Mechanical Design of Principal Investigator Rack Drawer (PIRD) for SOFIA


SOFIA (Stratospheric Observatory For Infrared Astronomy), the world's largest airborne observatory with 2.5-meter diameter infrared telescope is equipped with 7 Science Instruments (Si): EXES, FIFI-LS, FLITECAM, FORCAST, GREAT, HAWC, and HIPO. Flying at altitudes between 39,000 and 45,000 feet, SOFIA, a 747-SP (Special Performance) aircraft, avoids 99% of the atmospheric water vapor and is able to observe the occultation of stars by solar system objects. By determining the size, compositions, and atmospheric structures of these objects, SOFIA can help answer the questions on creation and evolution of the universe, formation of the stars and planets, and nature of black hole at the center of Milky Way galaxy.

PIRD

Principal Investigator (PI) rack installed on SOFIA houses various electronic and utility equipment required to control or monitor the StIs. A total of 3 PI racks can be installed on SOFIA. USRA/ NASA requires a mechanical design for a PI Rack Drawer (PIRD) that can be used for storing laptop, books, or tools. Mechanical design deliverables include: conceptual design, 3D assembly model, stress analysis calculations, engineering drawings, ICD (Interface Control Documentation) compliance documentation and associated vendor documents/drawings. These documents are necessary to meet approval requirements from USRA, NASA, and FAA (Federal Aviation Administration) / AFSRB (Airworthiness & Flight Safety Review Board) before PIRD is fabricated, tested, and installed on SOFIA.

Airworthiness Design

Airworthiness criteria provides a potential safety of the aircraft during emergency situation. Typically, FAA has to confer the certificate of airworthiness for the design and construction of any aircraft part or assembly to be put into operation in flight. At NASA, AFSRB performs similar roles & responsibilities as FAA does for commercial airlines. The design of PIRD must comply with FAA AFSRB airworthiness requirements. In order to comply with FAA/ AFSRB/ NASA requires the design of PIRD to meet the load requirement of 9g in forward; 6g in downward; and 3.5g in lateral directions, where g is the acceleration due to gravity. The specified design load for PIRD is 50 lbs. That implies PIRD shall be designed for loads: 9 x 50 = 450 lbs.; 6 x 50 = 300 lbs. and 3.5 x 50 = 175 lbs.

An example of usefulness of airworthiness is the survival of almost everyone during a recent deadly crash of Boeing 777 aircraft of Asiana International Airport. Many lives were saved partly due to 9g interior design, and 16g seat design criteria used in the construction of this aircraft.

Conceptual Design & 3D Models

3D model of the conceptual design of the PIRD is created and developed using Creo-Parametric 3D Modeling computer application tool by PTC. This application also helps to perform the stress analysis. However, the stress analysis is mostly done manually to ensure the accuracy of the calculations and to compare with the computer application results.

Material for PIRD Assembly

PIRD is made of CS (Carbon Steel) while its assembly parts such as Latch, C-brackets, L-brackets, and Front plate are designed with Aluminum (AL) 6061. AL has a density of 0.098 lbs./ inch³ and CS has a density of 0.284 lbs./ inch³. Thus, AL weighs about 2.9 times lighter than CS. Thus, it minimizes the load on the PI Rack. In terms of tensile strength, AL (tensile strength = 42,000 lbs./ inch²) provides about 76% of tensile strength of CS (55,000 lbs./ inch²). Thus, AL becomes more suitable in terms of weight and tensile strength combination for the critical load and bending moment design of PIRD. In order to achieve maximum tensile strength at joints, Stainless Steel (SS 18-8, SS 304/ 316) is used for fasteners & pins.

Design Modifications

Vendor supplied Drawer is analyzed and modified for its ability to sustain the 9g loads. Corners of the Drawer are reinforced with newly designed L-brackets. Front plate is redesigned and reinforced with fasteners to take 9g load and support the Latch assembly.

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References:

www.nasa.gov