SAE INTERNATIONAL

AEROSPACE RECOMMENDED PRACTICE

ARP4927™ REV. A

Issued 1995-03
Reaffirmed 2007-07
Revised 2023-12

Superseding ARP4927

(R) Integration Procedures for the Introduction of New Systems to the Flight Deck

RATIONALE

Revision B is a new document that has a new format. It was produced to clarify the fact that any requirements should come directly from an identified need and that the integration of any new system should be compatible with existing systems and should consider any required training.

1. SCOPE

This SAE Aerospace Recommended Practice (ARP) provides guidance to achieve the optimum integration of new aircraft systems which have an impact on the cockpit layout or crew operating procedures. This process may also be used for modification of existing cockpits.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR1093 Numeral, Letter and Symbol Dimensions for Aircraft Instrument Displays

ARP4032 Human Engineering Considerations in the Application of Color to Electronic Aircraft Displays

ARP4102 Flight Deck Panels, Controls, and Displays

ARP4105 Abbreviations, Acronyms, and Terms for Use on the Flight Deck

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For more information on this standard, visit
https://www.sae.org/standards/content/ARP4927A/

3. INTRODUCTION

3.1 The guidance in this document is primarily aimed at test and evaluating groups that represent the end user, the crew, for the investigation, and installation of cockpit items/systems/functions in an existing aircraft. This document is not aimed at the design process of a new system, rather the selection of a suitable one for an existing aircraft.

3.2 The document may be used during the selection and integration of new items or capabilities into an existing aircraft, considering diverse requirements while ensuring that the aircraft remains operable by the intended crews.

3.3 The successful integration of a new system will depend on engineering and evaluation processes to ensure that the requirements are captured. The selection of a new system is based on requirements, but it must be shown that the aircraft will continue to be operated safely, efficiently, and in accordance with certification once the new system is included into an existing cockpit. In general terms, the evaluating team should consider the following steps:

- Understand the system requirements.
- Define how to meet the system requirements.
- Define the constraints.
- Consider candidate solutions.
- Investigate candidate solutions.
- Select optimum solution.
- Verify and validate selected solution.

4. SYSTEM REQUIREMENTS

4.1 The new system requirement should be clearly and succinctly stated, and it should serve as the title of the report.

4.2 Need for Change

The need for change will normally drive the project; this should be understood by the evaluators.

4.3 Concept of Operations

The concept of operations for the upgrade must be defined within the existing aircraft utilization envelope.

4.4 Aircraft Limitations

The integration of a new system may lead to changes in the operational limits of the aircraft, even with minor changes to the aircraft itself. These further effects must be investigated at an early stage.

4.5 Change Management

The requirements and assumptions of existing systems should be well documented and analyzed prior to the addition of any new system. The requirements and assumptions of the new system should be similarly documented and tracked. If any of the assumptions in design change, these must be assessed to ensure that there are no interaction problems or unexpected problems with existing systems, the flight crew, or the environment.

5. DETAILED DEFINITION

The detailed definition of the new system will serve as an outline for the later investigation. The definition will change with each new system requirement and the lists below are not exhaustive. Some guidance is given under the following headings:

- Constraints
- Physical Installation
- Flight Phases
- Human Factors
- System Performance
- Redundancy or Non-Normal Modes

5.1 Constraints

The constraints imposed upon the selection of a new item are dealt with by engineering and project managers. The evaluator should understand these constraints for the system integration in order that the investigation is efficient.

5.2 Physical Installation

This refers to the location of where the new system will be placed. A modern cockpit may allow installation of additional systems in several places, but optimal solutions must be identified within the context of the existing cockpit layout, number of crew, and concept of operations.

5.3 The evaluation team represents the end user, and this should be the mindset during the investigation of systems. A good understanding of the future operating crews' knowledge, skills, and attitude is essential for this phase.

5.4 Points that could be considered in the detailed definition are as follows (the list is not exhaustive):

a. Physical interaction with existing systems, in a non-pressurized, and pressurized aircraft.

b. Obstruction of external view or internal view of other systems/instruments by one or all crew members.

c. Space, weight, wiring/cabling, structural considerations.

d. Connection with existing aircraft architecture, such as databus or other related systems.

e. Access from both seats or one seat only, input, and/or feedback.

f. Operability with one crew member temporarily absent from the flightdeck.

g. Multi-element considerations or the dispersed installation of the system modules.

h. Lighting requirements, effects of sunlight, and day/night modes.

i. Power source and alternate power sources, if applicable.

j. Cooling.

k. Accessibility for installation and maintenance.

5.5 Flight Phase

To aid in the choice of location for the system, the concept of operations should identify the flight phases during which it will be used. This will greatly influence the human factors definition as well. A clear understanding of the system's use during flight phases may influence the limitations imposed on the crew's use of the system at various stages of the flight. There may be a requirement to inhibit output or interaction with the new system during some flight phases in order to avoid crew distraction.

5.6 Human Factors (HF)

5.6.1 The human cognition, human performance, and human-machine interface (HMI) with systems is a vast subject and expert advice should be sought from HF and human performance specialists at an early stage in the project. SAE International has published technical papers on HF. These may be found on www.sae.org.

5.6.2 The definition of the HF requirements is key to ensuring that a system which meets a technical need can also be appropriately operated by the crew, with specific training or without.

5.6.3 The HF definition will be influenced by the expected population of the final user. For example, cultural, language, knowledge, skills, and attitude will all play a role in this definition. A small group of highly specialist crews operating specific tasks will have different HF considerations when compared to a global population of airline pilots.

5.6.4 This document does not serve as a complete guide to the HF definition. However, examples of areas to consider for the definition of the HF/HMI are as follows:

a. Which of the main crew tasks is involved: aviate, navigate, communicate?

b. Workload impact: what is the change from current workload levels?

c. Task distribution: who completes which tasks, when, and how?

d. Changes to existing checklists.

e. What is the proposed level of automation and manual control?

f. Multi-tasking: do other tasks need to be performed at the same time?

g. HMI, including language, input commands and feedback, tactile, audio, visual.

h. Viewability by one or several operators, linked to flight phase.

i. Human cognition: can the system and its functions be understood by the expected user population?

j. Crew alerting: does the crew need to be alerted by the system? If so, how?

k. CRM and crew communication: what are the changes from the current operation?

l. System mode awareness and alerts feedback: in normal, standby, off, non-normal, limited modes?

m. Training required to operate the new system fully.

n. Likelihood and consequence of human errors.