EPIC
General Aviation
Manufacturers Association

Advanced Air Mobility Aircraft Entry into Service (EIS) Communication, Navigation, and Surveillance (CNS) Typical Capabilities List (TCL)

A report by GAMA Electric Propulsion and Innovation Committee (EPIC)

Version: 1.0; September 2023

Background

Advanced Air Mobility (AAM) aircraft offer a new combination of vertical or short takeoff and landing, in novel or traditional airframes, that will conduct quiet electric operation and integrate advanced automation. AAM aircraft enable new missions in the National Airspace System (NAS), such as short-range urban and regional air mobility operations, and remotely-piloted or remotely supervised (leveraging advanced levels of automation) operations.

It is expected that in the longer-term, to enable the full range of AAM capabilities, modifications will be required in aviation regulations and operational procedures, with introduction of new automation-capable avionics and CNS capabilities currently not in use. **There is, however, a need to understand the expected airborne equipage at entry into service (EIS) to help inform planning activities.**

The NextGen Advisory Committee (NAC) produced a Minimum Capabilities List (MCL) which as part of its re-evaluation in 2022 specifically attempted to consider "*How new entrants into the NAS like… electric aircraft and UAS fit into MCL?*"[1] The NAC's response to the FAA noted that "*One area that potentially warrants additional study in the future will be small electric powered "air taxis".*" To help inform the Federal Aviation Administration (FAA), industry and other stakeholders' understanding of EIS considerations, GAMA explored developing a Minimum Capability Lists for AAM aircraft, to enable effective communication about new NAS operations.

Instead of an MCL – which may be premature for an emerging industry – this document provides a Typical Capabilities List ("TCL") for avionics equipage at EIS for AAM, in the areas of Communication, Navigation, and Surveillance (CNS), as well as other aircraft safety equipment to level set expectations and promote a smoother NAS evolution. Clarity of communication requires setting a few broad definitions and communicating the operational intent at EIS. The provided definitions are deliberately broad in order to include a range of

[1] https://www.faa.gov/sites/faa.gov/files/MCL-Ad-Hoc-Team-NAC-Task-21-1-Addendum-for-NAC-Approval.pdf

configurations and operational styles, and definitive enough to provide scope. Following the necessary scoping remark and intended operational paths, this document provides survey-based information about aircraft equipment suites, as well as the method used to gather the information and its limitations.

Scope

GAMA previously briefed the FAA at roundtables that eVTOL aircraft at EIS (2024-2025) will be single pilot, primarily conducting VFR operations, evolving to IFR capability, and operating within the existing National Airspace System (NAS) using traditional CNS equipage. This paper encompasses a broader set of aircraft, not just eVTOL, to include all AAM, including eVTOL, powered lift, rotorcraft, and fixed wing aircraft; these aircraft have more varied flight rule operational capabilities at EIS.

In this document, AAM Aircraft refers to:

- Newly certified electric aircraft capable of human occupancy, operating chiefly below 10,000 ft AGL.
- Remotely piloted or remotely supervised (relying on advanced levels of automation) aircraft capable of human occupancy.
- Used for commercial service carrying cargo or fewer than 9 passengers.

This paper deals with the period 2024 through 2028, which encompasses EIS and early vehicle operational envelope expansion.

Varied Evolution

Most, if not all, of the current AAM manufacturers intend to integrate into the ***current* National Airspace System at EIS**. The overall goal is to be transparent to the current ATC system at EIS. There is a wide spectrum among the AAM manufacturers as to what ATC services and regulatory structure they intend to utilize. Initial operations will use the full spectrum of options from VFR-day only to all weather IFR. This reflects the wide variety of aircraft that identify as AAM, from new small conventionally piloted electric vertical lift

aircraft to existing conventionally powered fixed wing airplanes converted to full automation. The operating environment for these aircraft is as varied as the aircraft themselves from low altitude urban operations to conventional regional 14 CFR Part 135 operations conducted today.

It is expected that the number of aircraft and frequency of operations for all these aircraft will grow exponentially as the industry matures, which will then require changes in the NAS to accommodate these operations. This is expected to be an evolutionary process after EIS. Each manufacturer has a unique concept of operation, in both equipage and operational capability, and it is not accurate to condense the evolution of the entire industry into a single concise philosophical roadmap.

Survey to Inform EIS Equipage and NAS Operations

GAMA conducted a survey of aircraft OEMs and received nine responses about planned CNS aircraft equipage. The survey respondents represent the more mature OEMs that are several years into aircraft development, most with on-going certification projects and planned EIS within 2024-2028. The survey was conducted using the FAA's annual General Aviation and Part 135 Activity Survey Questionnaire, specifically its Installed Avionics Equipment (Question 17)[2] with minor modifications. The questionnaire and survey responses were structured around (1) communications, (2) navigation, (3) surveillance, and (4) safety equipment.

To facilitate an open exchange between competitors, the survey was conducted anonymously. The tabulated results of the survey show the percentage of manufacturers responding indicating equipage of particular avionics at EIS, and available from GAMA.

The results are summarized here. **Appendix A** contains detailed survey results.

---

2 https://www.faa.gov/sites/faa.gov/files/data_research/aviation_data_statistics/general_aviation/cy2020/2020GASurvey_Appendix_B_Documents_29OCT2021V1.pdf

Survey Results

Area 1: Communications

All aircraft OEMs indicated plans to use standard VHF voice communication for interaction with air traffic control. Some OEMs also indicated plans to enable data link communications for specific functions (*e.g.*, D-ATIS).

Area 2: Navigation

The primary navigation capability will be based on WAAS-enabled, IFR-approved GPS to support terminal and enroute procedures.

The survey results provided greater variability for other aircraft navigation capabilities, but OEMs are considering VOR-enabled navigation and VOR/DME-based Area Navigation (RNAV) capabilities as well as some DME/DME based RNAV. Most aircraft OEMs also plan for a standard 200 channel ILS/VOR with localizer and glideslope.[3]

Area 3: Surveillance

All aircraft OEMs indicated the intention to equip with ADS-B enabled Mode S transponder providing the aircraft air-to-ground surveillance capability and in adherence with 14 CFR 91.215 and 91.225 requirements.

Some OEMs indicated plans for dual frequency receive capability (*i.e.*, 1090MHz and 978 MHz UAT link) to support traffic situational awareness. All OEMs indicated plans for ADS-B IN functionality to support Aircraft Surveillance Application (ASA) such as Cockpit Display of Traffic Information (CDTI). Some OEMs also stated plans for a Traffic Collision Avoidance System (TCAS) or other traffic functions (*e.g.*, TAS).

[3] The FAA has noted the applicability of helicopter procedures under part 97 to powered-lift aircraft to enable participation in the IFR system (88 FR 39097)

Note: Display of traffic information from FAA primary and secondary radar to a ground-based remote pilot was not an available choice on the survey but remains an item of interest for 2028.

Area 4: Other Safety Equipment

Most, but not all OEMs, indicated plans for a Terrain Awareness and Warning System (TAWS) at different versions, including TAWS and HTAWS depending on the aircraft configuration.

Some OEMs indicated plans for weather in the cockpit; either using UAT or a weather radar.

Most of the OEMs also indicated plans for a Flight Data Recorder (FDR) based on the EUROCAE ED-155 flight data recorder standards.

Summary

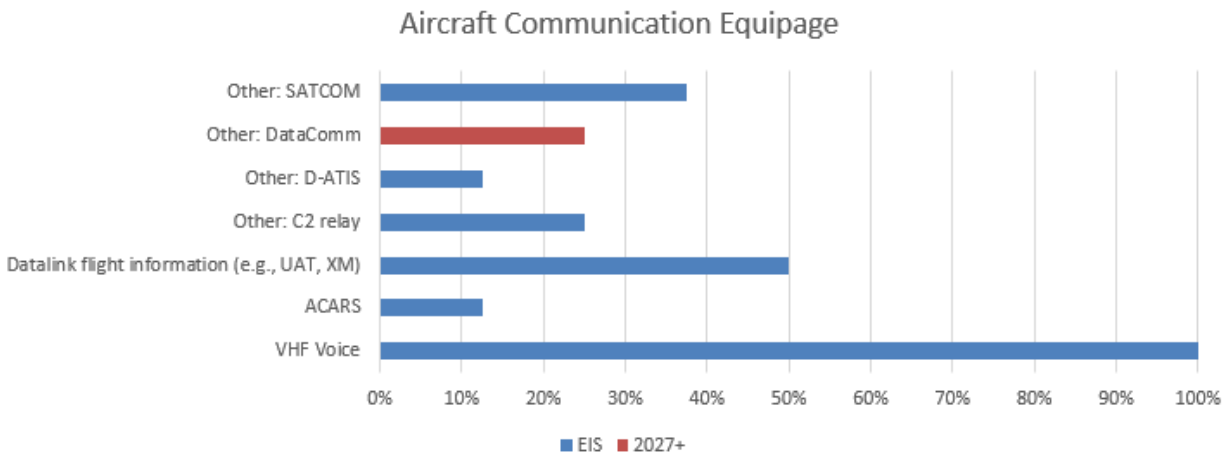
This AAM EIS Typical Capabilities List, created from survey results, is being made available for reference and to assist in ongoing work to promote AAM EIS. By providing FAA and other AAM stakeholders with this information, planning efforts to add or amend regulations and procedures can proceed with reduced uncertainty.

APPENDIX A – Communication, Navigation and Surveillance (CNS) Survey Results

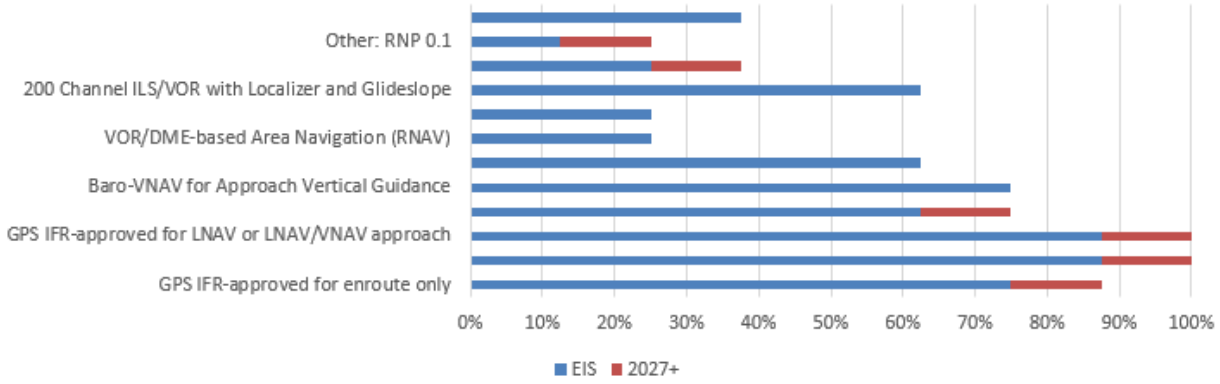
In addition to the proffered choices, some respondents provided additional information about planned equipment that was not on the survey. These voluntary responses are captured in these charts with the prefix "Other." Thus, any equipment percentages that begin with "Other" may underestimate true intended equipage.

Also, some responses indicated equipage for indicated avionics would start in 2 or 3 years after EIS; this equipage is indicated with differently colored stacked bars bearing the label "2027."

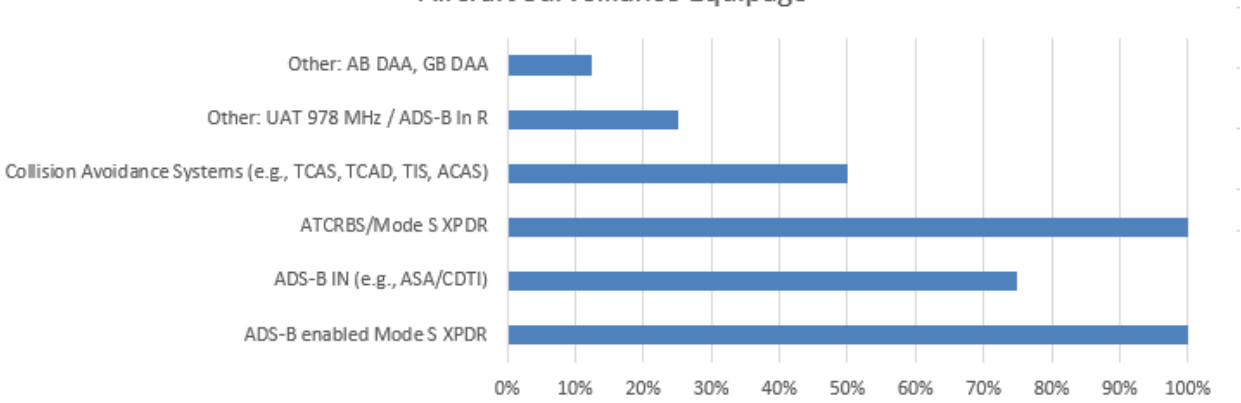
Initial survey results were reviewed with the GAMA CNS subcommittee and with representatives from FAA-ANG. Respondents were given an opportunity to amend or correct survey results prior to publication of this document.



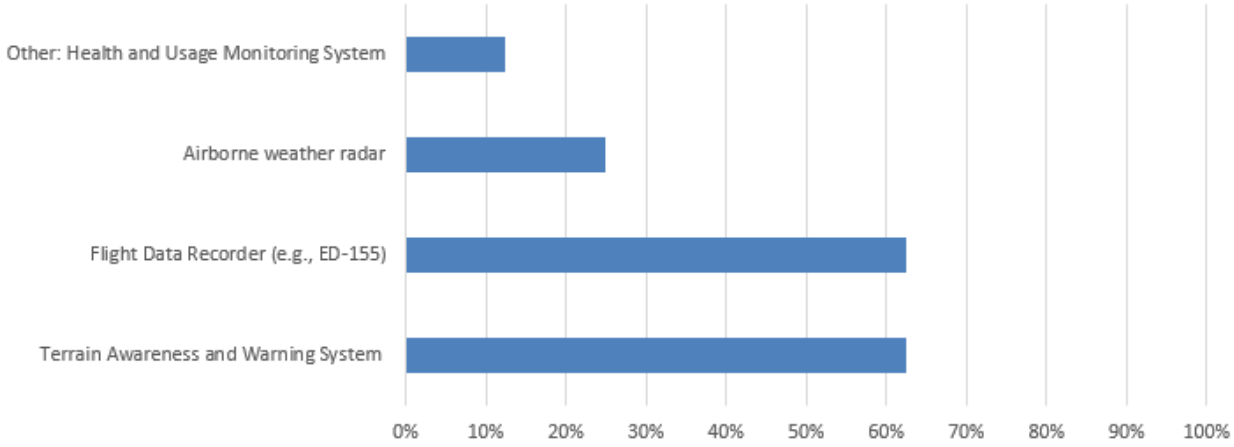
Aircraft Navigation Equipage



Aircraft Surveillance Equipage



Other Airborne Equipage



Glossary

AAM	Advanced Air Mobility
AB DAA	Airborne Detect and Avoid
ACARS	Aircraft Communications, Addressing and Reporting System
ACAS	Airborne Collision Avoidance System
ADS-B	Automatic Dependent Surveillance Broadcast
ADS-B In	Automatic Dependent Surveillance Broadcast with receive mode
ADS-B In R	Automatic Dependent Surveillance Broadcast with receive re-broadcast of traffic from ground station
AGL	Above Ground Level
ANG	Office of NextGen (FAA)
ASA	Aircraft Surveillance Application
ATCRBS	Air Traffic Control Radar Beacon System
C2	Command and Control
CDTI	Cockpit Display of Traffic Information
CNS	Communication, Navigation, and Surveillance
D-ATIS	Digital Automatic Terminal Information Service
DME	Distance Measuring Equipment
FAA	Federal Aviation Administration
ED	EUROCAE Document [document standard number]
EIS	Entry Into Service
EPIC	Electric Propulsion and Innovation Committee
GAMA	General Aviation Manufacturer's Association
GBAS	Ground Based Augmentation System
GB DAA	Ground Based Detect and Avoid
GPS	Global Positioning System
IFR	Instrument Flight Rules
ILS	Instrument Landing System
LNAV	Lateral Navigation approach guidance
LPV	Localizer Performance with Vertical Guidance
MHz	Megahertz

Mode S	Secondary Surveillance Radar selective interrogation and communication
NAS	National Airspace System
OEM	Original Equipment Manufacturer
RNAV	Area Navigation
RNP	Required Navigation Performance
SATCOM	Satellite Communications
SSR	Secondary Surveillance Radar
TAS	Traffic Advisory system
TCAS	Traffic Alert and Collision Avoidance System
TCAD	Traffic Collision Avoidance Device
TIS	Traffic Information Service
UAT	Universal Access Transceiver
VFR	Visual Flight Rules
VHF	Very High Frequency
VNAV	Vertical Navigation
VOR	VHF Omnidirectional Range
XM	Commercial satellite radio service brand name
XPDR	Transponder