

# Rules and Regulations

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## DEPARTMENT OF TRANSPORTATION

### Federal Aviation Administration

#### 14 CFR Part 25

[Docket No. NN301; Special Conditions No. 25-290-SC]

#### Special Conditions: Boeing Model 747SP; NASA Stratospheric Observatory for Infrared Astronomy (SOFIA); Cryogenic Systems Using Liquid Nitrogen and Liquid Helium

**AGENCY:** Federal Aviation Administration (FAA), DOT.

**ACTION:** Final special conditions.

**SUMMARY:** These special conditions are issued for the Boeing Model 747SP airplane. This airplane, as modified by L-3 Communications/Integrated Systems, of Waco, Texas, will have novel and unusual design features associated with cryogenic systems using liquid nitrogen and liquid helium. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for this design feature. These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

**DATES:** Effective July 8, 2005.

**FOR FURTHER INFORMATION CONTACT:** Kathi Ishimaru, FAA, Propulsion/Mechanical Systems Branch, ANM-112, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Avenue SW., Renton, Washington, 98055-4056; telephone (425) 227-2674; facsimile (425) 227-1232.

#### SUPPLEMENTARY INFORMATION:

##### Background

On March 17, 1997, L-3 Communications/Integrated Systems, 7500 Maehr Road, Waco, Texas 76705, applied for a Supplemental Type

Certificate (STC) to modify a Boeing Model 747SP airplane for use as a flying observatory. This airplane will fly in the stratosphere to altitudes of 45,000 feet and use infrared technology to observe objects in space. The airplane is a stratospheric observatory for infrared astronomy or SOFIA. The modification consists of the installation of a 2.5-meter telescope, scientist workstations, and containment vessels for liquid helium and nitrogen (liquid converters, valves, evaporating coils, liquid lines, regulators, indicators, fittings, etc). Various science instruments (each having their own airworthiness approval), each weighing approximately 800 pounds, located in the workstation area, can be attached to the telescope for a specific mission (one per mission only).

The mission of the SOFIA airplane is to collect infrared signals. The observatory collects very weak infrared signals that were emitted by distant objects in space thousands of years ago. These signals are focused through the telescope onto sensors in the science instrument which is located on the cabin side of the telescope. To detect the weak infrared signals, the detectors in these sensors are cooled to temperatures near absolute zero by the use of cryogenic fluids. These fluids are contained in vessels similar to vacuum bottles. Their design and installation are covered by these special conditions. These extremely cold environments can only be produced by cryogenic liquids. The SOFIA observatory depends on liquid helium and nitrogen to chill the internal passageways of the detector systems. The amount of cryogens used here is small.

Cryogens, in a much greater quantity, are used in the area where the telescope mirror is installed. Liquid nitrogen is converted to a gas and circulated around the mirror to pre-cool it to prevent it from fogging up as it goes from a warm moist atmosphere on the ground to the cold dry atmosphere at high altitudes.

The modified Boeing Model 747SP airplane, with the L-3 Communications/Integrated Systems design will fly to 45,000 feet and in a gradual arc pattern for extended periods of time. Additionally, various science instruments will be installed under this STC or similar STCs, which will be referenced back to this STC.

#### Type Certification Basis

Under the provisions of 14 CFR 21.101, L-3 Communications/Integrated Systems must show that the modified Boeing Model 747SP airplane, as changed, continues to meet the applicable provisions of the regulations incorporated by reference in Type Certificate No. A20WE, or the applicable regulations in effect on the date of application for the change. The regulations incorporated by reference in the type certificate are commonly referred to as the "original type certification basis."

If the Administrator finds that the applicable airworthiness regulations (*i.e.*, part 25, as amended) do not contain adequate or appropriate safety standards for the Boeing Model 747SP airplane modified by L-3 Communications/Integrated Systems because of a novel or unusual design feature, special conditions are prescribed under the provisions of § 21.16.

In addition to the applicable airworthiness regulations and special conditions, the Boeing Model 747SP must comply with (1) either the "No Acoustical Change" provisions of § 21.93(b) or 14 CFR part 36, as amended by Amendments 36-1 through 36-23 and any later amendments that are effective 5 years prior to the STC approval date, and (2) either the "No Emissions Change" provisions of § 21.93(c) or 14 CFR part 34, as amended by Amendments 34-1 through 34-3.

Special conditions, as defined in 14 CFR 11.19, are issued in accordance with § 11.38 and become part of the type certification basis in accordance with § 21.101.

Special conditions are initially applicable to the model for which they are issued. Should L-3 Communications/Integrated Systems apply at a later date for a supplemental type certificate to modify any other model included on the same type certificate to incorporate the same novel or unusual design feature, these special conditions would also apply to the other model under the provisions of § 21.101.

#### Novel or Unusual Design Features

The modified Boeing Model 747 SP will incorporate the following novel or unusual design features:

1. Cryogenic fluids (nitrogen and helium) contained in the science instrument in the cabin compartment. The cryogenic gases could cause an asphyxiation hazard to the crew and passengers.

2. The cryogenics (liquid nitrogen), stored for chilling the mirror during ascent, might come in contact with the airplane's structure, which could cause damage to the surrounding structural areas.

The cryogenic systems must be designed and installed to ensure that no failure of the systems, including a leak in any part of the systems, would prevent continued safe flight and landing of the airplane.

There are no specific regulations that address the design and installation of liquid nitrogen systems and liquid helium systems. Existing requirements such as 14 CFR 25.1309 and 25.1438(b) are applicable to this installation. However, these regulations do not address the effect of cryogenic gases of passengers or crew and aircraft structure. The FAA needs to specify additional design standards, which specifically address these novel or unusual design features for systems utilizing cryogen liquids to ensure that a minimum level of safety is maintained, establishing a level of safety equivalent to the current regulations.

#### Discussion of Comments

Notice of proposed special conditions No. 25-05-01-SC for the Boeing Model 747 SP; NASA Stratospheric Observatory For Infrared Astronomy (SOFIA) airplanes was published in the **Federal Register** on February 8, 2005 (70 FR 6598). No comments were received, and the special conditions are adopted as proposed.

#### Applicability

As discussed above, these special conditions are applicable to Boeing 747SP airplane. Should L-3 Communications/Integrated Systems apply at a later date for a supplemental type certificate to modify any other model included on Type Certificate No. A20WE to incorporate the same novel or unusual design feature, these special conditions would apply to that model as well.

#### Conclusion

This action affects only certain novel or unusual design features on the Boeing Model 747SP airplane. It is not a rule of general applicability and it affects only the applicant who applied to the FAA for approval of these features on the airplane.

#### List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and record keeping requirements.

■ The authority citation for these special conditions is as follows:

**Authority:** 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

#### The Special Conditions

■ Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the type certification basis for the Boeing Model 747SP airplane as modified by L-3 Communications/Integrated Systems, of Waco, Texas:

1. Occupied compartments that contain cryogenic fluids must be provided with a means of ventilation to prevent the accumulation of cryogenic gases to a level that may cause an asphyxiation hazard to the crew or passengers.

2. Cryogen dewars must be limited to a maximum capacity of 70 liters of liquid nitrogen and 80 liters of liquid helium. These limits placed on the instrument are adequate to allow the instrument to perform the mission.

3. Pressure relief valves must provide release of gases to prevent overpressure of dewars and plumbing lines. The pressure relief valves must be vented overboard through a drain in the bottom of the airplane unless it is substantiated that the valves can be safely vented inside the airplane. The cryogenic system must be designed to prohibit the pressure relief valves from freezing due to air condensing and freezing.

4. Cryogenic equipment and plumbing installations must be designed such that a spill, rupture, or any other failure to contain the liquid cryogen will not result in direct contact of the liquid cryogen with load bearing structure or critical airplane equipment that is essential for the continued safe flight and landing of the airplane. Because of the extremely low temperature of the liquid cryogen, direct contact may adversely affect the material properties and integrity of load bearing structure. Direct contact of liquid cryogen with critical airplane equipment may cause failure of the equipment to perform its intended function.

5. An analysis must be accomplished to substantiate that the airplane will not be overpressurized in the event of a catastrophic failure of all the dewars containing cryogenic fluid.

6. The location of the cryogenic equipment and plumbing installations must minimize the risk of damage due to an uncontained rotor or fan blade failure. All equipment containing high-

energy rotors must be considered, such as turbine engines, auxiliary power units, ram air turbines, electric/pneumatic engine starters, air cycle machines, and certain cooling fans. In addition to properly locating the cryogenic system, operational procedures and shields may be used to minimize the risk of damage. New equipment containing high-energy rotors whose uncontained failure could damage the cryogenic system must comply with § 25.1461, Amendment 25-41.

7. The cryogenic system must be designed to minimize condensation of the atmospheric air, which could result in a liquid enriched with oxygen due to nitrogen having a lower boiling point than oxygen. Any condensation from system components or lines must be collected by drip pans, shields, or other suitable collection means and drained overboard through a drain fitting separate from the pressure relief vent fittings, if equipped for compliance with Special Condition No. 3. The condensation must be isolated from combustible materials including grease, oil, and ignition sources.

8. Instructions for continued airworthiness (ICA) must require periodic inspection of cryogenic components. The ICA must also include periodic inspection of plumbing insulation to ensure integrity.

9. Shutoff valves must be installed where multiple cryogenic pressurized storage vessels are connected together by manifolds so that a leak in one pressurized storage vessel can be isolated and will not allow leakage of the cryogenic fluids from any other pressurized storage vessel.

10. Cryogenic components must be burst pressure tested to 3.0 times, and proof pressure tested to 1.5 times the maximum normal operating pressure. Tests must account for the worst-case combination of temperature and material strength properties that the components are exposed to in service.

11. The plumbing installation must be designed to account for thermal expansion and thermally induced stresses.

12. The cryogenic system must be protected from unsafe temperatures and located where the probability of hazards of rupture in a crash landing are minimized.

13. The proof of strength of airframe load bearing structure in the vicinity of cryogenic equipment and plumbing must account for temperature extremes, and the effect on the strength of materials, resulting from carriage of cryogenic fluids.

Issued in Renton, Washington, on May 26, 2005.

**Ali Bahrami,**

*Manager, Transport Airplane Directorate,  
Aircraft Certification Service.*

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## DEPARTMENT OF TRANSPORTATION

### Federal Aviation Administration

#### 14 CFR Part 25

[Docket No. NM308, Special Conditions No. 25-289-SC]

#### Special Conditions: Gulfstream Model LP 1125 Westwind Astra Airplane; High Intensity Radiated Fields (HIRF)

**AGENCY:** Federal Aviation Administration (FAA), DOT.

**ACTION:** Final special conditions; request for comments.

**SUMMARY:** These special conditions are issued for the Gulfstream Model LP 1125 Westwind Astra airplane modified by Duncan Aviation, Inc. This airplane will have novel and unusual design features when compared to the state of technology envisioned in the airworthiness standards for transport category airplanes. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for the protection of these systems from the effects of high-intensity radiated fields (HIRF). These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that provided by the existing airworthiness standards.

**DATES:** The effective date of these special conditions is May 19, 2005.

Comments must be received on or before July 8, 2005.

**ADDRESSES:** Comments on these special conditions may be mailed in duplicate to: Federal Aviation Administration, Transport Airplane Directorate, Attn: Rules Docket (ANM-113), Docket No. NM308, 1601 Lind Avenue SW., Renton, Washington, 98055-4056; or delivered in duplicate to the Transport Airplane Directorate at the above address. All comments must be marked: Docket No. NM308.

**FOR FURTHER INFORMATION CONTACT:** Joe Jacobsen, FAA, Standardization Branch, ANM-113, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Avenue SW., Renton, Washington, 98055-4056; telephone (425) 227-2011; facsimile (425) 227-1320.

**SUPPLEMENTARY INFORMATION:**

#### Comments Invited

The FAA has determined that notice and opportunity for prior public comment is impracticable because these procedures would significantly delay certification of and delivery of the affected airplanes. In addition, the substance of these special conditions has been subject to the public comment process in several prior instances with no substantive comments received. The FAA therefore finds that good cause exists for making these special conditions effective upon issuance. However, the FAA invites interested persons to participate in this rulemaking by submitting written comments, data, or views. The most helpful comments reference a specific portion of the special conditions, explain the reason for any recommended change, and include supporting data. We ask that you send us two copies of written comments.

We will file in the docket all comments we receive, as well as a report summarizing each substantive public contact with FAA personnel concerning these special conditions. The docket is available for public inspection before and after the comment closing date. If you wish to review the docket in person, go to the address in the **ADDRESSES** section of this preamble between 7:30 a.m., and 4 p.m., Monday through Friday, except Federal holidays.

We will consider all comments we receive on or before the closing date for comments. We will consider comments filed late if it is possible to do so without incurring expense or delay. We may change these special conditions based on the comments we receive.

If you want the FAA to acknowledge receipt of your comments on these special conditions, include with your comments a pre-addressed, stamped postcard on which the docket number appears. We will stamp the date on the postcard and mail it back to you.

#### Background

On February 16, 2005, Duncan Aviation, Inc., Lincoln, Nebraska, applied to the Wichita Aircraft Certification Office, for a supplemental type certificate (STC) to modify certain Gulfstream Model LP 1125 Westwind Astra airplanes to include the installation of integrated display systems (electronic displays and electronic engine controls). These integrated display systems installed in this airplane have the potential to be vulnerable to HIRF external to the airplane. The subject Gulfstream Model LP 1125 Westwind Astra airplane is a small business jet powered by two

Honeywell (formerly Allied Signal and Garrett) TFE 731-3A-200G or TFE 731-3C-200G engines. This airplane operates with a 2-person crew and holds nine passengers.

#### Type Certification Basis

Under the provisions of 14 CFR 21.101, Duncan Aviation, Inc. must show that the Gulfstream Model LP 1125 Westwind Astra airplane, as changed, continues to meet the applicable provisions of the regulations incorporated by reference in Type Certificate No. A16NM, or the applicable regulations in effect on the date of application for the change. The regulations incorporated by reference in the type certificate are commonly referred to as the "original type certification basis."

The certification basis for the modified Gulfstream Model LP Westwind Astra airplane includes 14 CFR part 25 effective February 1, 1965, as amended by Amendments 25-1 through 25-54. In addition, the certification basis includes certain special conditions, exemptions, and equivalent levels of safety that are not relevant to these special conditions.

If the Administrator finds that the applicable airworthiness regulations (part 25, as amended) do not contain adequate or appropriate safety standards for the Gulfstream Model LP 1125 Westwind Astra airplane, modified by Duncan Aviation, Inc., because of a novel or unusual design feature, special conditions are prescribed under the provisions of 14 CFR 21.16. In addition to the applicable airworthiness regulations and special conditions, the Gulfstream Model LP 1125 Westwind Astra airplane must comply with the fuel vent and exhaust emission requirements of 14 CFR part 34 and the noise certification requirements of 14 CFR part 36.

Special conditions, as defined in 14 CFR 11.19, are issued in accordance with § 11.38, and become part of the airplane's type certification basis in accordance with § 21.101.

Special conditions are initially applicable to the model for which they are issued. Should Duncan Aviation, Inc. apply at a later date for an STC to modify any other model included on the same type certificate to incorporate the same or similar novel or unusual design feature, these special conditions would also apply to the other model under the provisions of § 21.101.

#### Novel or Unusual Design Features

The modified Gulfstream LP 1125 Westwind Astra airplane will incorporate integrated display systems