of ITU Docs on FM Immunity

Consistency of units (esp. field strength)

General Chapter

Criteria examples for extended flight inspection intervals:

- Demonstration of stability
- Correlation between ground and airborne results
- Evidence of high maintenance quality
- Tolerance decrease within 75% of acceptance standards for LOC / GP alignment and DS

New Text on RPAS / UAS

1.18 USE OF REMOTELY PILOTED AIRCRAFT SYSTEMS

1.18.1 A basic principle of flight inspection to assess compliance with Annex 10 Standards is to use representative avionics at normal aircraft speeds. While flight inspection aircraft and their avionics are not representative of all aircraft and avionics, they nonetheless facilitate making judgements on the operational relevance of signal anomalies. This principle does not prevent the use of more advanced measurement capabilities both in ground and flight testing; however, it requires that good correlation (impact of filtering, etc.) needs to be established.

1.18.2 Remotely piloted aircraft systems (RPAS) or unmanned aerial vehicles (UAV) should be assessed to determine that they provide the payload capability, speed and range necessary to conduct a flight inspection for navigation aids as recommended herein in a cost-effective manner. RPAS can and have been used for special and advanced measurement applications which are difficult to achieve with traditional ground and flight measurement capabilities. Nothing in this manual is intended to prevent the development of such capabilities. Some States are studying how the use of RPAS can help in making more regular measurement checks with the aim to reduce the periodicity of a full flight inspection with a typical flight inspection aircraft. These studies should take into account the guidance in section 1.15.

But keep in mind other parts of Chapter 1 and Attachments…

Chapter 1 & Attachment A Excerpts

1.11.5 The flight inspection crew normally consists of two pilots and one or two technicians or engineers

Attachment A:

- Aircraft type preference should be given to multi-engine turbine aircraft (or jets) including
  - Pressurization and Air Conditioning
  - Autopilot
  - Good speed range, high (like other airspace users) and low (for higher measurement resolution)
  - Standard avionics must match airspace requirements
  - Sufficient space for antennas with good calibration
  - Dual set of receivers is preferable

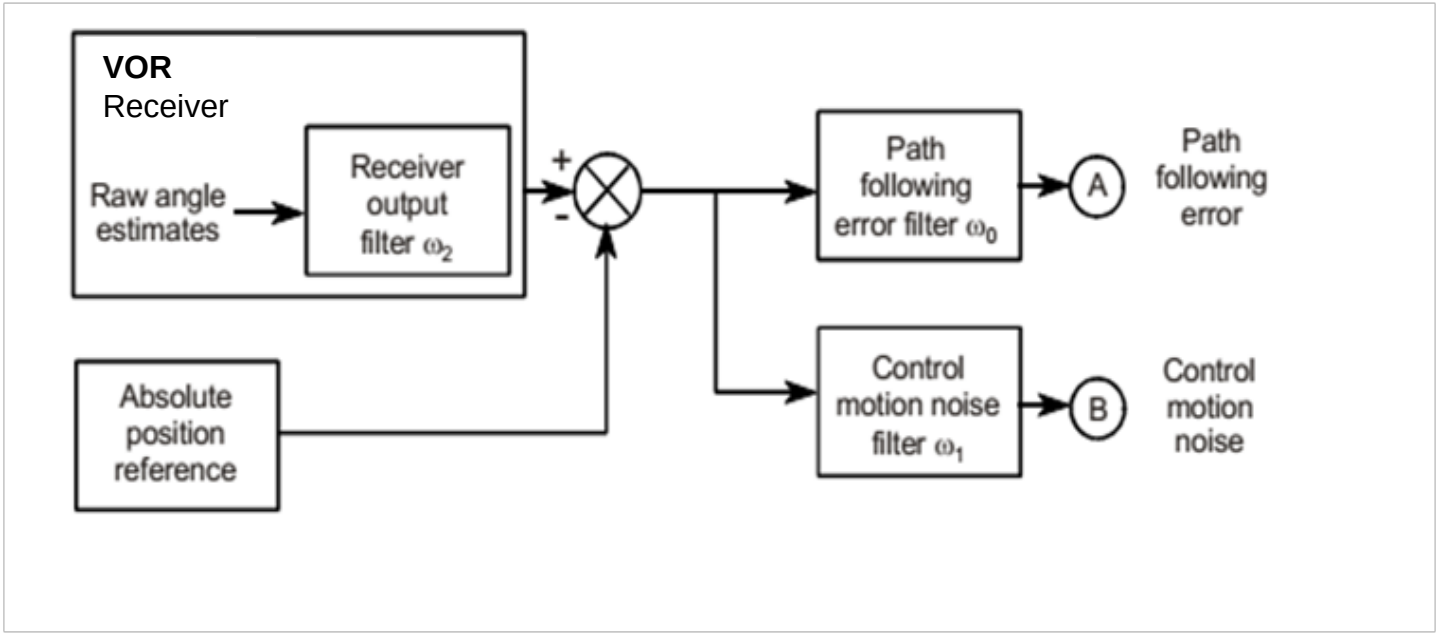
VOR Chapter

- Addition of alternative technique for PFE / PFN / CMN:
  - Motivated by wind turbine developments

✓ Alignment error tolerance 2°

✓ Bends or PFE / PFN tolerance 3.5°

✓ Roughness and scalloping or CMN tolerance 3°



DME Chapter

- Taking account of built-in test equipment
- DME/DME RNAV aspects moved to chapter 8 for better visibility
- Coverage measurements
  - Range measurement uncertainty: from 20 m to 50 m
    - To align with available equipment outputs
  - Field strength uncertainty corrected from 1 dB to 5 dB
    - Footnote on repeatability deleted

- DME will continue to play an important role to support PBN as a reversionary capability
  - Primary short-term A-PNT system in case of GNSS outages

ILS Chapter

- Updated definition of ILS (“means for glide path verification check”)
- Ensuring interference free operation when both LOCs at RWY radiate
- Displacement sensitivity: new ground figure and general update
- Cat I course alignment accuracy
- Consistent removal of need for mod balance flight check (“on special engineering request only”)
- Clarifications on alignment and power monitors
- New flight inspection report example
- New reference system accuracy table for DGNSS to complement angular tolerance table

Cat I LOC course alignment

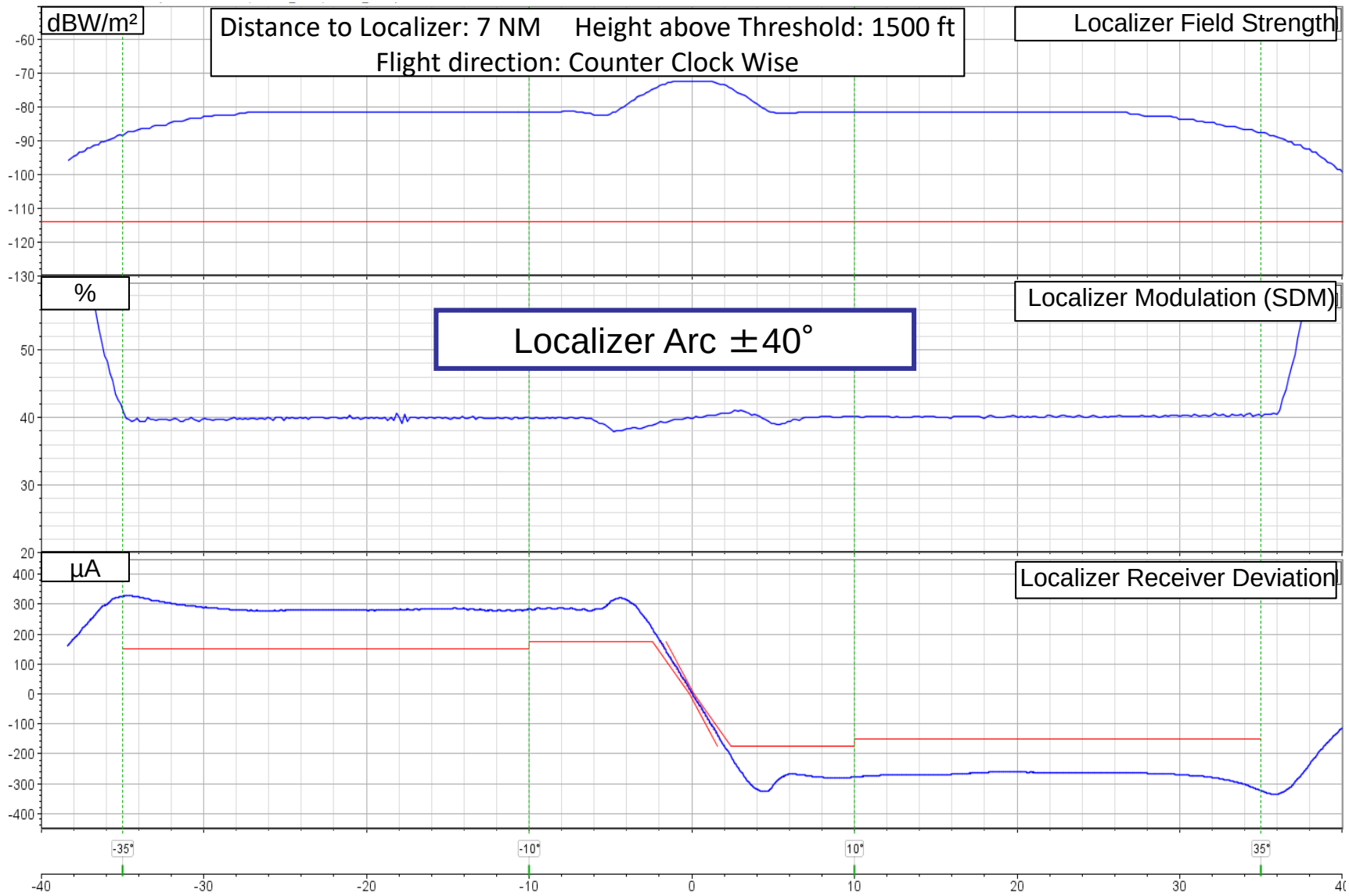
Previous:

- In the vicinity of ILS point B

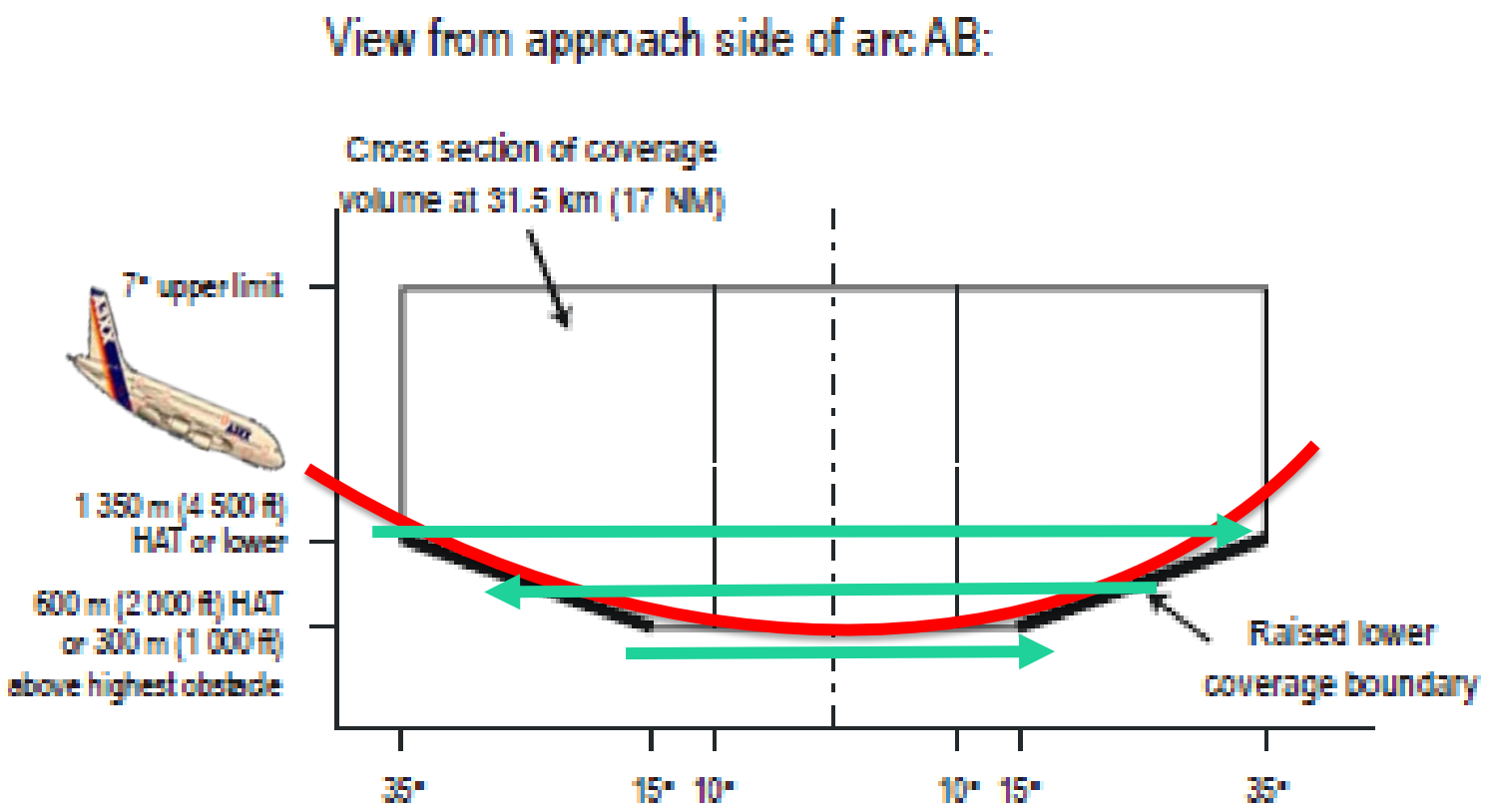
New:

- For at least 0.5 NM containing of ILS point B

Graphs from real inspection



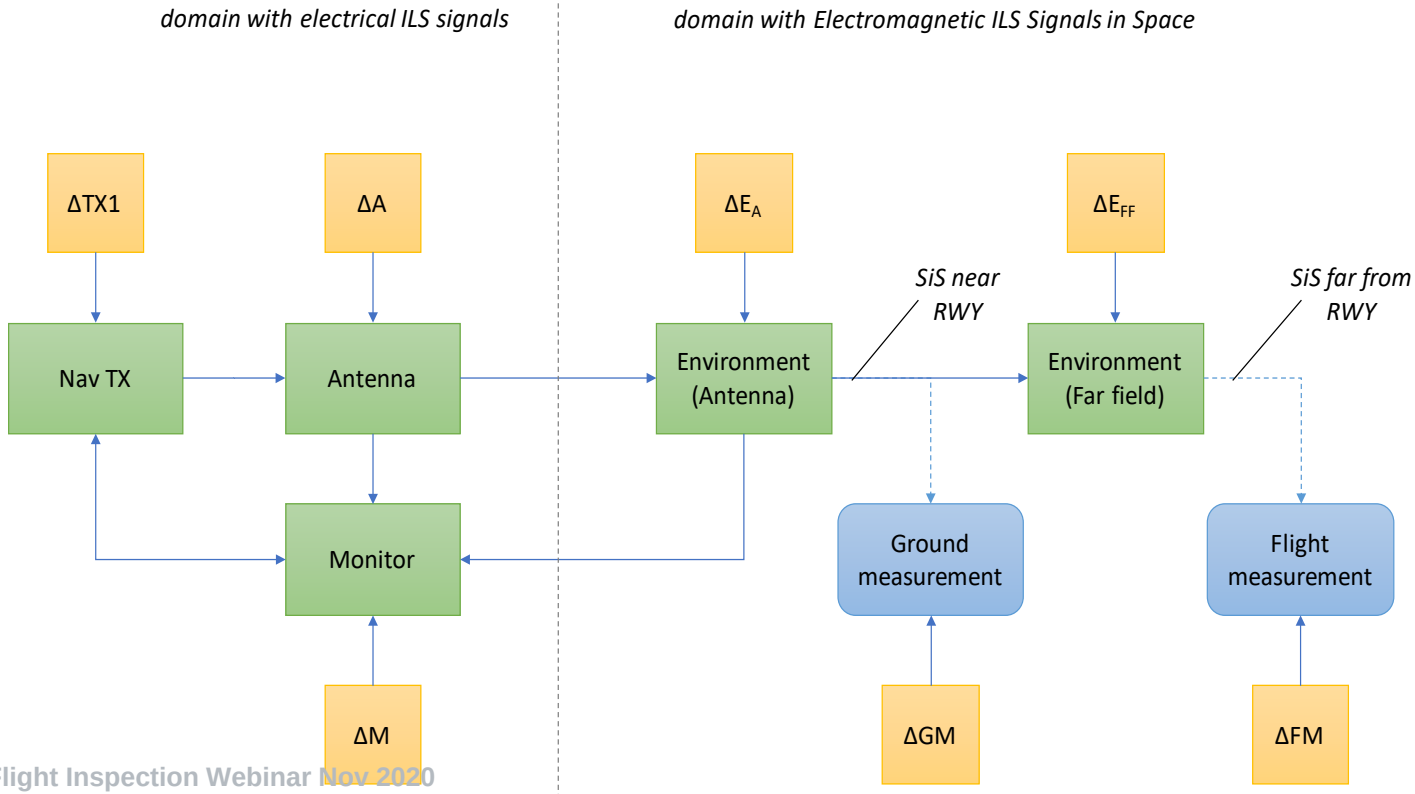
Reduced LOC elevation coverage



➢ Please select method for flight inspection

Current ICAO NSP Discussion

- New guidance in 5th edition discusses flight inspection periodicity in greater detail than before
- ICAO NSP also considering further reduction of FI runs, esp. ILS
  - Complemented by site modelling and site safeguarding
  - Initial motivation due to operational restrictions (night-time operations limits, airports at max capacity)



PBN Chapter

- Recognize PBN navigation infrastructure assessment as an activity
- Align with PBN Manual (Doc 9613) reference on flight inspection
- Link to facility-specific chapters
- Reference to attachment H in Annex 10 “Strategy for rationalization of conventional radio navigation aids and evolution towards supporting performance-based navigation”
- Mainly discusses DME but also covers VOR

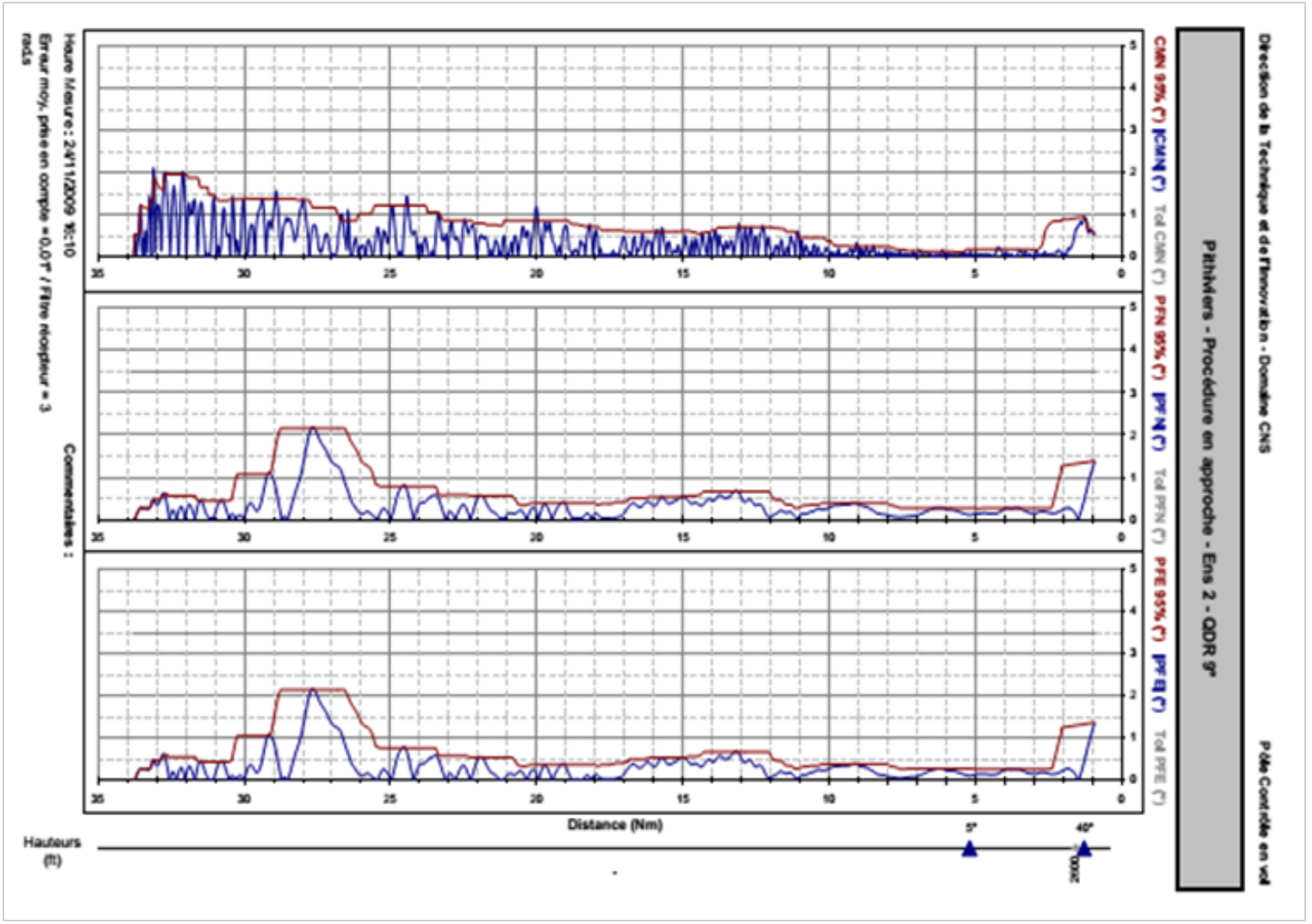
Conclusion

- In addition to realignment with Annex 10 Vol. I updates, goal was to resolve or at least improve long-standing issues of some debate in the flight inspection community
- Many errors were corrected, but for sure some remain
- Support from ICASC much appreciated
- Volume I effort is closed now, but feedback on Volume II matters remains timely

BACKUP SLIDES

- VOR CMN / PFE / PFN Example
- ILS FI Example Graphics
- General Chapter ICASC Link

PFE/PFN/CMN Technique



Prepare flight plan before flying

Run	Recordings, Flight Profile, Specifics and Remarks
#1	GP-Tx1, LOC-Tx1, DME-Tx1, Approach 8 to -1 NM
#2	GP-Tx2, LOC-Tx2, DME-Tx2, Approach 8 to -1 NM
#3	LOC-Tx2, Arc ±40°, 7 NM, 1500 ft, CCW
#4	LOC-Tx1, Arc ±40°, 7NM, 1500 ft, CW
#5	LOC-Tx1, Wide Alarm, Arc ±10°, 7NM, 1500 ft, CCW
#6	LOC-Tx1, Narrow Alarm, Arc ±10°, 7NM, 1500 ft, CW
#7	GP-Tx2, 90Hz Alignment Alarm, LOC-Tx2, 90Hz Alignment Alarm, Approach 5 to 0 NM
#8	GP-Tx2, 150Hz Alignment Alarm, LOC-Tx2, 150Hz Alignment Alarm, Approach 5 to 0 NM
#9	GP-Tx1, 90Hz Alignment Alarm, LOC-Tx1, 90Hz Alignment Alarm, Approach 5 to 0 NM
#10	GP-Tx1, 150Hz Alignment Alarm, LOC-Tx1, 150Hz Alignment Alarm, Approach 5 to 0 NM
#11	GP-Tx1, Level 12 to 2 NM, CL Az 0°, 1500 ft
#12	GP-Tx1, Level 12 to 2 NM, CL Az 8°, 1500 ft
#13	GP-Tx1, Level 12 to 2 NM, CL Az -8°, 1500 ft
#14	GP-Tx2, Level 12 to 2 NM, CL Az 0°, 1500 ft
#15	GP-Tx1, Wide Alarm, Level 6 to 2 NM, 1500 ft, Width Adjustment
#16	GP-Tx1, Wide Alarm, Level 6 to 2 NM, 1500 ft
#17	GP-Tx1, Narrow Alarm, Level 6 to 2 NM, 1500 ft

Note: 1) Ranges and heights are site dependant and the information provided here is for example only
2) Some states may perform more or less runs than this example protocol shows

ILS report example

Flight Inspection Report
ILS/DME 18 CCXX Airport, Country

Service Provider Name/Logo | **Sys Config** FIS-123-02 V8.44.1 | **Inspection Id** 2016-10-13 Airport ILS DME 18

Ident	I-ILS	**Cal. Aircraft**	XX-ILS		**GP**	**LOC**
Frequency	110.1 MHz	**Flight Inspector**	Kilo	**System**	Type No	Type No
Category	I	**Pilot**	Alpha	**Antenna**	M, 2F	2F
Inspection Type	Periodic Monitor	**1st Officer**	Bravo	**Nom Angle**	3.00°	0.00°
Date of Inspection	13.10.2016	**Ref Source**	DGPS+INS	**Nom ½cs**	0.72°	1.67°
Significant MET Cond.	None	**Sel. Ref Point**	Ref1	**Nom CS**	1.44°	3.33°

Facility / Transmitter No / Requirements / Unit					**1 GP 2**		**1 LOC 2**		**Tolerance**	
GP Angle / LOC Align.		GP (°)	LOC (µA)		2.99	2.99	-1.5	-1.8	2.78/3.22	±15.5
Alignment	150Hz	GP (µA)	LOC (µA)		-36.0	-37.0	-12.9	-13.4	-47	-14.5
Monitor	90Hz	GP (µA)	LOC (µA)		34.2	33.8	12.6	12.7	62	14.5
Modulation Depth		SDM		(%)	79.4	79.4	39.9	40.0	75/85	36/44
GP / Course Structure				(%)	100	100	100	100	95	95
Zone 1	- A	GP (µA)	LOC (µA)		-4.6	-4.8	-1.5	-1.5	30	30
Zone 2	A - B	GP (µA)	LOC (µA)		8.5	8.2	-2.0	-2.1	30	30-15
Zone 3	B - C/T	GP (µA)	LOC (µA)		7.0	7.3	-1.5	-1.8	30	15
Zone 4	T - D		LOC (µA)				N/A	N/A		N/A
Zone 5	D - E		LOC (µA)				N/A	N/A		N/A
RDH / Polarization ±20° bank		GP (m)	LOC (µA)		16.6	16.6	N/A	N/A	15-18	15
Aiming Point Offset				(m)	0.33	0.37				
Clearance		GP (µA/θ)	LOC (µA/°)		-320/0.45	-316/0.45	-262/21°	-260/20°	< -190	< -150
		GP (µA/θ)	LOC (µA/°)		370/1.75	380/1.75	278/-28°	276/-12°	> 150	> 150
LOC Course/Clearance Ratio				(dB)			-15	-15		-10
DS ¼ Sector 150Hz		GP (µA)	LOC (µA)		72	75	74	72	56/94	62/88
DS ¼ Sector 90Hz		GP (µA)	LOC (µA)		78	78	75	75	56/94	62/88
Wide	DS ¼ 150Hz	GP (µA)		(µA)	58	N/A	63	N/A	> 52	> 62
Monitor	DS ¼ 90Hz	GP (µA)		(µA)	63	N/A	64	N/A	N/A	> 62
Narrow	DS ¼ 150Hz	GP (µA)		(µA)	90	N/A	85	N/A	< 98	< 88
Monitor	DS ¼ 90Hz	GP (µA)		(µA)	98	N/A	85	N/A	N/A	< 88
Field Str GP/LOC		min at 10 NM		(dBW/m²)	-82	-80	-85	-84	-95	-107
Field Str LOC/LOC		min 17 and 25 NM		(dBW/m²)	N/A	N/A	N/A	N/A	-114	-114
Ident							ok	ok	Clearly audible	
Marker		OM (m)	MM (m)		N/A	N/A	N/A	N/A	400-800	200-400
Beacon			IM (m)				N/A	N/A		100-200
Facility / Transmitter No / Requirements / Unit							**1 DME 2**		**Tolerance**	
Range Error				(m)			17	18		75
Field Str		min at 25 NM		(dBW/m²)			N/A	N/A		-89
Ident							ok	ok	Clearly audible	

Operational Status: **Unrestricted**

* Out of Tolerance @ Adjustment

Remarks: @ GP Tx-1 Wide Monitor 150Hz adjusted from 51* µA to 58 µA.
GP Tx1 Coverage checked satisfactory ±8° centre line azimuth.

Flight Inspector:	Oscar Kilo		OK
Phone:	+98 76 54 32 10 00	**Signature, Date:**	14.10.2016
Email:	post@amc.com	**Distribution:**	Airport Management Comp., Country

ILS report example

Flight Inspection Report
ILS/DME 18 CCXX Airport, Country

Service Provider Name/Logo **Sys Config** FIS-123-02 V8.44.1 **Inspection Id** 2016-10-13 Airport ILS DME 18

					GP	LOC
Ident	I-ILS	**Cal. Aircraft**	XX-ILS			
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Facility / Transmitter No / Requirements / Unit					**1 GP 2**		**1 LOC 2**		**Tolerance**	
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Alignment	150Hz	GP (µA)	LOC	(µA)	-36.0	-37.0	-12.9	-13.4	-47	-14.5
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Modulation Depth		SDM		(%)	79.4	79.4	39.9	40.0	75/85	36/44
GP / Course Structure				(%)	100	100	100	100	95	95
Zone 1	- A	GP (µA)	LOC	(µA)	-4.6	-4.8	-1.5	-1.5	30	30
Zone 2	A - B	GP (µA)	LOC	(µA)	8.5	8.2	-2.0	-2.1	30	30-15
Zone 3	B - C/T	GP (µA)	LOC	(µA)	7.0	7.3	-1.5	-1.8	30	15
Zone 4	T - D		LOC	(µA)			N/A	N/A		N/A
Zone 5	D - E		LOC	(µA)			N/A	N/A		N/A
RDH / Polarization ±20° bank		GP (m)	LOC	(µA)	16.8	16.8	N/A	N/A	15-18	15

General Chapter

New in 1.4.5 ….Information regarding flight inspection service providers can be obtained … online from the International Committee for Airspace Standards and Calibration www.ICASC.co