DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE LIFE CYCLE MANAGEMENT CENTER
WRIGHT-PATTERSON AIR FORCE BASE OHIO

ADVISORY
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AIRWORTHINESS ADVISORY

Using AI/Complex Functions to Support Safety Critical Functionality

1. Purpose. This Airworthiness Advisory (AA) provides air system program offices with awareness of Certification Basis (CB) tailoring expectations when using Artificial Intelligence (AI)/Complex Functions (CFs) in support of safety critical functionality. The guidance provided in this AA focuses predominately on MIL-HDBK-516C, Section 15, Computer Systems and Software (CS&S) for the incorporation of AI/CFs within system functionality; however, other Sections may be impacted based upon the functionality being incorporated. This AA is applicable to all versions of MIL-HDBK-516[1].

2. Scope. This AA applies to all air systems owned, leased, operated, used, designed or modified by the United States Air Force (USAF), the Air National Guard, and USAF Reserve.

3. Cancellations. NONE.

4. Referenced Documents.

[1] MIL-HDBK-516C, *Airworthiness Certification Criteria*, 12 December 2014

[2] AC-17-01, *Verification Expectations for Select Section 15 Criteria*, 23 March 2017

5. Background. Air system software designs have traditionally utilized techniques and algorithms that implement a pre-programed, finite set of states and behaviors, with pre-defined data and control flow and expected outcomes. The nature of these designs and implementations assists in providing for predictable, deterministic operation under a known set of nominal and off-nominal conditions (e.g., inputs, failure states, internal/external stimuli).

In response to the need for more sophisticated, autonomous air system functionality, air system vendors and government agencies have recently begun exploring the incorporation of less traditional software designs. These software designs, herein referred to as CFs, forgo the use of pre-programmed behaviors and outcomes and instead utilize adaptive and learning algorithms, with supportive training, to arrive at desired solutions. Common classes of these types of designs include neural networks, machine learning, artificial intelligence, and similar non-deterministic algorithms. The exploration into the use of CFs has not been limited to mission critical applications, but applications performing Safety Critical Functions (SCFs) as well.

6. Discussion. While the use of CFs presents the potential for increased autonomous capability and decision-making, it also presents a unique set of challenges, particularly when used in support of SCFs. The design and operation of CFs can be counter to established expectations for safety critical software. CF operation can be non-deterministic, and the software testing and analysis techniques applied to traditional software designs may be insufficient to fully verify and

[1] This AA makes specific reference to MIL-HDBK-516C in several places and while not always specifically mentioned, it is also applicable to programs utilizing other versions of MIL-HDBK-516

validate CF designs to the necessary level of assurance. For these reasons, CF designs typically do not meet all of the CS&S verification expectations found in the criteria of MIL-HDBK-516C, Section 15, as detailed with the product and process attributes documented in Attachment 6 of AC-17-01.

Due to the factors noted above, air system program offices utilizing CFs in the support of SCFs may have to develop specific architectures and a tailored set of MIL-HDBK-516C standards and methods of compliance to ensure airworthiness aspects are adequately addressed.

7. Recommendations. Air system program offices should coordinate the use of CFs in the processing of SCFs with AFLCMC/EN-EZ Subject Matter Experts (SMEs) early in the air system's development lifecycle. Early coordination will assist air system program offices in addressing the necessary architectural and design attributes needed to support airworthiness expectations, as well as MIL-HDBK-516C tailoring considerations for the program office's CB.

8. Point Of Contact. The USAF Airworthiness Office is the POC for this AA. Provide comments, suggestions, or questions via email to the USAF Airworthiness Office Mailbox (USAF.Airworthiness.Office@us.af.mil).

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