JO-5
Aircraft Modification and Airworthiness Manual

National Aeronautics and Space Administration
Moffett Field, California 94035-1000

Code JO
Flight Operations
Aviation Management Office

MOFFETT FEDERAL AIRFIELD, CA
NASA AMES RESEARCH CENTER

CODE JO
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Record of Revisions

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PREFACE

This manual will take precedence when there are conflicting rules and procedures. The rules, procedures, and guidelines in this document are to be considered as minimum standards. The Aviation Management Office may review and give permission for deviations from rules and procedures of this manual.

This manual may be revised by new editions or updated by page changes or pen-and-ink corrections. When corrections or page changes are entered, the changes will be annotated on the Record of Revisions page.

Comments and recommendations concerning this manual are encouraged and should be submitted to the Chief, Aviation Management Office (Code JO). Extra copies of this manual can be obtained from the Aviation Management Office.

1. INTRODUCTION

1.1 Purpose

The purpose of this manual is to establish a process to ensure the airworthiness of modified aircraft and to evaluate the safety of NASA Ames flight operations. NASA Headquarters and NASA Ames documents already exist which establish policies and guidelines that define these processes and requirements. This document implements these requirements into one code JO document that defines define how NASA Ames will assess the airworthiness of all aircraft under its control, including Unmanned Aerial Vehicles (UAV's).

1.2 Policy

NASA Ames has a responsibility to ensure that all aircraft used to conduct flight operations with NASA personnel or NASA equipment on board meet the appropriate approved airworthiness and operational safety standards. That responsibility is specified in NPD 7900.4, NASA Aircraft Operations Management:

> ***Para 1.b.*** *"All NASA aircraft operations will meet approved programmatic needs and mission management requirements, be duly authorized, and be accomplished in airworthy aircraft by qualified flight crews in accordance with approved operational procedures. NASA will comply with applicable Federal guidelines and regulations."*
>
> ***Para 1.c.*** *"Policies and procedures will be established by affected NASA Centers for initiation, review, approval, and implementation of all flight programs. Procedures will be established at each Center and aircraft operations facility, including Headquarters, to comply with the NASA and Federal Aviation Administration (FAA) airworthiness, and safety/flight readiness review policies and procedures."*
>
> ***Para 1.d.*** *"NASA will take all necessary actions to prevent loss of life, personal injury, property loss, mission failure, or test failure.*
>
> ***Para. 5.j.*** *"Managers at all levels are responsible for the safe conduct of aircraft operations under their control. All aviation-related contracts require compliance with aviation safety program requirements."*

NASA Policy Document NPD 8700.1 is one of several NPDs referenced in NPD 7900.4A. An excerpt from NPD 8700.1 helps to establish the foundation for NASA oversight policies. It states:

> ***Para. 1.b.*** *"It is NASA policy to maximize the likelihood of mission success by using qualitative or quantitative risk assessment techniques to identify and understand the risks, take appropriate steps to control or mitigate the risks, and then accept only reasonable and appropriate levels of residual risk before proceeding with a mission."*

1.3 Relationships to Other Offices

Nothing in this manual shall be interpreted to diminish or limit the independent authorities and functions of the FAA, NASA Ames Safety (Codes Q and QH), NASA Headquarters Safety and Health Office, the Inspector General, or other authorities within NASA.

1.4 Revisions

Periodic revisions will be made and recorded.

1.5 Referenced Documents

NHB 1700.1	NASA Basic Safety Policy Manual
APD 1740.1	Ames Airworthiness and Flight Safety Directive
NPG 7900.3	Aircraft Operations Management
NPD 7900.4C	NASA Aircraft Operations Management
NPR 7900.3B	Aircraft Operations Management Manual
NPD 8700.1	NASA Policy for Safety and Mission Success

1.6 Responsibilities

Per APD 1740.1:

A. The Center Director or a designated representative will:

1. Provide interpretation of NASA policies and requirements concerning airworthiness and flight safety for implementation at Ames.
2. Require that the flight operations policy is consistently formulated and implemented for all flight activities that the Center manages.
3. Maintain authority for granting any variances, deviations, or waivers from Ames Airworthiness and Flight Safety policy.
4. Perform an annual review of NASA and Center flight operations and airworthiness policies to
    a. Identify areas of noncompliance with approved procedures, and/or new policies or policy changes that may enhance the safety program.
    b. Advocate for acceptance and implementation of new policies or policy changes.
5. Appoint and maintain an Airworthiness and Flight Safety Review Board (AFSRB) membership that will include the Chair, the Executive Secretary (non-voting) and a minimum of four voting members with the experience and expertise to adequately conduct airworthiness and flight safety reviews of Center aircraft activities and operations.
6. Maintain a list of the AFSRB membership and announce any changes in the membership in a memorandum.

7. Perform an annual review of all AFSRB reports and products to determine trends or items requiring policy or process changes, and implement corrective actions when necessary.

B. The Airworthiness and Flight Safety Review Board Chair will:

1. Formulate and implement an effective flight safety review process.
2. 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.
3. Evaluate all flight activities and flight critical tests in an early phase to determine the necessity of a review by the AFSRB.
4. Determine the review schedule and requirements when a review by the AFSRB is necessary.
5. Augment the standing Board with experts to facilitate reviews, as appropriate. Some options might include: (1) appointing ad hoc committees (such as Flight Readiness Review Boards); (2) consulting with Ames Standing Safety Review Committees; or (3) soliciting expert advice from within or outside the Center.
6. Document all official action and/or recommendations and will provide a copy to the Center Director.
7. Provide the Center Director with an Annual Summary Report of the AFSRB review process and the AFSRB activities.

C. The Airworthiness and Flight Safety Review Board will:

1. Participate in reviews to establish the airworthiness and evaluate the safety of flight operations of all installations, modifications or operations that meet the following criteria:
   a. Installations or modifications that require redefinition of the aircraft's published flight envelope or aerodynamic characteristics
   b. Installations or modifications that involve the mid-air separation or engagement of components by the aircraft.
   c. Installations or modifications that involve hazardous materials
   d. Installations or modifications that involve one or more cutouts in the airframe.
   e. Installations or modifications that create a new airframe load path.
   f. Installations or modifications that require a modification to a window.
   g. Installation or modifications of systems that may affect the control of the aircraft.
   h. Installations that require an external appendage.
   i. UAV operations.
   j. Any other installation or modification as determined by the AFSRB.
2. Have a quorum containing the Chair, two Board members, and Executive Secretary present for all meetings. The Chair or Secretary may appoint another member, if someone cannot attend.

3. Conclude official Review Board meetings by either; (1) authorizing a project to proceed; or (2) requiring changes, further documentation, or demonstrations to satisfy airworthiness and flight safety concerns raised by the Board.
4. Evaluate the effectiveness of Center line-management to provide sufficient second-and third-party reviews of all flight project activities that could affect airworthiness and flight safety.

D. The organization responsible for the operation of the aircraft will:

1. Provide the following functions regarding the flight project or operations:
   a. Management and Oversight
   b. Technical Analysis, Review, and Assessment
   c. Oversight of Modification Process, Integration and Implementation
   d. Operations Planning/Operation System Review and System Safety
2. Formulate plans and appoint temporary review committees for second and third party of all flight project activities that may affect airworthiness and flight safety.
3. Inform the AFSRB Chair about all aircraft modification and operations activities that may require AFSRB review.
4. Monitor the program progress and safety status and report to line-management.
5. Approve operations, logistics, and support plans, and monitor aircraft and critical facility operations.

E. The Ames Safety, Environmental and Mission Assurance Office will:

1. Assist the Center Director in finding and appointing qualified staff for the safety review process.
2. 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.
3. Provide independent review and expert advice concerning aircraft operations safety and the operation of any flight-critical facilities used.

F. Directors of one-letter codes with line responsibility for flight projects or operations will:

1. Establish general (minimum) airworthiness criteria for Ames aircraft programs.
2. Assist program and project offices in the definition of project-specific airworthiness guidelines.
3. Support the AFSRB in flight projects reviews.

G. All other Directorates shall support the AFSRB, as required or requested.

H. Originators of flight projects, scientific missions, or aircraft acquisitions will follow the procedures established in NHB 1700.1, NASA Basic Safety Policy Manual, and NPG 7900.3, Aircraft Operations Management, or obtain waivers.

2. NASA AIRWORTHINESS GUIDELINES

NASA airworthiness directives state that flight programs will be conducted under guidelines that will vary depending upon who owns or operates the aircraft:

2.1 NASA-owned or NASA-operated aircraft:

Any aircraft owned or operated by NASA will be subject to the Center's airworthiness certification process, and the flight program will be subject to the Center's mission or flight review 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 Center Flight Operations organizations.

2.2 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 conduct a risk analysis to 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.

2.3 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.

2.4 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 that 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 AMO will coordinate the evaluation and analysis through the Enterprises and the 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. 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 the IAOP Review process in the same manner as NASA Centers.

2.5 Contractor-Owned and Contractor-Operated

If 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 119, 121, 125, 133, 135.) as a civil aircraft, the aircraft will be operated in accordance with the appropriate FARs and within the limitations imposed by the Operating Certificate. Prior to contract award, the flight operations office at the NASA Center that manages the contract will conduct a risk analysis. The risk analysis will include a review of the terms of the contract, the risks to NASA, the hazards associated with the proposed flight operation, the airworthiness of the aircraft, and the capabilities of the contractor. The results of the risk analysis shall be incorporated into the contractor selection process. At least one NASA flight operations officer shall 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 AMO through the Enterprises and the IAOP.

A. If the contractor's aircraft has an FAA Standard Airworthiness Certificate with appropriate maintenance/configuration documentation showing satisfactory condition, and if the risk analysis permits, the reviewers may accept the condition of the aircraft as documented.

B. If the aircraft has a Limited or Restricted Category Certificate, the operation must be restricted to the limitations imposed by the certificate, and if the risk analysis permits, the reviewers may accept the condition of the aircraft as documented.

C. If the aircraft has an Experimental or Provisional Certificate, the configuration and airworthiness must be reviewed and approved by a formal NASA airworthiness certification program.

D. If the Contractor-owned aircraft has no FAA Certificate, the aircraft configuration and airworthiness must be reviewed and approved by a formal NASA airworthiness certification program.

Table 1 Review Requirements

Owner	Operator	Airworthiness Standards/Review	Program Review Requirements
NASA	NASA	NASA / AFSRB	FRR
NASA	Any	NASA / AFSRB	FRR
Any	NASA	NASA / AFSRB	FRR
Military	Military	Per MOA / Agreement	FRR
Federal	Federal (ICAP)	Fed. Agency / MOA	FRR
Federal	Federal (non-ICAP)	Fed. Agency / AFSRB	FRR
Federal	Civil (Public)	NASA / AFSRB	FRR
Civil	Civil (Public)	NASA / AFSRB	FRR
Civil	Civil (Civil)	FAA A/W Cert. & FAA Ops Cert.	FRR

Table 2 Review Requirements for aircraft not controlled by Ames

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 • All non- U.S. certified or non- U.S. military aircraft	• Other NASA Center aircraft not designated as experimental • Unrestricted FAA-certified aircraft • Other U.S. government agency aircraft that have passed an ICAP review of the new configuration

3. AIRWORTHINESS REVIEWS

It is incumbent upon the person/office in charge of any project, which may possibly affect the airworthiness of an aircraft or the safety of those onboard or on the ground, to inform the Chief of the Aviation Management Office and the ASFRB Chairperson about that project. In addition, they must be notified of any changes in a previously reviewed project. At the discretion of the Chief of the Aviation Management Office and/or the AFSRB Chairperson, one or more reviews may be required.

This chapter outlines the schedule and recommended format for Preliminary Safety, Design Safety and Flight Readiness Reviews.

It should be kept in mind that the purpose of these 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.

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 involved. The AFSRB and the Aviation Management Office are responsible for assuring adequate coverage of all airworthiness and safety related areas of the project.

The following table indicates when each of the reviews is to take place.

Review Type:	Held at Program Stage:
Preliminary Safety	• Early in the program • Normally with the initial design review when major hardware and software are involved
Design Safety	• May be held in conjunction with the project Preliminary Design Review • Hardware design is essentially complete • May be held in conjunction with project Critical Design Review
Flight Readiness	• Before the first scheduled flight • Flight hardware is completed and installed in the aircraft • All aircraft modifications are completed • Experimental procedures and initial flight plans are finalized
Periodic	• During flight and maintenance operations

3.1 The Preliminary Safety Review Outline

The Preliminary Safety Review is to be held in the early stages of a program or project as soon as the objectives, schedules, and design criteria have been established and the basic plans have been formulated. The following outline is to be used as a general guide for the topics to be covered during this review.

I. General Project Description
   A. Project Objectives
      1. Experimental Research Objectives
      2. Hardware Development Objectives
      3. Proposed Flight Plans
   B. Project Organization

C. Hardware Concept
   1. Hardware Functions
   2. Design Criteria
   3. Procurement Status
   4. Computer Software Requirements

D. Project Requirements
   1. Aircraft to Be Used
   2. Aircraft Performance Requirements
   3. Aircraft and System Simulation Requirements
   4. Aircraft Modifications
   5. Other Requirements

E. Proposed Schedules
   1. Hardware and Software Development
   2. Aircraft Development or Modification
   3. Experiment Program

II. Airworthiness Design Considerations

A. Preliminary Analytical results
   1. Pilot Information/Control Analysis
   2. Failure Modes, Effects and Criticality Analysis
   3. Risk Matrix
   4. System and Hardware Reliability Estimates

B. Human Engineering Considerations
   1. Displays
   2. Monitors and Warning Devices
   3. Flight Personnel Workload Estimates

C. Interfacing of Project Hardware or Modifications to Aircraft
   1. Aircraft Controls
   2. Pilot Controls and Displays
   3. Navigation
   4. Communications
   5. Air Data and Flight Control Sensors
   6. Aircraft Power Systems

III. Experiment Plan
  A. Flight Plan
    1. Schedule, Duration, and Location
    2. Flight Profiles
    3. Test and Training Flights
  B. Ground Support Requirements
    1. Airport Facilities
    2. Communication Equipment
    3. Maintenance Support Requirements
    4. Navigation Aids
    5. Special Requirements
IV. Program Summary
  A. Current Status
  B. Action Item Assignment

3.2 The Design Safety Review Outline

The Design Safety Review is held at a point in the program when the hardware designs are essentially final, normally prior to fabrication, installation and modification. At this time, detailed hardware specifications are available and simulation and flight plans are substantially complete.

I. Project Overview
  A. Project Description
  B. Schedule Milestones
  C. Current Status
II. Airworthiness Design Implementation
  A. Airworthiness Design Integrity
    1. Safety Analysis
    2. Failure Modes, Effects and Criticality Analysis
    3. Fault Tree Analysis
    4. Stress Analyses
  B. Aircraft Compatibility
    1. Aircraft Modifications Requirements
    2. Results of Detailed Interface Studies
    3. Aircraft Operating Envelope

C. Operational Criteria
   1. Flight Operations Plans
   2. Flight Crew Procedures
D. Simulation and Pre-flight Test Results
E. Evaluation by the Project Pilot
   1. Displays, Monitors, Warning Devices
   2. Aircraft Performance and Handling Characteristics Expectations
F. Quality Assurance Plans
G. Maintenance Support Plans

III. Experiment Program
A. Finalized Experiment Plans
B. Experiment Management
   1. Procedures
   2. Software Control
C. Experiment Schedule

IV. Project Summary
A. Disposition of Previous Open Items
B. Action Item Assignment

3.3 Flight Readiness Review Outline

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.

I. Project Overview
A. Project Description
B. Operations Summary
C. Schedule

II. Flight Safety Evaluation
A. Simulation Program Status
B. Configuration Control
   1. Hardware Configuration Control Status
   2. Software Configuration Control Status

C. Hardware Status Reports
    1. Aircraft Modification
    2. Equipment Installation
    3. Aircraft Readiness
    4. System Integration Status
    5. Acceptance Test Results
D. Ground Support
    1. Airport Facilities
    2. Navigation Aids
    3. Guidance and Landing Aids
    4. Communications Equipment
    5. Maintenance Facilities
E. Updated Analytical Summaries
    1. Hazard Analysis
    2. Failure Modes, Effects and Criticality Analysis
    3. Stress Analyses
F. Project Pilot Report
    1. Evaluation of Simulation Results
    2. Review of Flight Crew Procedures
    3. Assessment of Aircraft Readiness
    4. Potential Problem Areas
    5. Operational Limitations

III. Modification Installation Inspection by the Board

IV. Project Summary
A. Disposition of Previous Open Action Items
B. Action Item Assignment

4. MODIFICATION AND INSTALLATION DESIGN STANDARDS

The standards below are derived from accepted aerospace practices, civilian and military regulations, and the structural design manuals of the aircraft. Analysis must be provided to substantiate all new and modified structure and wiring. Drawings must be provided which document all installations and modifications. These drawings must include installation instructions.

4.1 Structural Installation Standards

4.1.1 Emergency Landing Loads Standards

The following minimum ultimate inertial load factors will be used to protect personnel and maintain structural integrity in the event of emergency landing.

LOAD DIRECTION	OUTSIDE CABIN (G's)	WITHIN CABIN (G's)
Forward	10	16
Aft	1.5	1.5
Up	3	3
Down	10	14
Side	3	3

4.1.2 General Structural Installation Standards

A. All installations will be secured to prevent injury or interference with the aircraft's primary systems, particularly in the events of turbulence, emergency, or crash landing.

B. All installations must possess adequate strength to react all aerodynamic, inertial, and pressurization loads throughout the aircraft's factory-design envelopes. (Installations that reduce factory design envelopes may be permitted under limited circumstances as approved by the AFSRB. An example is the reduction of the factory dive speed of a project aircraft to permit flight test of an external protuberance whose aerodynamic forces could not be tolerated at this extreme speed.)

C. Installations that require that an aircraft's primary structure provide a load path for a new project installation will be reinforced so that the chosen load path can safely carry the sum of the original aircraft design loads plus the added installation loads. An example of this is the reinforcement of aircraft rings to support a probe mounted on the outside of the aircraft.

D. A limit uniform pressure coefficient, $\Delta p/q0$, of magnitude 1.0 will be applied to closeout panels in viewing apertures.

E. The Prandtl-Glauert correction will be used to estimate the increase in loads caused by compressibility.

F. External installations must be evaluated to determine their effect on aircraft stability, control, trim, handling qualities, and performance.

G. Limit loads will be multiplied by a factor of safety of 2, including fitting factor of safety.

H. No installation or modification will interfere with maintaining a minimum 20" wide escape path within the cabin.

I. No installation or modification shall interfere with escape hatches, power plants, control surfaces, or cables.

J. No installation or modification will interfere with cockpit controls or gauges.

K. Other conditions imposed by the AFSRB.

4.2 Electrical Installation Standards

A. Circuit modifications added to line aircraft busses to supply project-power to customers will be routed through a single cockpit project-power switch. This switch will open the power circuit to all projects in the fuselage in the event of fire, smoke, or other emergency declared by the cockpit crew.

B. As practicable, all customer power will be drawn through the aircraft project-power switch. Uninterruptible Power Supplies (UPS) are permitted, as long as each installation has an emergency shutdown that can be easily accessed during an emergency declared by the cockpit crew. The use of a UPS and its shutdown procedure will be documented. Power extension cords are prohibited during flight.

C. Customer installation wiring is to be of certified commercial grade for avionics with a grounding lead and have jackets that are non-toxic in the event of a fire. Wiring and cabling will be protected from overload by fuse or circuit breaker. Wiring will be secured to prevent movement and will be properly identified.

D. Protective covers will be provided for sources of arcing, high voltage, and shorts, including shorts caused by liquid spills. Power receptacles will be located to minimize shorts from spilled liquids. Aircraft systems will be protected from overload by project support installations by using circuit breakers.

5. Guidance For Presenting To The AFSRB

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

5.1 Aero Structures

1. Have all aspects of new design or modification been considered for effect on structure and vice-versa?
2. Are ground load and ground vibration tests adequate? Is there any evidence of airframe vibration (flutter, buffet, acoustics)?
3. Is instrumentation satisfactory? Does it tell you all you need to know for safety and mission accomplishment? What are the shortcomings?

4. Have all safety and mission concerns been adequately addressed? What factor of safety in design or test? What is the Margin of Safety?
5. Are you reasonably certain the flight can be conducted safely.

5.2 Modifications

1. Can the type and amount of power available support the electrical requirements of the installations?
2. Have operating procedures and an inspection checklist been developed for the installation?
3. Is cooling air adequate to properly cool avionics? In flight? On ground?
4. Have partial flight manuals and checklist been prepared and approved?
5. Have weight and balance figures been computed and are they within recommended limits?
6. Does the installation of test equipment in the aircraft interior keep aisles and emergency exits clear for evacuation?
7. Do installed racks and test equipment have projections (bolts, rivets, knobs, handles) which could cause injury to aircrew personnel?
8. Does instrumentation installed in the cockpit obstruct vision or egress or add discomfort and distraction to the aircrew?
9. Is the aircraft properly placarded and has the test instrumentation in the cockpit been properly identified and marked?
10. Do any external modifications affect the pitot-static system?
11. Have magnetic interference (RMI) ramifications been considered? Will flight day RMI be different than other days?
12. Have modifications been photographically documented on film or video?.
13. Review fact sheet. Are all changes incorporated?

5.3 Controls (Flight, Engine, Etc.)

1. Have all "fail to operate" and full hard-over impacts been assessed?
2. Is the system implemented as intended by the designer? How is it assured?
3. Have end-to-end tests been conducted on the full-up total system? Have all credible inputs been accomplished to observe system response?
4. Do all lights and indicators obtain intelligence from credible sources?
5. How does failure or erroneous signal in a light or indicator impact safety or mission accomplishment?
6. Is simulation satisfactory? Have appropriate sensitivity changes been examined?
7. Is there a “last resort” provision to switch back to a previously annunciated failed system in the event vehicle loss is imminent anyhow? (i.e. - the system may be healthy with the warning system malfunctioning.)

8. Have all prudent efforts been considered to continue operating system in a degraded "get-home" condition in lieu of switching to a dormant or benign backup system whose health is not utterly known?
9. Has consideration been given to using parallel-active dual systems rather than primary-active, backup-benign systems?
10. 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.)?
11. Do you have any undue concerns about questions in the "Flight Control Ops" section of this document?
12. Have all safety and mission concerns been adequately addressed? Has a system safety assessment been accomplished?
13. Are you reasonable certain flight can be conducted safely

5.4 Aerodynamics

1. Have all aspects of new design or modification been considered for effect on aerodynamics? Weight? CG? Inertia? Exterior Configuration? Surface control movements? Pitot-static system? Other instrumentation?
2. Have effects of in-flight unplanned alteration of appendages or flight surfaces been assessed?
3. Is the aero model satisfactory? Are there any undue concerns? How are you going to verify the aero model during envelope expansion flights?
4. Is simulation satisfactory? Have appropriate sensitivity changes been examined?
5. Is instrumentation satisfactory? Does it tell you all you need to know for safety and mission accomplishment? What are the shortcomings?
6. Have all safety and mission concerns been adequately addressed?
7. Are you reasonably certain flight can be conducted safely?

5.5 Propulsion

1. Are propulsion characteristics compatible with the intended flight envelope? Altitude? Speed? G-force? Angle-of-attack? Sideslip?
2. Where is flameout or engine stall anticipated?
3. Are procedures adequate to avoid overtemp or other engine damage?
4. Are engine recovery procedures adequate?
5. Is testing in an area where emergency power-off landing can be safely conducted?
6. Are flight control and electrical/hydraulic power adequate for power-off landing.

5.6 Man/Machine Dynamics

1. Have all aspects of new design or modification been considered for effect on dynamics and vice-versa? Weight? CG? Inertia? Exterior configuration? Surface control movements? Pitot-static system? Other instrumentation?
2. Have effects of unplanned alteration of appendages or flight surfaces been assessed?
3. Is simulation satisfactory? Have appropriate sensitivity changes been examined?
4. Is instrumentation satisfactory? Does it tell you all you need know for safety and mission accomplishment? What are the shortcomings?
5. Do you have any undue concerns about questions in the "Flight Control Ops" section of this document?
6. Have all safety and mission concerns been adequately addressed?
7. Are you reasonably certain flight can be conducted safely?

5.7 Instrumentation

1. 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?
2. Has a complete set of operating instructions been formulated and published?
3. Are the instrumentation appendages (nose boom pitot head, vanes, etc.) ahead of the engine checked regularly for structural integrity?
4. Has proper consideration been given to the separation of shielding of instrumentation and aircraft wiring, especially in the area of weapons system control circuits?
5. Have provisions been made for coordinating the data when more than one recording device is to be used?
6. Have adequate written procedures been developed for the maintenance, inspection, and calibration of the instrumentation?
7. 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?
8. Are you reasonable certain that this test can be conducted safely?
9. Is it necessary or advisable to monitor internal black-box temperatures monitored? In flight? On ground? During build-up and maintenance?
10. Are black boxes instrumented to reveal elapsed operating hours? On-off cycles? Are hours and cycles frequently monitored and documented?
11. Are film/tape time limits on recorders and cameras understood? Speeds? Initiation and shutoff times?
12. Has the instrumentation installation been documented by photography/video prior to flight?

5.8 Flight Operations

1. For each flight test maneuver or event:
   - Who are the key people monitoring the event? Are they properly trained?
   - What recorders, channels, and parameters are being monitored for critical and precautionary indications?
   - What are the critical and precautionary limits for the given event?
   - Is there any question concerning whom you notify, how you notify them, and with what urgency? Are there any questions concerning how you expect people to react when you notify them of a critical or precautionary indication?
2. Is there any question concerning the parameters monitored, type of sensor used, or the method of display?
3. Are you satisfied with the limits and accuracy of the monitored parameters? With interfaces with other monitored parameters?
4. Have you checked scaling and sensing (direction) of the parameters you are to monitor?
5. Are you satisfied with your communication network, procedures and equipment?
6. Are flight envelope limits clearly defined and understood before flight by necessary persons?
7. Will you be able to detect faulty instrumentation indications of critical flight parameters?

5.9 Maintenance

1. Are there any special maintenance procedures that will be required to support the test? Are they published as a requirement?
2. Have inspection requirements been compiled into preflight, post-flight, and phase documents.
3. Has the aircraft and in particular, the modification areas been thoroughly inspected for foreign objects?
4. In the case of joint maintenance support, who is in charge?
5. Are you reasonably certain that the test can be conducted safely?

5.10 Project Management

1. Has a review of all system safety documentation been accomplished?
2. What are your mission rules and accepted risks?
3. What configuration control process is utilized?
4. Has the Project utilized appropriate Lesson Learned databases?