DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AERONAUTICAL SYSTEMS CENTER (AFMC)
WRIGHT-PATTERSON AIR FORCE BASE OHIO

BULLETIN
AWB–013A
29 JUNE 2011
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United States Air Force (USAF) Airworthiness Bulletin (AWB)-013A

Subject: Risk Identification and Acceptance for Airworthiness Determinations

Attachments: (1) Glossary of References and Supporting Information
(2) USAF Airworthiness Risk Acceptance Matrix
(3) System Safety Risk Assessment (SSRA) Contents
(4) Template for Risk Acceptance Briefing to Risk Acceptance Authority

1. **Purpose:** The purpose of this bulletin is threefold: (1) to provide further instruction on the airworthiness risk assessment process cited in AFI 62-601 paragraph 1.16.1 and describe the process for correlating the risks associated with noncompliance to applicable airworthiness certification criteria into system safety hazards that must then be accepted by the proper risk acceptance authority (RAA); (2) to provide content guidance and templates for system safety risk assessments (SSRAs) for the identified hazards for both the Risk Acceptance (RA) Staff Summary Sheets (SSS) and presentation at the Airworthiness Board (AB), as well as a template for the accompanying briefing presentation to the RAA, if such a briefing is required; and (3) to establish the USAF Airworthiness Risk Acceptance Matrix as a requirement for identification of risk levels, and the selection of the risk acceptance authority levels required for airworthiness determinations.

2. **Office of Primary Responsibility (OPR):** USAF Airworthiness Office (ASC/EN) is the OPR. Comments, suggestions, or questions on this bulletin should be emailed to the USAF Airworthiness Office Mailbox (ASC.ENSI.Mailbox@wpafb.af.mil).

3. **Policy:** AFI 62-601 requires the Technical Airworthiness Authority (TAA) to issue design-based Military Type Certificates (MTC)/Military Flight Releases (MFR) for type designs or non-design-based MFRs. The design-based MTC/MFR is issued ONLY AFTER required risk assessment, risk management, and risk acceptance actions for safety hazards have been accomplished and documented by the Program Manager (PM).

   AFI 62-601 paragraph 1.16 addresses the interrelationship between the safety hazard risk acceptance process and the airworthiness assessment process. Essentially, airworthiness risk assessments and acceptance of individual safety hazard risks are two separate and distinct processes that intersect at the AB. Safety hazard risk identification, started early in the design process, is accomplished through the PM chain of authority at the individual safety hazard level, in accordance with (IAW) AFI 91-202 using the MIL-STD-882D hazard risk criteria. The issuance of MTCs and MFRs is accomplished at the air system level by the TAA and identifies risks associated with noncompliance to applicable certification criteria.

Each noncompliant criterion can then be correlated to individual safety hazards. These safety hazards along with those developed through the system safety process, as they relate to airworthiness are combined and used by the TAA to support system airworthiness assessments.

4. **Process Description:** AFI 62-601 states, "*Noncompliance with an applicable airworthiness certification criterion is an indication of a potential safety hazard or other limitation in the design of the system and may have airworthiness ramifications.*" The USAF, MIL-HDBK-516B Expanded is mandated for establishing the airworthiness certification basis, which consists of all applicable criteria, associated standards, and methods of compliance. MIL-HDBK-516B Expanded does not distinguish between aircraft types; nor does it dictate a level of safety. The USAF mission is inherently more dangerous than the civilian/commercial mission and varies widely based on the aircraft type and usage. Yet, they both have to meet acceptable safety standards; this requires the USAF to be able to determine the risks associated with not meeting the applicable certification basis.

   a.) Airworthiness Risk Process: Airworthiness certification consists of three steps.

   i) The first step is to develop the certification basis per AWB-004, document it in a Tailored Airworthiness Certification Criteria/Modification Airworthiness Certification Criteria (TACC/MACC) document per AWB-005, and submit to the TAA for approval per AWB-003.

   ii) When the program verification activities identified in the approved certification basis have been completed, the second step is for the PM/Chief Engineer (CE) to evaluate whether the substantiating data satisfies the certification basis (shows compliance). For noncompliance, the mitigated risks associated with non-compliance and mitigation plans to minimize the hazards must be determined and implemented. MIL-STD-882D shall be used in evaluating these risks. The result of these two steps is submittal of the TACC/MACC Compliance Report (to include SSRAs) for TAA review per AWB-003.

   iii) The third and final step is for the TAA to "find compliance" by reviewing the substantiating data submitted as part of the TACC/MACC Compliance Report, concurrence on all medium, serious, and high risk levels and reevaluation of these risks, as necessary.

   b.) Correlation of noncompliant certification criteria to system safety hazards:

   When the individual criterion in the certification basis is not satisfied by the aircraft/system, each instance of noncompliance carries an associated risk. Not meeting certification criteria can generally be traced back to hardware or software design deficiencies, lack of/insufficient requirements, lack of/insufficient testing, lack of/insufficient analysis, etc. It is these areas which can be "traced back" from the

airworthiness criteria noncompliance that are the sources of the safety hazards that drive the risk acceptance determination requirement.

So far, in practice, it has been observed that certification criteria noncompliance can usually be traced back to and characterized as a known safety hazard. Once the safety hazards due to noncompliance with airworthiness criteria have been identified and severity determined, it is recommended that the PM cross check them with the hazards they have already identified for their program via the system safety hazard assessment (HA) process. This cross check may determine the hazard probability of occurrence and preclude initiating a redundant RA effort for a risk that may have already been addressed earlier in the program. Identifying system safety hazards as a result of noncompliance with the approved certification basis is only one of the many sources of safety hazard identification. The hazards identified as a result of criteria noncompliance generally overlap with the hazards previously identified by the program's ongoing system safety hazard analysis process, but they could be new hazards.

c.) Risk Level Determination: Compliance with the applicable criteria is expected to result in an air vehicle (design controllable) probability of aircraft loss that falls in the 0.1 to 1 per 100K flight hours at maturity. Determining actual operational loss rates cannot be definitively accomplished based on predicted loss rates. Mishaps from "all causes" cannot be translated into specific actions in up-front development processes. Operational aircraft loss rates for Air Force aircraft that are mature can be expected to be one order of magnitude higher than predicted performance. This is based on USAF and commercial aviation data as cited in USAF Airworthiness Certification Circular # 5. Therefore, it is critical that the risk hazard predictions be as accurate as possible. Further, aircraft loss rates can normally be expected to be higher in the early stages of operational life. The following paragraphs give more detailed guidance on risk hazard predictions.

(1) MIL-STD-882D identifies risk in two parts, severity and probability of occurrence, to establish a hazard risk index (HRI). For airworthiness purposes, the probability of occurrence for a remote event with catastrophic consequences should be less than one expected occurrence per fleet life. The best means of calculating this number is to take the expected service life of the aircraft in flight hours times the number of expected aircraft in the fleet. Inverting this product gives the appropriate probability of occurrence per flight hour for remote for a given fleet size of common configuration. The other levels of probability of occurrence should flow logically from that value.

(2) Individual hazards identified as part of the program's safety analyses efforts, as well as identified during the execution of the airworthiness certification must be

reported in accordance with AFI 91-202 and MIL-STD-882D. Attachment 2, USAF Airworthiness Risk Acceptance Matrix, is the tailored MIL-STD-882D risk matrix that describes the process for classification of risks for airworthiness determinations; it provides further instruction on the risk acceptance requirements for individual hazards, before they can be addressed in SSRAs at the AB. This matrix is required for risk determination and risk acceptance for USAF airworthiness determinations, and supersedes any other program-specific tailoring for hazard identification and risk acceptance of any systems' MIL-STD-882D system safety programs.

(3) SSRAs should be written for all medium, serious and high risks. These shall be submitted for TAA concurrence as part of the TACC/MACC Compliance Report and presented during the AB. Low risk hazards, while not requiring an SSRA, shall be summarized in the TACC/MACC Compliance Report and presented during the AB. Detailed guidance for SSRAs can be found in Attachment 3.

d.) Airworthiness Risk Acceptance: Once an individual hazard is identified and the severity and the probability of occurrence (i.e., the two components of 'risk') has been determined, refer to Attachment 1 of this AWB to determine its severity. It is then necessary for the risk to be accepted by the appropriate USAF RAA, prior to the aircraft receiving it's MTC/MFR to begin operations. As noted in paragraphs 4.a.iii and 4.c.3, prior to initiating the RA process with the RAA, the PM must obtain TAA concurrence on all medium, serious, and high risks. This process ensures that all USAF operated aircraft meet the appropriate acceptable safety standards and those deviations, characterized as safety risks, are identified and known to the users.

For AB purposes, for each individual risk identified and accepted, it is expected that a mitigation plan would be put in place to reduce risk as much as possible. This plan would need to be funded and implemented on a schedule agreeable to the RAA. It is also expected that the risks and their mitigation plans and progress would be periodically reviewed IAW AFI 91-202.

Corresponding with the AFI 91-202 review or as requested, the TAA shall be provided the following items by the PM:

(1) Status on how the aircraft is performing with regard to airworthiness and, in particular, the accepted risks (i.e., any mishaps, incidents, issues, etc.), and any new risks.

(2) Updated risk levels and acceptance documentation (i.e., new risk level based on implementation plan status, change in the mitigation strategy, new risk acceptance authority signatures, etc.).

(3) Issues or concerns with the risk reduction implementation plans (i.e., schedule or funding changes).

AFI 91-202 requires AF Safety Center (AFSC) coordination on SSRA packages for serious and high risks. Contact AFSC/SEF for the format and information that AFSC wants to see addressed in the RA package that is sent to them for their coordination.

e.) Periodic updates to SSRAs: Not all risks that are identified may be acceptable for long-term operational use and the RAA may require that these risks be lowered over time. AFI 91-202 requires a periodic review of serious and high hazards by the appropriate RAA. The TAA must then reassess the MFR that was previously granted, so that aircraft limitations can be modified when the risks improve/change. This requirement drives the need for periodic risk reviews to ensure that these risks are indeed being lowered over time. Currently, the PM/CE will review the SSRAs IAW timelines defined in AFI 91-202 to determine if they need to be updated. The updated SSRAs will be submitted to the TAA to review and concur on the risk update. The PM will take the updated SSRAs to the appropriate RAA IAW AFI 91-202 and MIL-STD-882D.

(1) SSRAs that are formally accepted by RAA: The TAA will review and modify the MFR as appropriate to address the accepted SSRAs.

(2) SSRAs not accepted: If the risks are not accepted by the RAA, the MFR will be revoked by the TAA and the PM will need to update the TACC Compliance Report and submit it to the TAA.

5. SSRA Templates: Content guidance and example formats for SSRAs for the identified hazards for both the RA SSS and presentation at the AB are provided in Attachments 3 and 4. Preparation and coordination of the entire SSRA package itself is performed using local implementation instructions. The SSRA is expected to be one of the technical tabs to the RA SSS.

6. Briefing Chart Templates: Attachment 4 shows sample chart formats for the briefing to the RAA and the TAA which accompanies the presentation of the SSRA package, if such a briefing is required. The briefing should do more than just summarize the RA package; it should get into the same level of detail as the staff package itself.

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Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

AFPD 62-6, *USAF Airworthiness,* 11 June 2010
AFI 62-601, *USAF Airworthiness,* 11 June 2010
AWB – 003, *TACC/MACC Document Submittal and Review Process*
AWB – 004, *Development of an Airworthiness Certification Basis*
AWB – 005, *TACC/MACC Document Construction and Format*
Airworthiness Certification Circular # 5, *Airworthiness Certification Risk Evaluation and Acceptance*, 29 November 2005
AFI 91-202, *The US Air Force Mishap Prevention Program*, 01 Aug 1998
MIL-HDBK-516B, *ASC/EN Airworthiness Certification Criteria Expanded Version of MIL-HDBK-516B,* 26 September 2005
MIL-STD-882D, *DoD Standard Practice for System Safety*, 10 Feb 2000
USAF Airworthiness SharePoint website:
https://cs.eis.afmc.af.mil/sites/AeroEngDisciplines/Systems/Airworthiness/default.aspx

Abbreviations and Acronyms

AB – Airworthiness Board
AFI – Air Force Instruction
AFKN – Air Force Knowledge Now
AFPD – Air Force Policy Directive
ASC/EN – Aeronautical Systems Center, Engineering Directorate
ASC/ENSI – Aeronautical Systems Center, Engineering Directorate Systems Integration Branch
AWB – Airworthiness Bulletin
CE – Chief Engineer
HA – Hazard Assessment/Analysis
HRI – Hazard Risk Index
IAW – In accordance with
MACC – Modification Airworthiness Certification Criteria
MFR – Military Flight Releases
MTC – Military Type Certificates
PM – Program Manager
RA – Risk Acceptance
RAA – Risk Acceptance Authority
SSRA – System Safety Risk Assessment
SSS – Staff Summary Sheets
TAA – Technical Airworthiness Authority
TACC – Tailored Airworthiness Certification Criteria

USAF – United States Air Force

Terms

Hazard –Per MIL-STD-882D: "Any real or potential condition that can cause injury, illness, or death to personnel; damage to or loss of a system, equipment or property; or damage to the environment." A hazard is simply a threat of harm. A hazard description has three components: the source, the mechanism, and the outcome. Per AFI 91-202: "A condition, procedure, or practice that creates a potential for producing death, injury, occupational illness, or equipment damage."

Mishap Risk –Per MIL-STD-882D: It is an expression of the impact and possibility of a mishap in terms of potential mishap severity and probability of occurrence.

Residual Mishap Risk –Per MIL-STD-882D: The mishap risk that remains after all planned mishap risk management measures have been implemented is considered residual mishap risk. Residual mishap risk is documented along with the reason(s) for incomplete mitigation.

Risk Assessment –Per AFI 91-202: An evaluation of possible loss in terms of hazard or deficiency severity and mishap probability of occurrence. Per MIL-STD-882D, Para 4.3: Assess the severity and probability of the mishap risk associated with each identified hazard, i.e., determine the potential negative impact of the hazard on personnel, facilities, equipment, operations, the public, and the environment, as well as on the system itself.

USAF Airworthiness Bulletin – Procedures, practices and requirements for executing USAF airworthiness policy as defined and published by the TAA.

Attachment 2

USAF AIRWORTHINESS RISK ACCEPTANCE MATRIX

HAZARD CATEGORIZATION		SEVERITY*			
		CATASTROPHIC (1)	CRITICAL (2)	MARGINAL (3)	NEGLIGIBLE (4)
FREQUENCY	**FREQUENT (A)** = or > 100/100K flt hrs	1	3	7	13
	PROBABLE (B) 10-99/100K flt hrs	2	5	9	16
	OCCASIONAL (C) 1.0-9.9/100K flt hrs	4	6	11	18
	REMOTE (D) 0.01-0.99/100K flt hrs	8	10	14	19
	IMPROBABLE (E) = or < 0.01/100K flt hrs	12	15	17	20

HIGH	CAE Risk Acceptance HRI = 1 through 5	**MEDIUM**	PM Risk Acceptance HRI = 10 through 17
SERIOUS	PEO Level Risk Acceptance HRI = 6 through 9	**LOW**	Risk Acceptance As Directed HRI = 18 through 20

***Severity** is the worst credible consequence of a hazard in terms of degree of injury, property damage or effect on mission defined below:

(1) **Catastrophic:** Class A (damage > $2M / fatality / permanent total disability / loss of Aircraft)
(2) **Critical:** Class B ($500K < damage < $2M / permanent partial disability / hospitalization of 5 or more personnel)
(3) **Marginal:** Class C ($50K < damage < $500K / injury results in 1 or more lost workdays)
(4) **Negligible:** All other injury/damage less than Class C

Attachment 3

SYSTEM SAFETY RISK ASSESSMENT (SSRA) CONTENTS

The SSRA that is sent or briefed to the Risk Acceptance Authority (RAA) needs to address the following areas, as a minimum:

- Background/System Description
- Root Causes for Hazard
- Hazard Description
- Severity (IAW MIL-STD-882D)
- Probability (IAW MIL-STD-882D)
- Probability Calculations/Background Info on your probability number and the source of Info
- HRI value for the unmitigated hazard
- HRI value for the mitigated hazard
- Estimated System Loss/personnel loss for life of your fleet
- Sensitivity Analysis/Historical Data for similar systems
- Existing Mitigations for the hazard (list and explain)
- Mitigation Options (what can be done in the future?)
- Recommendation(s) to Risk Acceptance Authority

SSRA contents shall also:

a. Include sufficient details (drawings, schematics, dimensions, etc.) to clearly describe the hazard.
b. Include information on criteria, standards and methods of compliance that were approved, completed and satisfied and those that were not that leads to the Hazard Risk Index (HRI).
c. Show the HRI calculation details (probability and consequence) to include inputs, confidence on the inputs, assumptions, where conservatisms exist due to lack of data, etc.
d. Explain why further analysis, testing, etc. is NOT required to better characterize the risk.
e. Translate each risk (HRI value) into expected aircraft losses and fatalities as a function of time.
f. For risks to be accepted for an interim period, include information on production break-in effectively and date production capacity for retrofit kits, retrofit hours, retrofit schedule, etc. In other words, when will the risk be mitigated to a "Medium" or "Low" HRI and what can be accomplished to accelerate the schedule. In addition, provide all reasonable and unreasonable options such as operational limitations, restrictions, etc. that would reduce the risk to Medium or Low during this period of time.
g. For all residual mishap risks without mitigations, provide all reasonable and unreasonable options such as limitations, restrictions, etc. that would reduce the risk to Medium or Low.

Attachment 4

TEMPLATE FOR RISK ACCEPTANCE BRIEFING TO RISK ACCEPTANCE AUTHORITY (RAA)

Program Name Risk Acceptance (RA) Briefings to RAA

Areas to Address

- Specific Briefing Objectives
- Background on Requirement for RA
- Hazard Acceptance Summary
- Discussion of specific hazard(s) requiring RA
- Coordination & Comments Obtained on SSS
- Recommendation to RAA for RA

Specific Briefing Objectives

- Give Program/Phase of program Info
  - Background for perspective
- Outline of what briefing will cover
  - e.g. RA of "x" hazards for program "Y"
- Cite Bottom line Up-Front
  - RAA to accept "x" risks
  - With/without suggested limitations/restrictions
    - Give rationale for them

Background on Requirement for RA

- AFI 91-202 direction for RA
- MIL-STD-882D or Program HRI Matrix
- Risk Acceptance Levels
- Relationship--RA to Airworthiness (AW) Board
  - Activities/Time-lines
- Logical order/grouping of hazards if >1
  - E.g., by subsystem or root cause

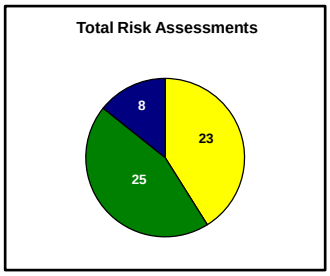
Hazard Acceptance Summary

- Chart that says
  - Total number of applicable AW criteria by section
  - Total number of non-compliant criteria by section
  - Associated risk severities for each non-compliant criteria
  - Mapping to the hazards
  - RHI level of the hazards

Hazards Due to Non-Compliance with MIL-HDBK-516B AW Criteria

Include information on criteria, standards & methods of compliance that were approved, completed and satisfied and those that were not that leads to the HRI

	TOTAL	RED	YELLOW	GREEN	BLUE
Structures	14	0	8	6	0
Flight Sciences	7	0	1	5	1
Mech. Subsystems	12	0	7	4	1
Avionics/Comms	8	0	2	3	3
Computer Resources	3	0	2	1	0
Propulsion	4	0	0	4	0
Ground Segment	3	0	1	0	2
Syst Engr. & Prod Supt	2	0	0	1	1
EMI	2	0	2	0	0
TOTALS	56	0	23	25	8



Total Risk Assessments (Distributed by Discipline)

Hazards Due to Non-Compliance with MIL-HDBK-516B AW Criteria (Cont'd)

Summary of non-compliances, residual airworthiness risks, & risk mitigation recommendations

Total applicable criteria	Non-Compliant criteria	Hazards
694	21	5

3% of the total criteria are non-compliant.

Hazard	HRI	Criteria affected	HRI	Description/Root Cause(s)
Lack of pre-production-level systems engineering and manufacturing processes	10 (II-D)	4.1.1	10	
		4.1.2	17	
		4.2.1	17	
		4.3.1	Medium	
		4.4.4	Low	
		4.5.2	Low	
		4.5.3	Low	
		4.6.1	Low	
Unverified smoke detector design (Assessment in Section x.x)		8.4.1	Medium	
		8.4.2		
		9.9.2		
Incomplete flammability and toxicity testing		8.4.14	Medium	
		9.2.6		
Limited and/or failed EMI/EMC testing		13.1.2	Medium	
		13.2.1		
		13.2.2		
Incomplete composite material characterization		5.1.2	Medium	
		5.3.1		
		5.3.2		
		5.4.2		

Address For Each Specific Hazard Requiring RA:

- Background/System Description
- AW Criteria Root Causes for Hazard
- Hazard Description
- Severity (IAW MIL-STD-882D)
- Probability (IAW MIL-STD-882D)
- Probability Calculations/Background Info on your probability number and the source of Info
- HRI value for the unmitigated hazard
- HRI value for the mitigated hazard
- Estimated System Loss/personnel loss for life of your fleet
- Sensitivity Analysis/Historical Data for similar systems
- Existing Mitigations for the hazard (list and explain)
- Unconstrained Mitigation Options (what can be done in the future?)
- Recommendation(s) to Risk Acceptance Authority

Additional Key Items that needs to be addressed

- Required Items to Address:
  - Translate each risk (HRI value) into
    - Expected aircraft losses and fatalities as a function of time
  - For risks to be accepted for *an interim period*, include
    - Information on production break-in effectivity & date,
    - Production capacity for retrofit kits,
    - Retrofit hours, retrofit schedule, etc.
    - Cite when risk(s) can be mitigated to "Medium" or "Low" and what can be done to accelerate the schedule
      - Provide all reasonable and unreasonable options such as limitations, restrictions, etc.
        - » that would reduce the risk to Medium or Low during this period of time

Additional Key Items that needs to be addressed (cont)

- Where Did probability numbers come from?
  - Assumptions, Data Sources, Reports, Analyses, Calculations, etc
  - Explain Uncertainties and How they were resolved
- Loss Projections: How Many Losses?
  - Systems, aircraft, lives, etc, losses expected?
    - Based on system flight hours, exposure, etc & 882D matrix
    - Explain your methodology
- Mitigations and controls?
  - Cite hazard controls that were evaluated to obtain mitigated HRI
    - Interim/Long-term Controls? Timelines to Implement?
  - What controls will have to be cited as operating restrictions or limitations in the RA memo/package?
    - Rationale for those you selected VS. not selected

Coordination & Comments Obtained on SSS

- Views of others
- Comment Resolutions
- Unresolved Disconnects
- Proposed Closure Actions, if Required

Recommendation to RAA for RA

- Outline/Summarize OPR's Proposed Operational Limitations or Restrictions Contingent to RA
- Be Prepared to Discuss Additional Limitations or Restrictions Recommended by RAA
- Discuss RAA's RA Format Preference
  - Concurrence on accompanying SSS, or
  - RAA memo capturing results of the RA briefing and the identified limitations/restrictions

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BACKUP CHARTS

For: Non-Compliant Mil-HDBK-516B AW Criteria Identified as Risks

Quad Chart for Each Non-Compliant Criterion

U.S. AIR FORCE

Paragraph 5.1.9 I-C

Structures

CRITERIA

Verify that flight loading conditions are based on realistic conditions of airframe response to pilot induced or autonomous maneuvers, loss of control maneuvers, and turbulence. Also verify that the realistic conditions considered are both required and expected to be encountered critical combinations of configurations, gross weights, centers of gravity, thrust or power, altitudes, speeds, and type of atmosphere and are used in the design of the airframe.

ISSUES

Flight test program was benign, had minimal instrumentation, and failed to achieve 80% and 100% flight loads survey/demonstration.

MITIGATION PLAN

1. **An Aircraft Structural Integrity Program (ASIP) will be established for the MDS. The ASIP Master Plan will address all known airworthiness issues through analysis, test, operational restrictions, inspection or redesign of applicable structural components. The ASIP Master Plan is subject to approval by the ASC/EN ASIP Technical Expert.**

PROJECTED TIMELINE

1. **TBD (pending approved funding and direction)**