

**SCIENCE INSTRUMENT  
AIRWORTHINESS AND CERTIFICATION PROCEDURES  
MANUAL  
Section 150:  
Reviews**

## **150 Reviews**

This section has been created to help clarify the requirements of the airworthiness review process. There are three reviews that have been developed which begin at (1) an informal Conceptual Airworthiness Design Review (CODR), follow with (2) a Preliminary Airworthiness Design Review (PADR), and finally (3) a formal Critical Airworthiness Design Review (CADR) just prior to final approval by the DER. The review team for these presentations will be the DERs, representing the structural, electrical, and mechanical systems aspects of certification as well as members of the SOFIA Airworthiness IPT (SIA-IPT) that can facilitate the communication between the DER and the SI team.

While these reviews are not required for the FAA, it is helpful for the SI team and the DER to meet and review plans before any detailed design has been done. The first review (CODR) is really to introduce the type of science instrument one is building and to discuss design considerations that may affect the further detailed design. The CODR should be a 1 1/2 hour to 2 hour presentation of a most general aspects of the science instrument. The PADR (30% review) is an opportunity to review some of the detailed preliminary design analysis and hazard reporting which was not expected or produced during the CODR. The PADR is expected to last one day with presentations from the SI team to the reviewers. There will be further detailed review and analysis at the CADR (90% review) directed at answering all concerns expressed during the PADR. After the CADR, there will be a time for final drawing and data package clean up before the DER will sign off on the designs and construction of the SI can begin.

### **150.1 Conceptual Airworthiness Design Review (CODR)**

This informal review is designed to perform an introduction between the Science instrument (SI) team and the Federal Aviation Administration (FAA) Designated Engineering Representatives (DERs). The SI design concepts should be discussed as well as specific design plans for mechanical, electrical, and hazardous materials to be implemented on this particular instrument. The presentation made by the SI team (lasting about 1 hour) follows the same outline as for the PADR (see Section 150.2) with less detail than one might expect at the PADR.

### **150.2 Preliminary Airworthiness Design Review**

The Preliminary Airworthiness Design Review will begin with the submission of a documentation package to the Airworthiness IPT (about 4 weeks before a PDR). The IPT will determine the completeness of the material. If further details are not required, the documents will be forwarded to the DERs for review

a couple of weeks prior to the scheduled PDR date. The PADR documents should include the following information at the 30% level:

Introduction of time line for certification.

Review of revised documents based on the conceptual design review, which would include, but is not limited to, the following topics:

- Mechanical analysis (stress, strength, pressure)
- Electrical specifications (loads, EMI)
- Preliminary hazard analysis and failure modes
- Operations procedures
- Maintenance, continued airworthiness concerns
- Test plans

### **150.3 Critical Item List**

This list will be generated during the review process based on the expertise of the DERs. At the completion of the CADR, it will be clear which items require further detailed analysis. The DERs will have an idea of what questions the FAA will ask and what further will be required in the way of analysis and documentation in order that they may best represent the science instrument to the FAA. This list is the identification of all items unique to an instrument that are critical to safety of flight. For example, assume an SI uses a cold stage for mounting detectors, filters, etc. Further assume that strength analysis has been done that indicates that under the worst case load the detectors, etc., mounted on the cold stage would be contained in the cryostat if the mounts were to fail, and that there are no secondary effects of this failure that impact safety. In this case, the detectors and mounts should not be considered critical items.

### **150.4 Critical Airworthiness Design Review (CADR)**

The following process describes the steps in proceeding from Preliminary Airworthiness Design Review (PADR) through Critical Airworthiness Design Review (CADR) to First Article or Qualification Testing. These steps can be found on the proposed FAA Certification Schedule Gantt Chart in Section 100 (Introduction) of this Certification Manual. This process is so important that a detailed breakdown was necessary so that it is clearly understood exactly what is expected from the Science Instrument (SI) teams.

#### **150.4.1 Getting to the CADR**

Once the PADR has been completed, the various SI teams will continue on with their design to the next major milestone, CADR. As seen on the proposed FAA Certification Schedule, the tasks to be completed are the engineering drawings, stress analysis, System Safety Assessment (which includes the Functional Hazard Analysis), Qualification Test Plan, Electrical Load Analysis, Continued Airworthiness, etc. CADR is defined as having 90% of the

engineering complete. Thus, 90% of all the above documentation must be completed for CADR. When scheduling the CADR, the SI teams will be required to provide all CADR data 4 weeks prior to their scheduled CADR. This will allow all interested parties to review the data and be prepared to provide comments/questions at the time of CADR.

#### **150.4.2 CADR**

During the CADR 90% review, the DERs will provide feedback to the SI teams on their designs. After CADR, the SI teams will incorporate any comments and complete/finalize all documentation. The CADR process will not be considered finalized until all comments have been addressed. Once all the documentation is 100% complete with the DER comments addressed, all data will be submitted to the Administrative DER: Bill Johns, Raytheon Systems Company.

#### **Communications during the Certification process**

Official communications before, during, and following the CADR will be handled by the administrative DER. Bill Johns (also an Electrical DER) at Raytheon Systems Company (RSC) is the focal point for all FAA documentation. Any released drawing(s), reports, etc., will be submitted to Bill. Bill will then distribute the documentation to the appropriate DER.

Informal communications can be sent directly to the responsible DER and to the SIA-IPT. All officially released data must go directly to the Administrative DER (Bill). The term “released” is defined as a document having been approved by the highest responsible member of that particular SI team. The DERs do not sign the completed document. The DERs approve that document via their FAA Form 8110-3.

#### **Official Documents**

The SI teams will submit four (4) copies of the data package to the Administrative DER. One copy goes to the FAA and each of the DERs each receive one copy.

##### **Formal Data Submission**

At this point in the process, the Admin DER is ready to formally submit the data to FAA Engineering in Ft. Worth, TX. A conformity request to FAA Engineering is submitted along with the data. Either at this time, or when the test plans are submitted to FAA Engineering, the Administrative DER will request delegation of test witnessing on behalf of FAA Engineering. FAA Engineering will then send a conformity request to FAA Manufacturing Inspection District Office (MIDO). This starts the “in-process conformity” and allows FAA Manufacturing to begin conformities.

NOTE: The SI teams will have to perform their conformities/inspections prior to either FAA MIDO or DAR conformity/inspection. This is termed a “company”

conformity. Typically, the STC applicant (in this case USRA) would perform the “company” conformity. For the SI teams to perform the “company” conformity on behalf of USRA, they must submit the name of the inspector, company name, location, etc., to RSC (Bill Johns). This inspector can be an SI team member or another person at the home institution who is designated to perform the inspection. The USRA can authorize an inspector to perform “company” conformities on their behalf.

### **150.5 Manufacturing**

As the drawings have now been reviewed and approved, the SI teams can begin part manufacturing. The SI team should communicate with the DAR prior to manufacturing of critical items identified at the CADR. They should schedule with the DAR the in-process conformity inspections that may need to occur during the manufacturing process. Part manufacturing prior to DER review and approval of drawings and compliance data will result in “at risk” manufactured parts. This means the parts are being manufactured “at risk” and there is a possibility that they will have to be scrapped, either due to DER concerns or because they have not had the “in-process” conformity performed. For a more detailed discussion of manufacturing see Section 350 of this manual.

#### **150.5.1 Conformity**

The conformity inspection of the assembly may occur by an inspector from the FAA MIDO or a DAR. The entire Science Instrument will be subject to in-process conformity as well as a final conformity on-site at the investigator’s facilities. This means that the FAA MIDO and/or DAR have the option of witnessing any or all building of the assembly. This could also occur at facilities that might be building sub-assemblies. The final conformity, in the assembled state, shall occur at the investigator’s manufacturing site. This will occur prior to shipment of the SI to NASA/Ames for flight test.

Once the SI conformity has been completed, the unit is now available for Qualification Testing or shipment to the aircraft.

#### **150.5.2 Long Lead Items**

A final note on this entire process. There will be long lead items that will require addressing early on in the program prior to the SI system CADR. This will probably include the cryostat. In this instance, it is acceptable to have a pre-CADR (in the form of a conference call) on just these items. The Science teams should send the completed drawings, supporting reports, etc., to the Administrative DER. Bill will then distribute these data to the DERs. After the DERs have had time to review the documentation, the pre-CADR is setup via a conference call. After the pre-CADR, the science teams will incorporate all

comments and get the final data package back to the DERs for their final review and approval.

**Note: The IPT encourages pre-CADR review of long lead time items. The final CADR will be a total system review including the pre-CADR items. It is the responsibility of the SI teams to ensure other aspects of this system are compatible with the part that is being pre-reviewed. For example, the cryostat may fall within the mechanical envelope and weight budget, but the whole SI system when reviewed at CADR might exceed one or both. It is the responsibility of the SI team to prevent this from happening.**

#### **150.6 Deliverables**

The following items are required as deliverables to the FAA (via the DER) in order to obtain certification. These materials will comprise a SOFIA science instrument Critical Airworthiness Design Review Data Package:

- Drawings

- Weight and Balance Report (Section 300)

- Structural Substantiation (Section 300)

- Electrical Load Analysis (Section 400)

- EMI Test Plan (ground and flight) (See Section 400)

- Functional Hazard Analysis/Failure Mode and Effects Analysis (Section 500)

- Operational Test Plan (Section 600)

- Continued Airworthiness Report (Section 600)