Ames Procedural Requirements

APR 1740.1
Effective Date: March 31, 2021
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COMPLIANCE IS MANDATORY

Subject: Airworthiness and Flight Review Process

Responsible Office: Code JO / Aviation Management Office

CHANGE LOG

Status [Baseline /Revision /Cancelled]	Document Revision	Date of Change	Description
Baseline	0	3/31/2021	Major revision/re-baseline to update responsibilities; clarify Commercial Aviation Service and Inter-Agency Airworthiness requirements; edits to comply with NPR 1400.1.

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PREFACE

P.1 PURPOSE

a. This APR defines the Ames Research Center's Airworthiness and Flight Safety readiness review processes. This will ensure that all aircraft used to conduct flight operations with NASA personnel or NASA equipment on board meet the appropriate NASA approved airworthiness and operational safety standards and Federal Aviation Administration (FAA) airworthiness and flight safety readiness review policies and procedures.

b. This APR supplements and clarifies the policies, responsibilities, and requirements stated in NPD 7900.4 and NPR 7900.3, and its implementation requires a thorough understanding of those directives.

P.2 APPLICABILITY

a. This directive is applicable to ARC and associated facilities, e.g., contractor's facilities, etc.

b. This directive applies to contractors, grant recipients, or parties to agreements only to the extent specified or referenced in the appropriate contracts, grants, or agreements.

c. In this directive, all mandatory actions (i.e., requirements) are denoted by statements containing the term "shall." The terms "may" or "can" denote discretionary privilege or permission, "should" denotes a good practice and is recommended, but not required, "will" denotes an expected outcome, and "are/is" denotes descriptive material.

d. In this directive, all document citations are assumed to be the latest version unless otherwise noted.

e. This instruction applies to all Ames flight tests, ground test programs, operations, reviews, and/or official flight duties involving Ames aircraft and applies to all Ames Civil Service or Contractor personnel operating, maintaining, or testing Ames aircraft.

P.3 AUTHORITY

a. NPD 7900.4, NASA Aircraft Operations Management

b. NPR 7900.3, NASA Aircraft Operations Management

P.4 APPLICABLE DOCUMENTS AND FORMS

a. NPR 8715.3, NASA General Safety Program Requirements

b. APR 1440.1, Records Management Program Requirements

P.5 MEASUREMENT/VERIFICATION

a. Verification of conformance to requirements in this directive are measured through Center and Responsible Organizational management reviews, self-assessments, and subsequent analysis and reports of conformance to requirements, as well as periodic internal audits.

b. The Airworthiness and Flight Safety Review Board Chairperson will provide the Center Director with an Annual Summary Report of the AFSRB review process and AFSRB activities.

P.6 CANCELLATION

a. APR 1740.1, Airworthiness and Flight Safety, dated April 6, 2016.

Eugene Tu
Director

DISTRIBUTION STATEMENT:

Internal and external distribution.

CHAPTER 1 RESPONSIBILITIES

1.1 The **Center Director** shall:

a. Review and approve recommendations of the Airworthiness and Flight Safety Review Board (AFSRB) and maintain authority for granting any variances, deviations, or waivers from Ames Airworthiness and Flight Safety policy.

1.2 The **Chief of Flight Operations** shall:

a. Provide interpretation of NASA policies and requirements concerning aviation operations at Ames.

b. Approve operations, logistics, support plans, and monitor aircraft.

1.3 The **Airworthiness and Flight Safety Review Board** (AFSRB) shall:

a. Participate in reviews to establish the airworthiness and evaluate the safety of flight operations of all installations, modifications, or operations that meet one or more of the following criteria:

(1) Installations or modifications that require redefinition of an aircraft's published flight envelope or aerodynamic characteristics.

(2) Installations or modifications that involve the mid-air separation or engagement of components by the aircraft.

(3) Installations or modifications that involve hazardous materials.

(4) Installations or modifications that involve one or more cutouts in the airframe.

(5) Installations or modifications that create a new load path in the airframe structure.

(6) Installations or modifications that require a modification to any aircraft window.

(7) Installation or modifications of systems that may affect the control of the aircraft.

(8) Installations that require an external appendage.

(9) Unmanned Aircraft Systems (UAS) and/or operations other than change of payload for an already approved vehicle.

(10) Any other installation or modification as determined by the AFSRB.

b. Have representation from Safety and Mission Assurance, Aviation Safety Officer (ASO), and engineering present for all meetings.

Note: The above representatives will be voting members.

c. Conclude official Review Board meetings by either authorizing a project to proceed or requiring changes, further documentation, or demonstrations to satisfy airworthiness and flight safety concerns raised by the Board.

d. Issue an Airworthiness Statement or Certificate of Airworthiness for each Project that satisfies the requirements for that Airworthiness Review.

1.4 The **Airworthiness and Flight Safety Review Board Chairperson** shall:

a. Formulate and implement an effective flight safety review process. Perform reviews to ensure the flight safety of all flight projects conducted at or for the Ames Research Center. Evaluate the acquisition of, or modifications to, aircraft as well as changes in the flight envelope or operational procedures of the aircraft to determine the necessity of review by the AFSRB. To implement the assigned task, the AFSRB Chairperson is given the responsibility and the authority to perform reviews that will vary depending upon the complexity and the criticality of the project under consideration.

b. Maintain a list of the AFSRB membership and announce any changes to the membership in a memorandum to Center management. Appointment to the AFSRB is made using the ARC Safety Committee Chartering Form.

c. Evaluate all flight activities and flight critical tests in an early engineering design phase, including in the field changes, to determine the necessity of a review by the AFSRB.

d. Determine the review schedule and requirements when a review by the AFSRB is required.

e. Augment the standing Board with experts to facilitate reviews, as appropriate, such as:

(1) Appointing ad hoc committees (such as an Independent Review Team (IRT)).

(2) Consulting with Ames Standing Safety Review Committees; or soliciting expert advice from within or outside the Center.

(3) Document all official actions and/or recommendations and provide a copy to the Project Manager and affected flight test personnel.

(4) Provide the Center Director with an Annual Summary Report of the AFSRB review process and AFSRB activities.

(5) If required, evaluate the effectiveness of Center project management to provide sufficient second-and third-party reviews of all flight project activities that could affect airworthiness.

1.5 The **Flight Readiness Review Board (FRRB)** shall:

a. Include the following members or their designees: the Chair of the FRRB, the Chair of the AFSRB, the Safety and Mission Assurance Office, the mission manager and/or Principal Investigator, the Range Safety personnel, the ASO, and, in the case of UAS operations, the UAS operator.

b. Review a specific flight or series of flights for appropriate planning and operational readiness. See NPR 7900.3 for specific required topics of review.

c. Review context/environmental specific risks associated with the flight/s.

d. Issue a Mission Readiness Review Approval Letter, when required, for each Project that satisfies the requirements for that Mission Readiness Review.

1.6 The **Flight Readiness Review Chairperson** shall:

a. Be the Chief of Flight Operations, Chief Pilot, or designee with considerable aviation experience approved by the Chief of Flight Operations.

b. Lead the FRRB meeting.

c. Issue a Flight Release Approval for each Project that satisfies the requirements for that Flight Readiness Review.

1.7 The **Project Manager** or delegate shall:

a. Perform the following functions regarding the flight project or operations involving CAS:

(1) Provide requirements for aircraft use or acquisition prior to contract award.

(2) Provide project milestones and deliverables.

(3) Perform technical analyses to comply with regulations and meet safety assurance levels set by NASA.

(4) Perform operations planning/operation system review and system safety.

(5) Maintain records of the above in accordance with Chapter 3 of this APR.

(6) If not directly performing the above functions for a deployment, designate one or more Mission Managers who shall be the On-site manager of the operation.

b. Formulate plans and appoint temporary review committees for second and third party of all flight project activities that may affect airworthiness and flight safety.

c. Inform the AFSRB Chair about all aircraft modification and operations activities that may require AFSRB review or that deviate from the original AFSRB approval.

d. Provide the briefing to the AFSRB to include the documentation to satisfy applicable sections of Appendix C of this APR

e. Provide the briefing to the FRRB to include the documentation to satisfy applicable sections of Appendix F of this APR.

f. Comply with the recommendations of the AFSRB.

g. Monitor the program progress and safety status and report to the AFSRB and FRRB.

1.8 The **Ames Safety and Mission Assurance Office** shall:

a. Assist the Center Director and AFSRB Chairperson in finding and appointing qualified staff for the safety review process.

b. Provide independent oversight to determine the adequacy and completeness of required safety, reliability, and quality assurance activities with respect to Center aircraft and flight operations.

c. Provide independent review and expert advice concerning the safety and risk of flight activities, including range safety.

d. Participate in AFSRB and FRRB.

1.9 **Directorate Heads**

1.9.1 Directors of one-letter codes with line responsibility for flight projects or operations shall:

a. Ensure that all Ames aircraft programs and projects will meet appropriate airworthiness and operational criteria and applicable regulations.

b. Assist program and project offices in the execution of project-specific airworthiness and operational requirements.

c. Support the AFSRB and flight projects.

1.9.2 All other Directorates shall support the AFSRB, as required or requested by the AFSRB Chairperson.

1.10 **Originators of flight projects, scientific missions, or aircraft acquisitions** shall follow the procedures established in NPR 8715.3 and NPR 7900.3, or obtain waivers from the Center Director for Ames requirements or from the NASA Headquarters Aircraft Management Office for NASA requirements.

1.11 **Other Personnel** shall participate in the review as determined. For a UAS mission, this includes the Mission Manager and/or Principle Investigator, Pilot, Operator(s), and Range Safety personnel.

CHAPTER 2 PROCEDURE

2.1 Overview of Airworthiness and Flight Readiness Reviews

2.1.1 It is incumbent upon the Project Manager, to inform the ASFRB Chairperson of any circumstance in the project that may possibly affect the airworthiness of an aircraft or the safety of those onboard or on the ground. In addition, the AFSRB Chairman must be notified of any changes or deviations from a previously approved project. At the discretion of the AFSRB Chairperson, additional reviews may be required.

2.1.2 The purpose of these reviews is to fully provide NASA management with the necessary assurances that a satisfactory approach has been taken to minimize and manage risk to achieve safe and productive flight operations. The Project Manager must communicate that a sound engineering approach has been taken; demonstrate an ability to meet project requirements; establish current project status; and above all, indicate the project's overall attitude toward safety.

2.1.3 The depth, detail, and formality of the each of the reviews are a function of the degree of risk associated with the aircraft or flight operation involved. The AFSRB is responsible for assuring adequate coverage of all airworthiness and safety related areas of the project.

2.1.4 In order to maintain necessary assurances that a satisfactory approach has been taken to minimize and manage aircraft operations risks, an in-depth Flight Readiness Review (FRR) is required prior to the first scheduled flight of aircraft under the purview of Appendix F of this APR and NPR 7900.3 Chapter 2.

2.2 NASA Commercial Aviation Services (CAS) and Inter-Agency Airworthiness Guidelines

2.2.1 Flight programs may procure CAS or IAAs from outside operators. However, in accordance with NPR 7900.3 section 8.3.1.3 (aircraft acquisition alternatives), this will only be permitted when all suitable options are exhausted.

2.2.2 In addition, the Chief of Flight Operations or designee shall review and concur with all contracts or agreements that include aviation operations prior to approval/award in accordance with NPR 7900.3 section 10.2.4 and the following additional steps:

a. The entity establishing the contract or agreement will give the Chief of Flight Operations at least 11 business days to review prior to the any review meeting (such as a Partnerships Review Board (PRE) meeting).

b. Prior to award of the contract or agreement, the flight operations office will conduct an inspection of the operator. The inspection will include a review of the terms of the contract or agreement, the risks to NASA, the hazards associated with the proposed flight operation, the airworthiness of the aircraft, and the capabilities of the contractor/partner.

c. The results of the inspection shall be incorporated into the contractor/partner selection process.

d. At least one NASA flight operations officer will be a member of the selection board or team. If the Center has no flight operations office, support from another NASA flight operations office will be coordinated by the NASA Headquarters Aircraft Management Office through the Directorates and the IAOP.

2.2.3 Operations will be conducted under guidelines that vary depending upon who owns or operates the aircraft:

a. NASA-owned or NASA-operated aircraft: Any aircraft owned or operated by NASA will be subject to the Center's airworthiness approval process. If the NASA aircraft is operated by a NASA Center other than the owning Center, responsibilities for flight safety, airworthiness, and mission review will be established by a written agreement between the respective Centers' Flight Operations Offices;

b. NASA-owned, military-operated: If a NASA aircraft is operated for NASA by the U.S. military, the owning NASA Center's flight operations office will determine whether NASA or military standards for airworthiness, operations, maintenance, and safety should apply. Responsibilities will be established by written agreement between the military unit operating the aircraft and the Flight Operations Office at the NASA Center that owns the aircraft.

c. Military-owned and military-operated: If NASA equipment or personnel are required to be aboard a military owned and operated research or research support aircraft, and operated at a NASA Center, responsibilities and tasks will be established by written agreement between the military unit with operational responsibility for the aircraft, and the flight operations office at the NASA Center where the flight operations are to be conducted. If the operation is not conducted at a NASA Center, the head of flight operations at the Center that manages the project will sign the agreement.

d. Federal or State Agency-owned and -operated: If the aircraft is owned by another Federal or State agency (including State Universities) and operated for NASA, that agency must have a formal aviation program with written standards which describe a complete flight program, including management, administration, operations, maintenance, modifications, airworthiness, safety, and training. Those standards must be related to, and address the risks associated with the types of operations the aircraft will perform. The flight operations office at the NASA Center responsible for the flight project will conduct the risk analysis and evaluate the capabilities of the agency. If that Center has no flight operations office, support from another Center's flight operations office is required. The NASA Headquarters Aircraft Management Office will coordinate the evaluation and analysis through the Directorates and the Inter-center Aircraft Operations Panel (IAOP). If the Federal or State agency's operation has been previously evaluated by an Interagency Committee for Aviation Policy (ICAP) Aviation Resource Management Survey Team, the Center flight operations office may use the results of that survey for its evaluation, as determined by the Chief of Flight Operations. If the Federal or State agency is expected to provide long-term, continuous support (greater than one year), the agency's aviation program will be subject to IAOP Review process in the same manner as NASA Centers.

e. Exclusive use of CAS aircraft by NASA under a NASA agreement or contract:

(1) Will not be subject to a NASA airworthiness approval review when the aircraft is owned by a contractor and operated for NASA under a Federal Aviation Administration (FAA) Operating Certificate (such as Federal Aviation Regulation [FAR] Part 121 or 135.) as a civil aircraft for a commercial purpose, the aircraft will be operated in accordance with the appropriate FARs and within the limitations imposed by the Operating Certificate.

(2) Will be subject to the NASA airworthiness approval process when either:

(a) The Contractor-owned aircraft has an Experimental or Provisional Certificate; or

(b) The Contractor-owned aircraft has no FAA Certificate.

(3) Allows reviewers to accept the condition of the aircraft as documented, if the risk analysis permits, when the contractor's aircraft has an FAA Standard Airworthiness Certificate with appropriate maintenance/configuration documentation showing satisfactory condition; or

(4) Allows reviewers to accept the condition of the aircraft as documented, if the risk analysis permits, when the aircraft has a Limited or Restricted Category Certificate and the operation is restricted to the limitations imposed by the certificate.

2.2.4 The following two tables summarize the required reviews.

Table A-1: Airworthiness Standards/Review

Owner	Operator	Airworthiness Standards/Review
NASA	NASA	NASA / AFSRB
NASA	NASA Military	NASA / AFSRB Per MOA
Military	Military	Per MOA / Agreement
Federal/State	Federal/State (ICAP)	Fed. Agency /State Per MOA
Federal/State	Federal/State (non-ICAP)	Fed. Agency /State AFSRB
Federal/State	Civil (Public)	NASA / AFSRB
Civil	Civil (Public or 107 research)	NASA / AFSRB
Civil	Civil (Civil or non-exclusive use CAS)	FAA A/W Cert. & FAA Ops Cert.

Table A-2: Summary of Review Requirements for Aircraft Controlled by Ames Research Center

An AFSRB review is required for:	An AFSRB review is NOT required for:
• All NASA or military experimental aircraft • All restricted/experimental FAA certified aircraft • Other U.S. government agency aircraft that have not passed an ICAP review • Integrating a NASA payload into an aircraft • All non-U.S. Airworthiness certificated or non-U.S. military aircraft	• Other NASA Center aircraft not designated as experimental • Unrestricted FAA airworthiness certificated aircraft • Other U.S. government agency aircraft that have passed an ICAP review of the new configuration

2.3 **Airworthiness and Flight Safety Review Board**

2.3.1 The first-level review is conducted by the entire AFSRB. In this review, the Board will determine whether a particular project has adequately considered and integrated flight safety into its proposed plans. This judgment will be based upon a presentation to the AFSRB by the project. The recommendation of the Board to the Project Manager will be based on the general agreement of the members, with each major objection addressed and resolved.

2.3.2 The second level of review is by an Independent Review Team (IRT). An IRT is a team of experts, independent of the project, who will present their findings to the AFSRB to assist the Board in determining whether the proposed project should be cleared for flight. The Board will determine whether a particular project has adequately considered and integrated the expected level of flight safety into its proposed plans. The recommendation of the Board to the Center Director will be based on the general agreement of the members, with each major objection addressed and resolved.

2.3.3 In any of the above reviews, the AFSRB Chairperson has the authority to obtain assistance from any part of Ames or any outside source that may be necessary to ensure that the project will be conducted in as safely as possible. This assistance can take many forms, such as the hiring of consultants, obtaining aircraft manufacturer's expertise, using experts in various fields, or forming ad hoc committees to assess any or all parts of the proposed program.

2.4 **Independent Review Team (IRT)**

2.4.1 The Chairperson of the AFSRB may establish a formal Independent Review Team (IRT), or teams, to assist the AFSRB in judging whether a specific project is adequately prepared to proceed with its proposed program. The IRT should be established at a time when credible review and assessment can be made without delaying the operational schedule of the project, but in all cases, shall occur before the AFSRB for a first flight or major operation of the project. The membership of an IRT is selected to represent specific functions and disciplines necessary for an objective review and assessment of the particular project and its proposed plans. Broad experience and expertise are desirable among the Team members to assure recognition of potential problems in a wide range of areas. The members will not be associated with the program being reviewed in any manner such that their activities or recommendations may be influenced through such causes as an over-familiarity with the project, as determined by the Chairperson of the AFSRB. The Chairperson of an IRT should be a senior engineer with extensive experience and expertise in the major discipline of the project. Other members may be drawn from NASA field Centers, other government agencies or from the private sector as long as they are independent from the project under review.

2.4.1.1 IRTs are normally limited in scope to address safety as the main subject of review. Typically, an IRT may be formed if any of the following criteria are present:

a. A program will require a major modification to the aircraft;

b. A program or operation requires an in-depth review(s) to provide specific information for the AFSRB;

c. When a phased program is ready to enter a second or succeeding phase, to assess the results up to the approved limits provided in the original AFSRB review; or

d. A program is preparing to exceed some limit previously approved by the AFSRB.

2.4.1.2 IRTs shall be chartered to:

a. Conduct an independent review and assessment of the entire program, or subset of a program or operation, to assure that adequate and proper planning and preparation result in an acceptably safe project. This review should include, where applicable, the design, fabrication, performance, and documentation of software and hardware associated with the project, as well as ground and flight operational procedures. It should also include any substantiating wind tunnel, computational fluid dynamics, ground, and/or simulation testing that has been performed.

b. Verify compliance with the approved System Safety Plan and integration of all the analyses and results into the project's planning and tracking documentation.

c. Ensure that all risks have been identified, assessed, and either adequately controlled or presented to the Center Management as risks that must be accepted in order to conduct the program.

d. Provide engineering and technical recommendations to program personnel throughout the life of the IRT, while recognizing that it is not a function of the IRT to direct the actual work effort.

e. Maintain on-going communication between the IRT members, program personnel, ARC management, and the Chairperson of the AFSRB.

f. Submit a final report of the Team's activity, findings, and recommendations to the Chairperson of the AFSRB. This report shall include:

(1) Any unsatisfactory or marginal areas or conditions, any restrictions or limitations that should be imposed before the proposed operation may take place.

(2) A discussion of any hazards that must be presented to the Center Director for acceptance.

2.4.2 The report should ordinarily be signed by the entire IRT. However, the Chairperson may sign in an individual's absence, if he/she states that the absent member either concurred in the majority report or has filed a minority report. Any member not concurring with the majority report will submit a minority report stating any areas of nonoccurrence or additional claims or recommendations as appropriate. Typically the IRT will present an oral briefing to the AFSRB. The written report will be delivered to the AFSRB and the Project Manager at least 48 hours prior to the meeting of the AFSRB.

2.4.3 The IRT oral briefing to the AFSRB should include the material presented in the written report. Typically, the IRT Chairperson and IRT members will present the briefing. Project team members should be present to answer questions that may arise. Hardcopies of the oral presentation should be prepared and presented to the Project Manager and AFSRB members 24 hours prior to the AFSRB meeting.

2.4.4 The presentation of the IRT's final report, the Project Manager of the affected project will submit a report to the Chairperson of the AFSRB, addressing any open action items, or recommendations that may have been in the IRT report that require action before the first flight or significant operation of the project. Following these two report submissions; the AFSRB will make its final recommendations to the Project Manager as to whether the project should be allowed to continue on the course it has planned or make modifications to their plans before continuing. The Project Manager and the AFSRB Chairperson will maintain records of the reviews until all required items are satisfactorily addressed and flight approval is granted.

CHAPTER 3 RECORDS

3.1 Records document the results of achieved performance and provide evidence of activities performed to achieve measured performance. Records may be both informal and formal and not all records are required to fall under revision control. Organizations should consider the following attributes associated with records:

a. Records should be in a format that contains the appropriate amount of details to easily facilitate verification activities.

b. Records should be formatted in a manner that lends to simplicity in review and comparison to other records that are used to show evidence of recurring documentation on specific measurements.

c. Records that coincide with the ongoing recurring organizations' management activities are highly desirable.

d. AFSRB Records shall be maintained, managed, retained, and disposed of, by the AFSRB Records Custodian, in accordance with APR 1440.1 and include the following:

(1) Presentation package as shown in Appendix D.10.a

(2) AFSRB Meeting Minutes

(3) AFSRB Meeting Attendance List

(4) Airworthiness Statement or Certificate of Airworthiness for the aircraft reviewed, limitations or conditions, and duration of applicability.

e. FRRB Records shall be maintained, managed, retained, and disposed of, by the FRRB Records Custodian, in accordance with APR 1440.1 and include the following:

(1) Presentation Package as shown in Appendix D.10.b

(2) FRRB Meeting Minutes

(3) FRRB Meeting Attendance List

(4) Flight Release Approval Letter for the aircraft and mission reviewed, limitations or conditions, and duration of applicability.

f. Mission Readiness Review records shall be maintained, managed, retained, and disposed of by the FRRB Records Custodian, in accordance with APR 1440.1 and include the following:

(5) Presentation Package as shown in Appendix D.10.c

(6) MRRB Meeting Minutes

(7) MRRB Meeting Attendance List

(8) Mission Readiness Review Approval Letter for the aircraft and mission reviewed, limitations or conditions, and duration of applicability.

APPENDIX A. DEFINITIONS

Airworthiness Approval	A document issued for an aircraft, aircraft engine, propeller, article, or associated support equipment which certifies that the aircraft, aircraft engine, propeller, article, or associated support equipment conforms to its approved design and is in a condition for safe operation. For Category I or II UAS, an Airworthiness Statement issued by the AFSRB. For Category III UAS or Manned aircraft 1. A NASA Airworthiness Certificate (NF1677) issued in accordance with NPR 7900.3. 2. For an aircraft engine, propeller, article, or associated support equipment, an approval by the holder of an FAA Airframe and Powerplant Mechanic Certificate with an Inspection Authorization or equivalent.
Flights Test	A flight of an aircraft to develop and gather data for subsequent analysis to evaluate the flight characteristics of the aircraft and validate its design, including safety aspects.
Systems Safety	A concept that calls for a risk management strategy based on identification, analysis of hazards and application of remedial controls using a systems-based approach.

APPENDIX B. ACRONYMS

AFSRB	Airworthiness and Flight Safety Review Board
APD	Ames Policy Directive
APR	Ames Procedural Requirement
CAS	Commercial Aviation Service
CG	Center of Gravity
EMI	Electro-Magnetic Interference
FMEA	Failure Modes and Effects Analysis
FTA	Fault Tree Analysis
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FRR	Flight Readiness Review
FRRB	Flight Readiness Review Board
IRT	Independent Review Team
ICAP	Interagency Committee for Aviation Policy
IAOP	Inter-center Aircraft Operations Panel
MOA	Memorandum of Agreement
NEMS	NASA Equipment Management System
NHB	NASA Handbook
NPD	NASA Policy Directive
NPR	NASA Procedural Requirement
PRA	Probabilistic Risk Analysis
UAS	Unmanned Aerial System

APPENDIX C. REFERENCES

C.1 Federal Aviation Regulation, 14 CFR Parts 121 and 135

C.2 NPR 7120.5, NASA Program and Project Management Processes and Requirements

C.3 NPR 8580.1, Implementing the National Environmental Policy Act and Executive Order 12114

C.4 NPR 8715.5, Range Flight Safety Program

C.5 APR 7120.5, ARC Flight Systems Program & Project Management Procedures

APPENDIX D. GUIDANCE FOR PRESENTING TO THE AFSRB

Note: The following provides a non-exhaustive sampling of questions that may be asked of the Project Management by any of the members of the AFSRB during or after the review presentation. It also indicates what they may be looking for if/when they inspect modifications to the aircraft.

D.1 Aero-structures

a. Have all aspects of a new design or modification been considered for effect on structure and vice-versa?

b. Are ground load and ground vibration tests adequate? Is there any evidence of airframe vibration (flutter, buffet, acoustics)?

c. Is instrumentation satisfactory? Does it tell you what you need to know for safety and mission accomplishment? What are the shortcomings?

d. Have all safety and mission concerns been adequately addressed? What factor of safety was used in the design or test? What are the Margin(s) of Safety?

e. Is the Project management reasonably certain the flight can be conducted safely?

D.2 Modifications

a. Can the type and amount of power available support the electrical requirements of the installations?

b. Have operating procedures and an inspection checklist been developed for the installation?

c. Is cooling air adequate to properly cool avionics? In flight? On the ground?

d. Have adequate flight manuals and checklists, for the as configured vehicle, been prepared and approved?

e. Have weight and balance figures been computed and are they within limits?

f. Does the installation of test equipment in the aircraft interior keep aisles and emergency exits clear for evacuation?

g. Do installed racks and test equipment have projections (bolts, rivets, knobs, handles) which could cause injury to aircrew personnel?

h. Does instrumentation installed in the cockpit obstruct vision or egress or add discomfort and distraction to the aircrew?

i. Is the aircraft properly placarded and has the test instrumentation in the cockpit been properly identified and marked?

j. Do any external modifications affect the pitot-static system?

k. Have magnetic interference (RMI) ramifications been considered? Will flight day RMI be different than other days?

l. Have modifications been photographically documented?

m. Review fact sheets. Are all changes incorporated?

D.3 Controls (Flight, Engine, etc.)

a. Have all "fail to operate" and full hard-over impacts been assessed?

b. Is the system implemented as intended by the designer? How is it assured?

c. Have end-to-end tests been conducted on the full-up total system? Have all credible inputs been accomplished to observe system response?

d. Do all lights and indicators obtain intelligence from credible sources?

e. How does a failure or erroneous signal in a light or indicator impact safety or mission accomplishment?

f. Is/was simulation satisfactory? Have appropriate sensitivity changes been evaluated?

g. Is there a "last resort" provision to revert back to a previously annunciated failed system in the event vehicle loss is imminent? (i.e. -- to a system that may be healthy with the warning system malfunctioning.)

h. Have all prudent efforts been considered to continue operating a system in a degraded "get-home" condition in lieu of switching to a dormant or benign backup system whose health is not fully known?

i. Has consideration been given to using parallel-active dual systems rather than primary-active, backup-benign systems?

j. In the event of a failure, will an impacted item be automatically positioned at an optimum setting (i.e. - engine speed, flight control surface, etc.)?

k. Do you have any undue concerns about questions in the "Flight Control Ops" section of this document?

l. Have all safety and mission concerns been adequately addressed? Has a system safety assessment been accomplished?

m. Is the Program Management reasonable certain flight can be conducted safely?

D.4 Aerodynamics

a. Have all aspects of a new design or modification been considered for effect on aerodynamics? Weight? CG? Inertia? Exterior Configuration? Surface control movements? Pitot-static system? Other instrumentation?

b. Have effects of in-flight unplanned alteration of appendages or flight surfaces been assessed?

c. Is the aero model satisfactory? Are there any undue concerns? How will the aero model be verified during envelope expansion flights?

d. Is/was simulation satisfactory? Have appropriate sensitivity changes been examined?

e. Is the instrumentation satisfactory? Will it provide the required information for safety and mission accomplishment? What are the shortcomings?

f. Have all safety and mission concerns been adequately addressed?

g. Is the Project Management reasonably certain flight can be conducted safely?

D.5 Propulsion

a. Is the propulsion system suitable for the operational environment?

b. Are propulsion characteristics compatible with the intended flight envelope (e.g., altitude, speed, G-force, angle-of-attack, sideslip)?

c. Where is flameout or engine stall anticipated?

d. Are procedures adequate to avoid over-temperature or other engine damage?

e. Are engine recovery procedures adequate?

f. Is testing in an area where emergency power-off landing can be safely accomplished?

g. Are flight control and electrical/hydraulic power adequate for a power-off landing?

D.6 Man/Machine Dynamics

a. Have all aspects of the new design or modification been considered for effect on dynamics and vice-versa (e.g., weight, Center of Gravity (CG), inertia, exterior configuration, surface control movements, pitot-static system, other instrumentation, etc.)?

b. Have effects of unplanned alteration of appendages or flight surfaces been assessed?

c. Is/was simulation satisfactory? Have appropriate sensitivity changes been examined?

d. Is the instrumentation satisfactory? Does it tell the test team what they need to know for safety and mission accomplishment? What are the shortcomings?

e. Are there any undue concerns about questions in the "Flight Control Ops" section of this document?

f. Have all safety and mission concerns been adequately addressed?

g. Is the Project Management reasonably certain flight can be conducted safely?

D.7 Instrumentation

a. Has the proposed and/or completed installation been inspected by the project test aircrew to ensure that it offers the safest possible installation? Has a cockpit safety design board approved the changes and documented approval?

b. Has a complete set of operating instructions been formulated and published?

c. Are the instrumentation appendages (nose boom pitot head, vanes, etc.) ahead of the engine checked regularly for structural integrity?

d. Has proper consideration been given to the separation of shielding of instrumentation and aircraft wiring, especially in the area of weapons system control circuits?

e. Have provisions been made for coordinating the data when more than one recording device is to be used?

f. Have adequate written procedures been developed for the maintenance, inspection, and calibration of the instrumentation?

g. Has a complete set of emergency or alternate procedures for test instrumentation failures been formulated in order that some part of a scheduled mission can be accomplished safely with certain instrumentation inoperative?

h. Is the Project Management reasonable certain that this test can be conducted safely?

i. Is it necessary or advisable to monitor internal black-box temperatures? In flight? On ground? During build-up and maintenance?

j. Are black boxes instrumented to reveal elapsed operating hours? On-off cycles? Are hours and cycles frequently monitored and documented?

k. Are film/tape time limits on recorders and cameras understood? Speeds? Initiation and shutoff times?

l. Has the instrumentation installation been documented by photography/video prior to flight?

D.8 Flight Operations

D.8.1 For each flight test maneuver or event:

a. Who are the key people monitoring the event? Are they properly trained?

b. Have all safety and mission concerns been adequately addressed?

c. What recorders, channels, and parameters are being monitored for critical and precautionary indications?

d. What are the critical and precautionary limits for the given event?

e. Is there any question concerning whom the test team should notify, how to notify them, and with what urgency? Are there any questions concerning how the notified people should react when they are notified of a critical or precautionary indication?

f. Are there any questions concerning the parameters monitored, types of sensors used, or the method of display?

g. Is the test team satisfied with the limits and accuracy of the monitored parameters? With interfaces with other monitored parameters?

h. Has the scaling and sensing (direction) of the parameters to be monitored been verified and validated?

i. Is the test team satisfied with the communication network, procedures and equipment?

j. Are flight envelope limits clearly defined and understood before flight by necessary persons?

k. Will you be able to detect faulty instrumentation indications of critical flight parameters?

l. Unless otherwise certified, equipped or approved, flight into known icing conditions is prohibited.

m. EMI and radio interference with Command and Control functions (C2).

D.9 Maintenance

a. Are there any special maintenance procedures that will be required to support the test? Are they published as a requirement?

b. Have inspection requirements been compiled into preflight, post-flight, and phase document?

c. Has the aircraft and in particular, the modification areas been thoroughly inspected for foreign objects?

d. In the case of joint maintenance support, who is in charge?

e. Is the Project Management reasonably certain that the tests can be conducted safely?

D.10 Project Management

a. For an AFSRB Review, has the Project prepared a Presentation package that includes:

(1) Executed Agreement or Contract as applicable

(2) Description of aircraft and configuration

(3) Copy of Registration Certificate for each air vehicle

(4) Current Approved Flight Manual

(5) Radio frequencies for control and data, if applicable

(6) Description of modifications or changes, analyses to substantiate the changes

(7) Risk Analysis

b. For a Flight Readiness Review, has the Project prepared a Presentation package that includes:

(1) Mission Description

(2) Flight experiment and science flight requirements

(3) Payload status

(4) Science coordination requirements

(5) Description of aircraft and configuration

(6) Flight Test Plan

(7) Safety and Mishap Plan

(8) Inter-Center/interagency communication/coordination plan

(9) Roles and responsibilities including Key Personnel List, by position, necessary for the safe conduct of the mission including the Mission Manager, Pilot, Range Safety Officer,

(10) Operational Risk Analysis

(11) Ground operations procedures dealing with hazardous systems

(12) Schedule timeline

(13) Pre-accident and/or incident notification plan

(14) Liability coverage

(15) Deployment & Logistics

(16) Public Affairs/Outreach

(17) Mission assurance

(18) Acknowledgement of Risk of Damage or Loss Letter

c. For a Mission Readiness Review, has the Project prepared a Presentation package that includes:

(1) Mission Description

(a) Flight experiment and science flight requirements

(b) Payload status

(c) Science coordination requirements

(2) Description of aircraft and configuration

(3) Flight Test Plan

(4) Aircraft separation/coordination

(5) Safety and Mishap Plan

(6) Inter-Center/interagency communication/coordination plan

(7) Roles and responsibilities including Key Personnel List, by position, necessary for the safe conduct of the mission including the Mission Manager, Pilot, Range Safety Officer, etc.

(8) Operational Risk Analysis

(9) Ground operations procedures dealing with hazardous systems

(10) Schedule timeline

(11) Pre-accident and/or incident notification plan

(12) Liability coverage

(13) Deployment & Logistics

(14) Public Affairs/Outreach

(15) Mission assurance

(16) Acknowledgement of Risk of Damage or Loss Letter

d. Has a review of all system safety documentation been accomplished?

(1) Have closed risks been verified and validated?

(2) Has the Range Safety Representative reviewed and approved the documentation?

e. What are the mission rules and accepted risks? Have the appropriate personnel affected by mission rules and accepted risks been briefed?

f. What configuration control process is utilized? Does the Project use a documented Configuration Control process?

g. Has the Project utilized an appropriate Lesson Learned database?

h. Are all mission rules, procedures, processes, and personnel for the mission identified?

i. Are all Configuration Control records completed?

j. Have all personnel necessary to the mission completed any required training?

k. Have all approved permits, certificates, or clearances been acquired?

l. Does the Project have documentation of compliance with the National Environmental Policy Act (NEPA) with concurrence from the Environmental Management Division, according to NPRs 7120.5 and 8580.1?

m. Do the Risk Analysis Mitigations include the following Mission related considerations?

(1) Operational Procedures & Processes

(2) Range Safety

(3) Area of Operation and Environment

(4) Security & Fire Protection

(5) Recovery & retrieval

(6) Special considerations for equipment, materials, procedures, training.

D.11 Unmanned Aircraft Systems and Optionally Piloted Aircraft

Note: In addition to applicable areas covered in C1 through C10, the following are applicable questions to UAS.

(1) Have UAS specific safety/risk/hazards been identified and mitigations or procedures instituted to address them? Include communication links and frequency management plan; equipment limitations, data link integrity, flight control system fault and configuration control procedures; backup systems and procedures; and flight terminations systems including ground abort.

(2) Have methods for See-and-Avoid/Sense-and-Avoid been determined and instituted?

(3) Are critical command and control functions safeguarded from inadvertent activation/deactivation?

(4) Is the Control Station suitable for the pilot's use? Is there primary and back-up power? Have procedures been established for the pilot in case of lost primary and back-up power? Are the capabilities and limitations known?

(5) Have Lost Link, Flight Recovery, Flight Termination, or other Contingency Management Procedures been established and tested?

(6) Are Crew trained and current for the planned UAS operations?

(7) Has an Area of Operation been determined? This will include the Class of airspace, altitudes, times of operations, and the base of Operations

(8) Have the UAS operations been coordinated with the applicable FAA office or facility?

(9) Is the project in compliance with NPR 8715.5?

(10) Are ground safety procedures and protocols identified and established?

(11) As applicable, a Flight Termination System

(12) As applicable, a Statement of Expendability

(13) As applicable, a determination of the cost or replacement value of the UAS.

APPENDIX E. GUIDANCE FOR AN INDEPENDENT REVIEW TEAM

E.1 The purpose of a review is to provide NASA management the assurance that a satisfactory approach has been taken to achieve safe and productive flight operations. Reviews communicate an approach, demonstrate an ability to meet requirements, and establish current status.

E.2 The objectives of a review are to establish that all interfaces are compatible and function as expected, confirm that the system and support elements are properly configured, and ready to assure that flight operations can proceed with acceptable risk.

E.3 The members of an IRT may go to their respective supervisors and/or the Safety and Mission Assurance Office for help or advice in interpretation of the Team's charter, but, it is extremely important that the individual members remain totally independent from project management biases while operating as an IRT member. The Project Manager has the responsibility to ensure that individuals working under them have the time and priority necessary to do a thorough job as an IRT member.

E.4 The IRT should take advantage of other advisors and consultants to assist them in fully reviewing the project. If an outside consultant must be hired, the project should provide funding. Decisions and recommendations are the sole responsibility of the IRT and its Chairperson. One purpose of the IRT review is to expose individual or IRT concerns to higher management and the project while there is still time to avert a mishap. Project Team members are encouraged to reveal information freely, cooperate with other review team(s), and be totally open in all conversations including any doubts or uneasiness felt by the Project Team. Inviting IRT members to attend pertinent project meetings wherever applicable can emphasize this. The Project Team and the IRT have a common goal and often the IRT can help the project in attaining that goal. Briefings by the Project Team should be presented by qualified personnel to familiarize the IRT with overall efforts and specifics of all areas under evaluation. It is the responsibility of the project personnel to assure that all information presented is current, complete, and accurate; all hardware, software, and equipment submitted for evaluation is properly prepared and represents the actual configuration and functional characteristics intended for use; and all known or suspected anomalies, deficiencies, or areas of concern are identified.

E.5 Constant communication between the IRT and the Project Team can provide benefits in both directions. A concern or recommendation voiced to the Project Team in a timely manner may allow the project to take action without delaying the project. Likewise, the proposed action of the Project Team, communicated to the IRT in a timely manner, may uncover areas of confusion or misunderstanding on the part of either the IRT or the Project Team that could lead to an unnecessary expenditure of valuable time and/or resources.

IRT CHECKLIST

This checklist provides a non-exhaustive list of items to provide guidance for a review team to consider when conducting an independent review. The team may select only those items that apply to the project reviewed.

1. PROJECT MANAGEMENT

(a) Leadership

- Emphasis on safety as the primary concern
- Experience level of personnel

- Is there a clear line of authority to the person in charge?
- Examine team networking and external interfaces

(b) Organization and Staffing

- Sound organizational structure
- Staffing adequacy
- Safety and Mission Assurance representation

(c) Communication

- Ranking of safety over mission success and those over cost and schedule
- Free exchange of information, opportunity to be heard
- Tracking of top ranked issues and their resolution to everyone's satisfaction
- Problem reporting encouraged
- Line organization and project communications

(d) Project Team

- Key positions are filled and continuity encouraged
- Experience level of team members
- Adequacy of project team's reviews: Preliminary Design Review, Critical Design Review, Wind tunnel, test readiness, simulation
- Customer involvement in decision making and trade-offs

2. PROCESS AND EXECUTION

(a) Systems Engineering

- Risk trade-off system used by the project
- Risk management system used
- Ground test versus flight test trade-off
- Fault tree analysis used
- Margin adequacy for parameters
- Mission architecture provides data for failure analysis
- Emphasis on mission success over cost and schedule
- Formal review of past lessons learned
- Rigorous configuration control process in place

(b) Requirements

- Mission success criteria established and base lined
- Requirements level sufficiently detailed

- Change process used and effective
- Derived requirements flow from base requirements

(c) Validation and Verification

- Verification matrix structure and completeness
- Vertical: Mission phase for hardware or software
- Horizontal: Function, qualification method (analysis, test, similarity, none), results
- Sound verification processes
- Evidence that proper processes are used
- Mission critical software identified and treated as such
- System interface validation and data handoff
- Simulation as a validation and verification tool
- Other validation and verification facilities
- Independent Validation and Verification for software
- Normal and off nominal (contingency and emergency) testing
- Test repeats after configuration changes
- End-to-end testing results and configuration freeze

(d) Risk Management, Analysis, Test

- Risk analysis tools used: Risk Analysis, Failure Analysis, Failure Modes and Effects Analysis (FMEA), Fault Tree Analysis (FTA), Probabilistic Risk Analysis (PRA), etc.
- Problem reporting procedures
- Single-point failures identified and remedied or accepted
- Hardware and software reuse certification
- Day of flight configuration testing
- Potential failures identified, modeled, and mitigated or accepted
- Thoroughness of failure postulation

(e) Independent Reviews

- Review conducted by technical peers or experts
- Sustained support for review members
- Review independence from common management
- Review results reported to top management

(f) Operations

- Contingency planning validated and tested (simulated)

- Contingency training of personnel
- Mission Rules formulation and reasonableness
- Telemetry and health monitoring during critical operations

(g) Documentation

- Documentation of design decisions and limitations
- Decisions communicated to all concerned
- Documentation process must be continuous
- Electronic documentation distribution availability

(h) Continuity and Handover

- Transition plan for handover
- Personnel transfer with handover
- Recipient team training by development team
- Training of recipients in procedures and databases.
- Continuity in key positions; overlap
- New processes generated by the transition
- Transition risks

3. TECHNOLOGY

- Technology adequately matured
- Technology solutions alternatives considered
- Risk level of new technology
- New technology use and limitations

4. TECHNICAL AREAS

- View technical areas with the purpose, goals and objectives of the Project in mind
- Aerodynamics
- Control surface effectiveness
- External pylons, stores, protuberances, fixtures, mounts
- Alternate landing sites
- Aircrew
- Aircrew Evaluation of Simulation Results, aircraft readiness, problem areas
- Review of Flight Crew Training, Procedures, and Qualifications
- Avionics
- Redundancy, reliability EMI testing

- Computational Fluid Dynamics analysis
- Configuration Control

5. PROJECT REQUIREMENTS

- Flight vehicle under configuration control
- Hardware
- Software
- Data acquisition and transmission
- Documentation
- Experiment(s) Description
- Flight Envelope and Expansion Plans
- Flight Controls
- Verification and Validation of flight control computers and software functions
- Independent Verification and Validation

6. CERTIFICATE STANDARD (LEVEL A: FLIGHT CRITICAL)

- Fuels and oxidizers: hypergolics, pyrophorics, oxygen
- Ground Operations and servicing
- Ground Support
- Airfield Facilities
- Communications Equipment
- Ground Support Equipment Maintenance Facilities
- Navigation, Guidance, and Landing aids

(a) Ground Testing

- Communications
- Wind and Crosswind limits
- Guidance, Navigation, and Control onboard
- Handling Qualities
- Predictions: Simulation, analog
- Hazard Analysis
- Hazards identified
- Severity and Probability levels

(b) Risk Matrix

- Accepted risks

- Human Factors
- Hydraulics
- Redundancy
- Inspection methods at contractor's location and at ARC
- Instrumentation
- Air data system, pilot, computer influence Go/No go
- Mishap reconstruction capable Research data acquisition

(c) Life Support

- Anti-G suit
- Egress capability
- Sharp edge survey
- Mission Rules

(d) Limitations

- Operational restrictions
- Operations
- Checklists
- Emergency Procedures
- Fact Sheet
- Manuals
- Pilot training (ground and flight)

(e) Project Overview

- Experiments Planned
- Facilities required
- Hardware, Software
- Objectives
- Procedures used

(f) Propulsion

(g) Recommendations by the Review Board

- Action Items

(h) Research Vehicle

- Landing gear
- Mass properties

(i) Risk Management

- Assessment of residual risk
- Accepted Risk List
- Hazard Identification
- Severity and probability matrix

(j) Simulation

- Certification: qualified for use
- Configuration Management
- Nominal, off nominal testing Verification
- Validation

(k) Software

- Configuration Control
- Independent Validation and Verification
- Simulation

(l) Structures

- Aero-elastic effects
- Ground Vibration Tests

(m) Uncertainty Analysis

- Margins
- Monte Carlo Analysis

(n) Validation and Verification

- Validation: System performs adequately to accomplish the mission: Test, Analysis, Demonstration, Similarity, Inspection, and Simulation.
- Verification: System performs according to the specification: Test, Analysis, Demonstration, Similarity, Inspection, Simulation
- All up end-to-end check: Thermal, vibration, shock, pressure, all combined

(o) Vehicle Health Monitoring

- Waivers
- Wind tunnel predictions
- Wiring
- Work Breakdown Structure

APPENDIX F. FLIGHT READINESS REVIEWS

F.1 It should be kept in mind that the purpose of these Flight Readiness Reviews is to fully provide NASA management the assurances necessary that a satisfactory approach has been taken to minimize and manage risk and to achieve productive flight operations. The reviews need to communicate the project management and engineering approach, demonstrate an ability to meet requirements, establish current project status, and above all, indicate the project's overall attitude toward safety.

F.2 The depth, detail, and formality of the each of the reviews are a function of the degree of risk associated with the use of the aircraft (manned and UAS) involved. The AFSRB and the Aviation Management Office are responsible for assuring adequate coverage of all airworthiness and safety related areas of the project.

F.3 The Flight Readiness Review must be held prior to the first scheduled flight. At this time, project hardware is fabricated, installed and tested, all aircraft modifications have been completed and the experiment procedures and flight plans are finalized. The Chief of the Aviation Management Office, or designee, chairs this review.

F.4 The following elements should be considered during these reviews:

I. Project Overview

A. Project Description

B. Flight Operations Procedures Summary

C. Schedule

D. Go / No Go Criteria

1. Is there a process for determining whether to fly or not fly the mission?
2. Do all team members understand the process?

E. Test Plan

F. Mishap Plan

G. Safety Plan

H. Key Personnel List, by position, necessary for the safe conduct of the mission including the Mission Manager, Pilot, Range Safety Officer, etc.

II. Flight Safety Evaluation

A. Simulation Program Status

B. Aircraft Configuration Control

1. Hardware Configuration Control Status
2. Software Configuration Control Status
3. Minimum Equipment List (MEL) C. Hardware Status Reports

C. Aircraft Modification

D. Science payload and operations and payload integration

E. Aircraft Readiness

F. System Integration Status

G. Acceptance Test Results

H. Ground Support

1. Airport Facilities Have airfield facilities and operations been assessed for compatibility and differences accounted for in processes and procedures? Have any new procedures and processes been included into a structured risk assessment?

2. Navigation Aids

3. Guidance and Landing Aids

4. Communications Equipment

5. Maintenance Facilities

6. Range Safety procedures, roles, and responsibilities reviewed by the RSO.

I. Updated Analytical Summaries

1. Hazard Analysis

a. Can the mission be conducted safely?

b. Have all Mission related risks been evaluated?

c. Changes to Facilities and Operational procedures

d. Have any Safety, Mission, or Environmental concerns been evaluated?

e. Have these been approved by the Range Safety Representative in accordance with NPR 8715.5?

2. Failure Modes, Effects and Criticality Analysis

3. Stress Analyses

J. Project Pilot Report

1. Evaluation of Simulation Results

2. Pilot qualifications, flight operations training, flight manuals

3. Review of Flight Crew Procedures

4. Assessment of Aircraft Readiness

5. Potential Problem Areas

6. Operational Limitations

III. Modification Installation Inspection by the Board

IV. Project Summary

A. Disposition of Previous Open Action Items

B. Action Item Assignment