

Man Machine Interface Requirement Validation in Military Aircraft Certification

Hakan Isci

Savunma Teknolojileri ve Mühendislik A.S.

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ABSTRACT

Increasing electronic controls in aircraft flight deck, especially in military aircrafts, demands special attention from crew workload assessment and human error analysis point of view. The main objective for the Authority is to validate that the crew workload is adequate for different and complicated military missions. Besides, human error analysis is a regulatory requirement in Airworthiness Certification of airplanes. Human errors need to be observed during simulated operational use of novelties and analyzed later (during the debriefing with pilots or during the results analysis). The main objective during the debriefing is to identify their causes, their consequence, their criticality and the current safety barriers in terms of human errors management.

Simulators offer wide range of capability to identify the problems in early stages of the design. Degree of fidelity needed on evaluation media is related with the complexity of the military mission and project budget. Especially in modernization projects where full flight simulators are not available and does not worth to build a new one, step by step approach is needed from non-functional static mock-ups to functional simulation with final equipments and functional software. This paper represents recommended acceptance criteria for Military Airworthiness Authority for Man Machine Interface requirements in military modernization projects. A transport category aircraft avionic modernization project, a fighter avionic modernization project and a rotorcraft modernization projects are selected as sample projects. A scenario based methodology has been proposed for evaluation, specific military rare event cases are discussed to include in these scenarios. Additionally, aggravating factors for military environment, such as sustained g, night vision goggle operation etc. are

discussed. Simulator requirements are classified for different stages of evaluation.

INTRODUCTION

Certification for Military Aircrafts is relatively new topic because acceptance and flight clearances were generally performed as Qualification in the past. New concept of "As much as civil, as necessary as military" is widely accepted in military airworthiness to have better safety records for the military aircrafts. There are very well known Military Standards available for the industry to comply for Human Machine Interface (HMI). With the new concept of utilizing civil certification requirements and Advisory Circulars brought additional requirement sets and boiling all those in the same pot sometimes results with duplicated works.

Majority of new modernization projects brings more automation to the cockpit; hence it becomes more complicated for the pilot. New systems are widely preferred by the pilots; however, evidence that safe and effective operational performance can be achieved without excessive crew workload should be established and submitted to the Airworthiness Authority by showing qualitative workload assessments and if necessary quantitative workload testing.

There are multiple requirements given in Federal Aviation Rules (FAR) and Certification Specifications (CS in Europe) related with the evaluation of Human Factor issues. The very well known FAR 25.1523 states that the aircraft should be evaluated for the Minimum Crew Workload. That requirement simply states that the minimum flight crew must be established so that it is sufficient for safe operation, considering the workload on individual crewmembers; the accessibility and ease of operation of necessary controls by the appropriate

crewmembers; and the kind of operation authorized under Sec. 25.1525.

In military applications further requirements must be derived for the accessibility and ease of operation of the crew interfaces, including the effects of crew military equipments (such as helmet, gloves etc.), additional military tasks and the operating environment. There are various studies available showing that the high levels of automation in the new generation aircrafts have without a doubt offered considerable advances in safety over their forerunners, however new types of error have begun to emerge on these flight decks. [1]

It must be shown that the design of the crew interfaces allows the crew to perform their duties without unreasonable concentration or fatigue, and must enable the crew to obtain and maintain satisfactory situation awareness (which is not clearly requested in civil applications). Human Factor Harmonization Working Group (HFWWG) ended up with a report [2] published in 2004 and resulted with a recommendation of adding new requirement number 25.1302 for complex aircrafts. This proposed requirement highlights the need for a Situational Awareness assessment for the cockpit, however, until today new requirement has not been implemented to FAR / CS.

The flight deck must be designed such that the crew is able to obtain and maintain satisfactory awareness of the aircraft status and the status and functionality of aircraft systems, and be able to anticipate the future status of the aircraft and its systems and the effects of automation. Presentation of information; representation of system condition by display of system status; indication of systems failure and the impact on aircraft status and indication of prolonged or severe compensatory action by a system when such action could adversely affect aircraft safety must provide clear feedback.

Aircraft status information should be sufficiently accurate and operationally oriented to allow the crew, in any circumstances (including degraded modes), to be aware of the remaining operation capabilities of the aircraft.

The effects of human errors in managing the system, including assessment of the potential for error, the possible severity of the consequences, and the provision for recognition and recovery from error must be evaluated with representative set of pilots in a representative environment.

CERTIFICATION REQUIREMENTS

Due to the complex nature of both the environment and the operation, pure civil requirements are not sufficient for a complete Certification and Qualification process. Authorities generally issue Certification Review Items (CRI) and Special Conditions for these cases. However, certain aggravating factors like operation under

sustained-g environment, NVG operations, gun fire vibrations etc. are generally considered separately.

When Civil Requirements are taken as Certification Basis, following documents are referenced for the HMI evaluations.

- AC.25.1523 / AC 23.1523 Minimum Flight Crew
- PSACE100-2001-004 on Guidance for Reviewing Certification Plans to Address Human Factors
- INT/POL/25/14 Human Factors Aspects of Flight Deck Design (JAA)

Those reference documents cover the principals for the evaluation. Especially novelties take important attention for cockpit evaluation. Civil reference documents sometimes calls military standards for means of compliances. At the same time Military Contracts generally calls similar military standards for reference. In order to certify and in the end qualify a military aircraft, systematic approach is needed to avoid duplication of work and in the end turn backs on the design.

SCENARIOS

Scenarios must assess the adequacy of the cockpit HMIs and the crew procedures and tasks in different contexts (logistic or tactical). In particular, ease of use and ease of operation of the cockpit configuration, crew cooperation, error management and workload should be addressed during the test. In particular, the general system evaluation should provide outputs along the following tasks

Missions management:

- Low Level Flight
- Autonomous Approach
- Air Delivery
- Military Operations (Air to Air combat, search and rescue etc.)

Crew primary tasks:

- Fly
- Navigate
- Communicate
- Manage the systems
- Manage the surroundings
- Manage the displays

Scenarios must be agreed with the Authority before each evaluation. Checklist for the Authority participants must be prepared according to these scenarios.