

SAE INTERNATIONAL & EUROCAE

EUROCAE WG-114 (Artificial Intelligence)

SAE G-34 (Artificial Intelligence in Aviation Committee)

ARP6983 / ED-324 – Development and Assurance guidelines for Aeronautical Systems and Equipment Implemented with Machine Learning

FAA AI/ML Technical Exchange Meeting

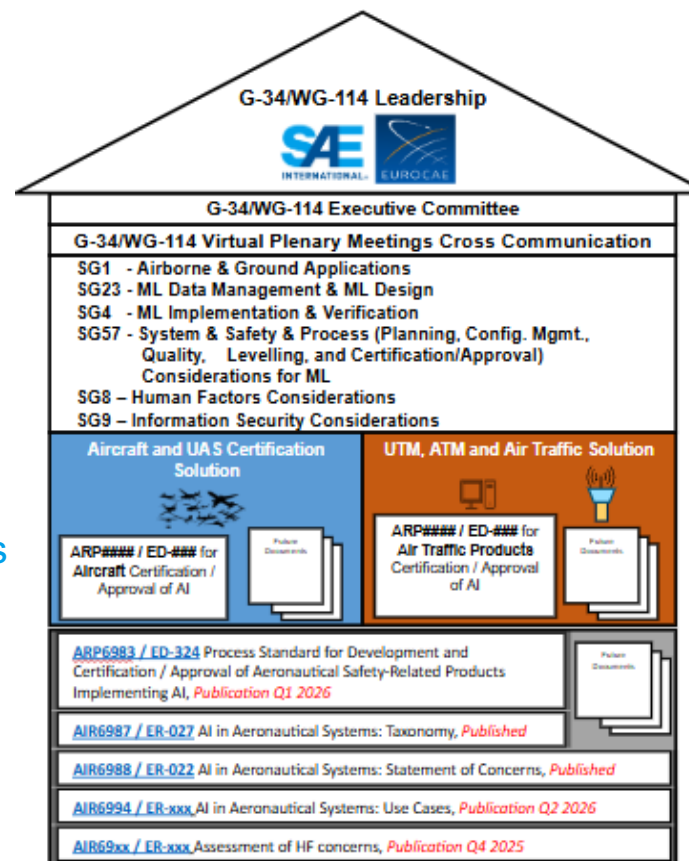
August 2025



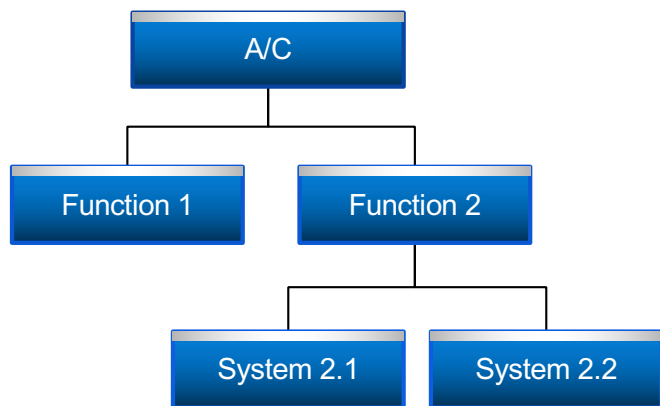
About SAE G-34 / EUROCAE WG-114 – Global picture

Joint Committee:

- Created in 2019
- Contributors: industries, authorities, university
- 2 published documents
 - ER-022 / AIR6988 (Statement of concerns)
Published on 30 April 2021
 - ER-027 / AIR6987 (Taxonomy)
Published on 12 December 2024
- WIPs
 - ED-324 / ARP6983 – Development and Assurance guidelines for Aeronautical Systems and Equipment Implemented with Machine Learning
Publication targeted for June 2026
 - ER-0xx / AIR6994 (Use Cases)
Publication planned for Q2 2026



Statement of Concerns – Gap in current Certification Approach



Airborne ED-79x/ARP4754x, ATM/ANS (EU) 2017/373

- | | | |
|--|---|--|
| 1. Knowledge-based Engineering (requirements, models, etc.) | → | Data-Based (driven) engineering |
| 2. Software/Hardware design done by humans for humans (explainable, auditable, etc.) | → | The complex design of an ML model is not directly understandable by humans |
| 3. Source code traceable to functional requirements | → | The low level design developed by the machine is not directly traceable to functional needs |

New Standard WG-114/G-34

ML Constituent with SW/HW items

SW Item

SW Item

Airborne: ED-12x/DO-178x + Suppl.
ATM/ANS: ED-109x/DO-278x/ED-153

AEH Item

AEH Item

Airborne & ATM/ANS: ED-80/DO-254

Traditional SW/HW Items without ML

Industry consensus on the ML challenges in Statement of Concerns (ER-022 / AIR6988)

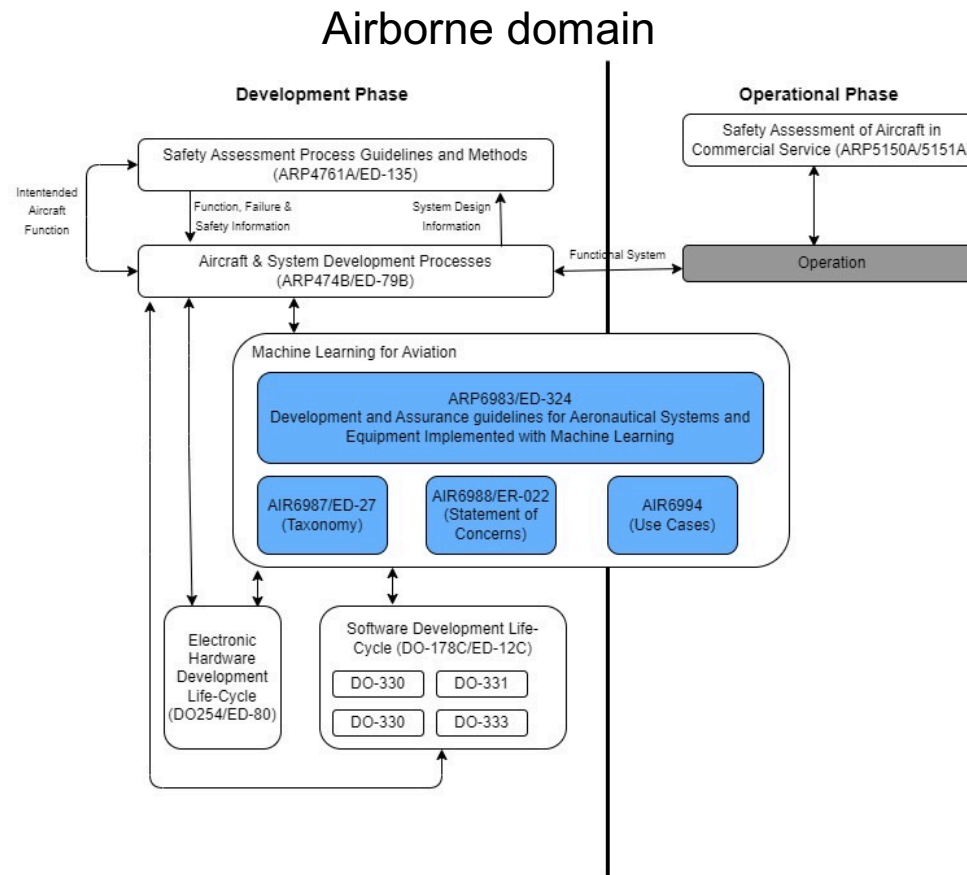
ARP 6983 / ED-324 – Concepts: Machine Learning Constituent (MLC)

ED-324 / ARP6983 – Scope issue 1

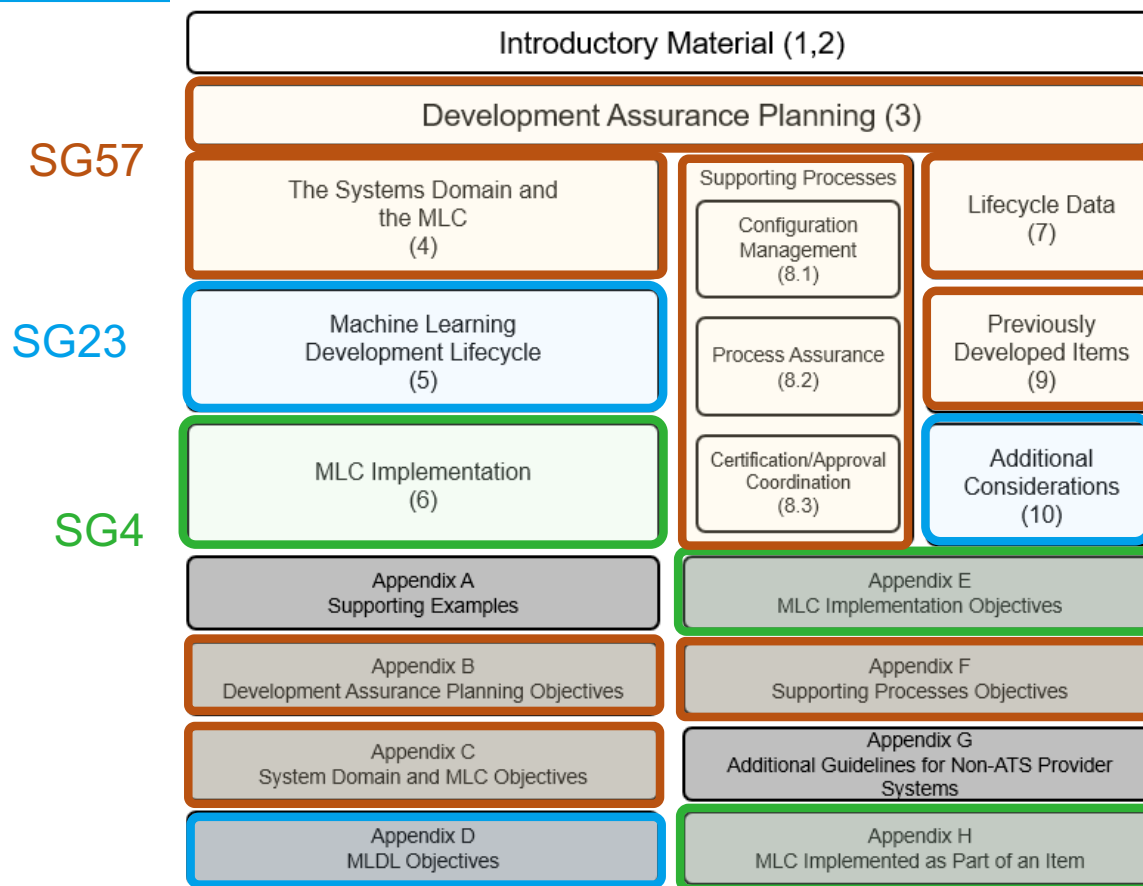
Disclaimer: This presentation is based on ED-324/ARP6983 Draft 7 (WIP), which content may change due to current SAE ballots & EUROCAE Open Consultations processes.

- Development assurance process focused on Learning Assurance
- Both airborne and ATM/ANS domains
- Crewed and uncrewed aircraft
- Issue 1 limited to a subset of ML technologies
 - Non-adaptive ML in supervised mode, and up to DAL C / AL 3 / SWAL 2
 - out of scope: Information security & Human factors considerations

ARP 6983 / ED-324 – Relationship to other Guidelines



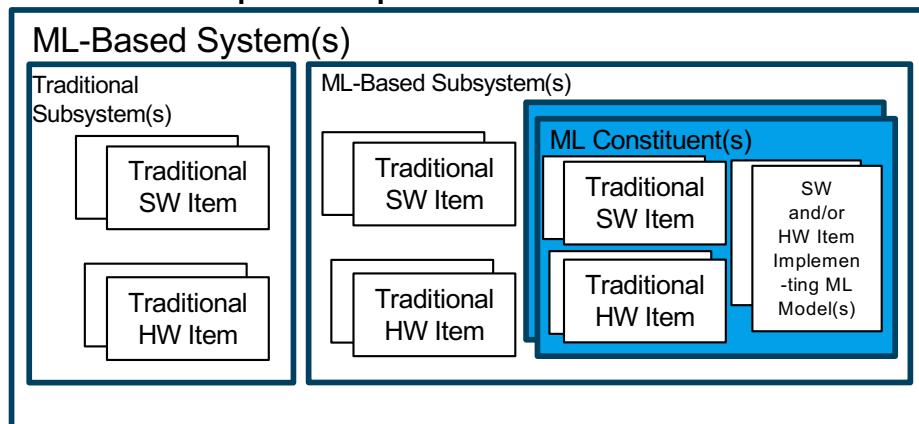
ARP 6983 / ED-324 – Document Structure



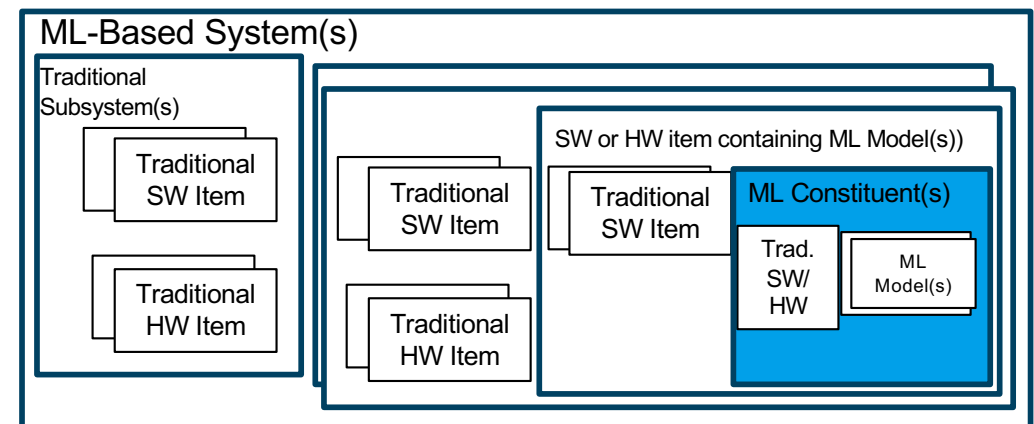
ARP 6983 / ED-324 – Concepts: Machine Learning Constituent (MLC)

A defined and bounded set of one or more ML model(s) and the ML data processing required for their execution, implemented in hardware and/or in software, and considered as a single entity for assurance purposes.

- Transition point from conventional system development and safety processes to MLC Development process

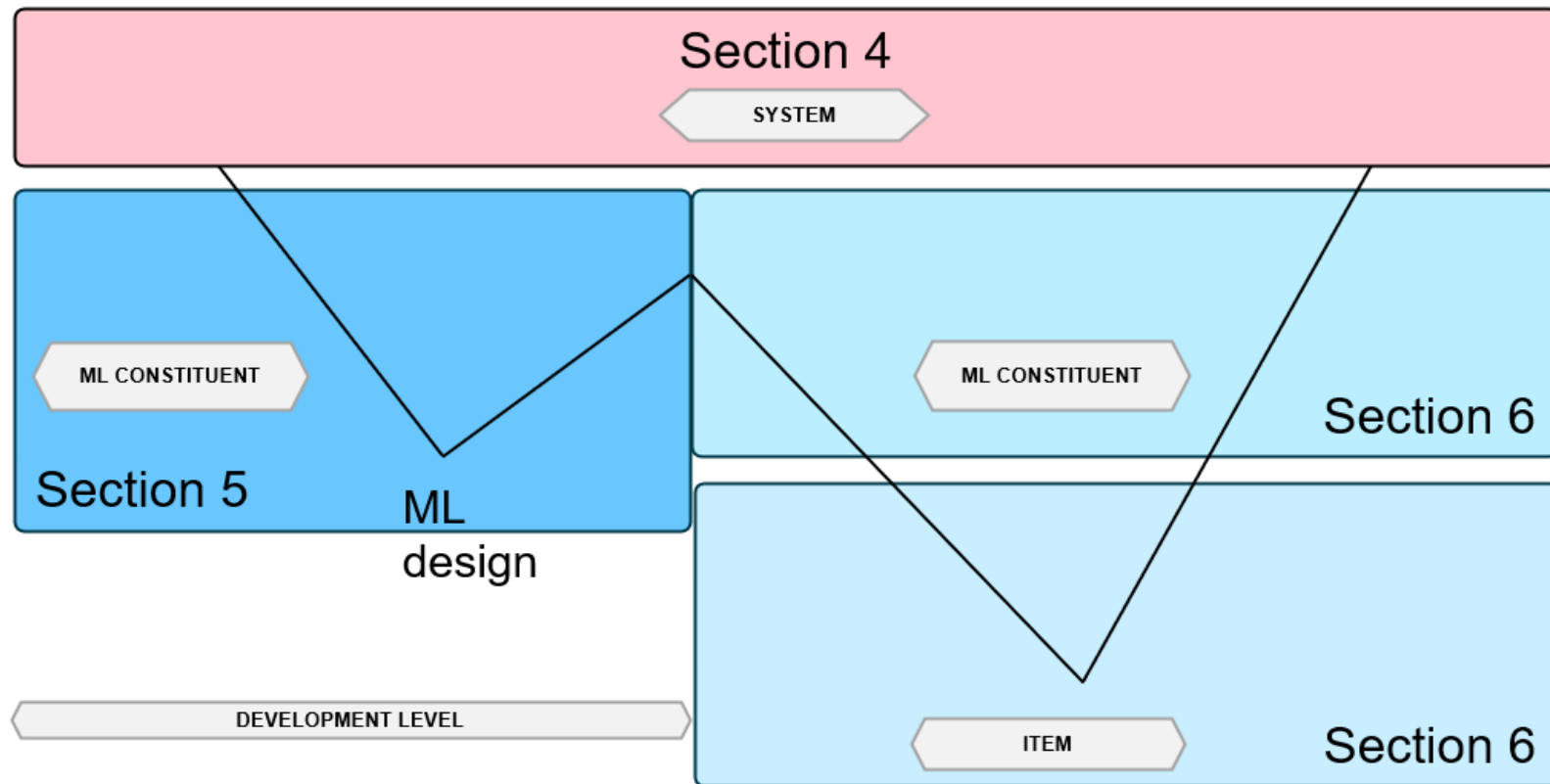


MLC as a container of Items (MLC category 1)

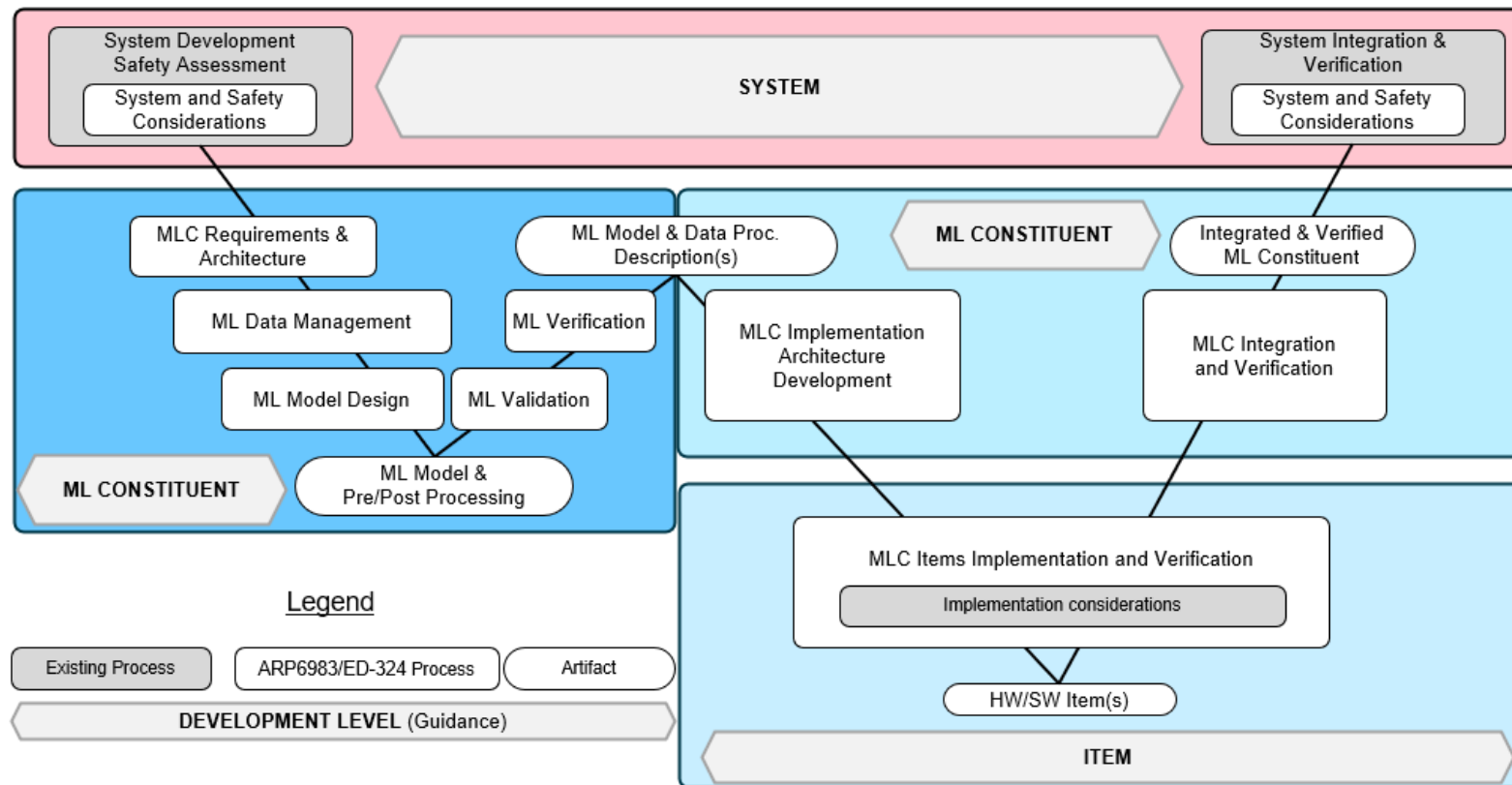


MLC as part of an Item (MLC category 2)

ARP 6983 / ED-324 – Concepts: MLC Development Process



ARP 6983 / ED-324 – Concepts: MLC Development Process



ARP 6983 / ED-324 – Objectives

ARP Objectives example: Section 5 Machine Learning Development Life Cycle

Table#	OBJECTIVES	OBJECTIVES PER ASSURANCE LEVEL*			
		TOTAL	DALC/AL3/SWAL2	Ø/AL4/SWAL3	DALD/AL5/SWAL4
Table 1	ML CONSTITUENT REQUIREMENTS PROCESS	5	5	5	5
Table 2	ML DATA MANAGEMENT PROCESS	9	9	6	6
Table 3	ML MODEL DESIGN PROCESS	5	5	2	2
Table 4	VALIDATION OF THE OUTPUTS OF THE ML CONSTITUENT REQUIREMENTS PROCESS	5	5	3	3
Table 5	VALIDATION OF THE ML DATA REQUIREMENTS	5	5	0	0
Table 6	VALIDATION OF THE ML MODEL REQUIREMENTS	5	5	0	0
Table 7	VERIFICATION OF OUTPUTS OF ML DATA MANAGEMENT PROCESS	12	12	9	8
Table 8	VERIFICATION OF OUPUTS OF ML MODEL DESIGN PROCESS	18	18	12	7
Table 9	VERIFICATION OF ML VERIFICATION PROCESS RESULTS	9	9	5	3
	TOTAL	73	73	42	34

*Objective count is a snapshot in time and may change as the ARP progresses

How the ARP Addresses Safety at the System Level (1/2)

- **The WIP ARP aims to provide a balanced approach of safeguards, with a process that is objective based to control the development**
 - FHA is still required, and the ARP cannot be used if the outcome is higher than IDAL C/AL3/SWAL2
 - This guards against novelty uncertainties to avoid risk at the product level
 - Only supervised offline learning: limits risk by preventing online learning and limiting system integration techniques
 - Modulated objectives: system safety effect dictates the development objectives and needed artifacts
 - Product functional intent at the system level is best served when ML specificities are guided with a proportionate rigor
 - Does not disturb the existing eco-system of standards established at system level, instead addresses a novelty gap and its safety needs

How the ARP Addresses Safety at the System Level (2/2)

- **The WIP standard aims to provide a balanced approach of safeguards, with a process that is objective based to control the development (cont.)**
 - Requirements are established at the system level to guide the performance, data quality, and process
 - MLC concept (container of items or part of an item) introduced to bound the learning and system novelties
 - Once deployed, an ML model is software and is either correct and qualified (with or without Open Problem Reports) or incorrect and not qualified
 - Hardware supporting MLC implementation needs (sensors, graphics processors, memory devices, data-links etc.) are treated as random hardware
 - Takes a performance-based approach, as safety in ML is synonymous with performance at thresholds and error acceptance
 - ARP uses a systematic approach to limit development errors and unintended behaviors at the system level
 - Overall, the ARP dictates an incremental and cautious approach for integration at the system level

ARP 6983 / ED-324 – Use Case Overview

Use Case	ML technique(s)	ML algorithm category	MLC Category	MLC IDAL/AL/SWAL	ARP6983/ED-324 standard coverage)
Time-Based Separation	Supervised	Regression	Category 1	IDAL C	Section 4 and 5
Automated Fuselage Skin Anomalies Inspection	Supervised	CNN	Category 1 (implementation in one or several items)	IDAL C	Sections 5 and 6
Collision Avoidance Use Case	Reinforcement	NN - Fully Connected Layer	Category 1 Homogeneous MLC case (SW)	IDAL C	Section 4 (all parts) 5.2 ML Constituent Requirements Process
ACAS-XU Use Case	Supervised	Fully connected NN	Category 1	IDAL C	Section 4 (system), 5 (MLDL) and 6 (implementation)
ML-based Automatic Air-to-air Refueling Use Case	Supervised	CNN	Category 1	IDAL C	Sections 4, 5, 6
NASA low-dimensional Use Case for Engine Health Management	Supervised Offline	Shallow NN or Nonlinear Regression	Category 2	IDAL C	Section 4 (partial) - System requirements but no QSA Section 5
Aircraft Emergency Braking System (AEBS) - Powered by Runway Sign Classifier (RSC)	Supervised	CNN-based object detection DNN	Category 1	IDAL C, IDAL D	Sections 3, 4, 5, 6, 7, 8, 10
Multi-sensor Ensemble-guided Attention Network for Aerial Vehicle Perception Beyond Visible Spectrum	Supervised	Transformer with attention layers	Category 1	research only IDAL C	4,5 and whatever will be applicable from 6 for the development portion
Vision Landing System (VLS) Use Case	Supervised	CNN	Category 2 (both can be applied)	IDAL C	Sections 4 and 5
Autonomous Integrated Resilient System for Enhanced Navigation in Secure Environments	Supervised	CNN + Fully connected NN	Category 1	IDAL C	Sections 4 and 5

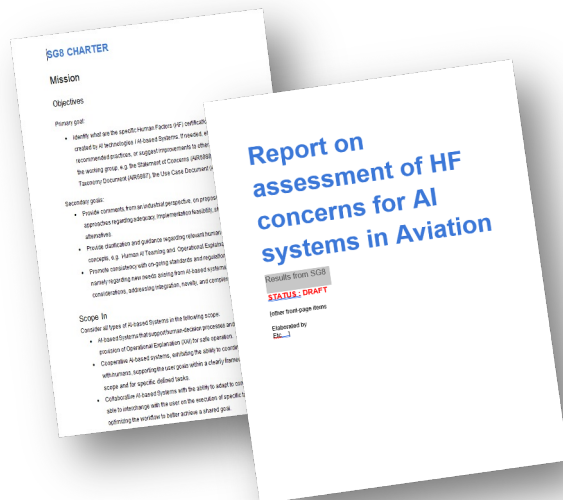
ARP 6983 / ED-324 – SG8: Human Factors Considerations

Scope & Focus

End Users considerations in relationship with the AI development.

Expected Result

Guidance to develop AI that address end-users needs.



Planned Activities

- Charter approved
- Engaging outside (EASA, FAA, ANAC, G10H, S18H)
- Identification and selection of Use Cases
- Identification of Human Concerns
- Analysis of assurance provision for AI systems to address human concerns

ARP 6983 / ED-324 – SG 9: Information Security

Scope & Focus

The **security aspects** of **initial and continuing airworthiness** and **ATM/ANS** certification and **maintenance** for AI-based aeronautical systems.

Expected Result

Guidance to develop AI that addresses information security concerns

Planned activities

- SG creation approved in the July plenary by WG-114
- Charter in work
- Engaging outside (EASA, FAA, S-18, G-32, ISO, etc.)
- Gap analysis of information security concerns

ARP 6983 / ED-324 Schedule

- SAE Ballot 1 ended on April 7th, ≈1800 comments are being addressed
- EUROCAE Open Consultation started August 1st 2025, will run 45 days
- SAE Ballot 2 planned for March 2026
- Target publication issue 1: June 2026
- Use Cases in work to illustrate how to apply the recommended practice to different applications
- Issue 2 will follow, covering more ML techniques (such as Reinforcement Learning)

Note: This is the current schedule, it is subject to change

Acknowledgements

- The content of ED-324 / ARP6983 is the work of **many individuals** (too many to name) beyond the few who presented today and the leadership, SG leads, and editors.
- Special thanks to Trung Pham for the invitation to present.

Any questions?