13 Systems Stress Analysis

The purpose of this section is to provide guidance on the analysis of hydraulic, fuel and environmental control (ECS) systems. Additionally this section will address analysis of avionics and other 'black box' installations along with support of electrical wiring and external stores. These are topics which have received limited attention in the current stress analysis references. In many cases the criteria used for the analysis, e.g. acceleration levels to be used in design, system pressures, or stiffness requirements will come from program specific or customer generated guidance.

Currently this Section refers the analyst to the appropriate sections of the Lockheed Martin Stress Memo manual (SM113 and SM125), Reference 13.1-1, or the General Dynamics Structural Analysis Manual (Section 9.3), Reference 13.1-2, for guidance.

13.1 References

13.1-1. anon., *Lockheed Martin Engineering Stress Memo Manual*, Lockheed Martin Aeronautical Systems, Marietta, GA (October 1998 Release; April 2002 Revision)

13.1-2. anon., *Structures Analysis Manual, Volume 1 and Volume 2*, General Dynamics Convair and Space Structures Divisions (1988).

13.1-3. Staff, *LTV Structures Manual*, LTV Aircraft Products Group, Grand Prairie, TX (June 1989 Revision)

13.1-4. anon., "Metallic Materials And Elements For Aerospace Vehicle Structures," *MIL-HDBK-5*[1], Battelle Memorial Inst., Secretariat (2001).

13.2 Fuel, ECS, and Hydraulic Systems

Refer to program specific or customer generated guidance for system operating, proof and burst pressures. For analysis techniques of tubing and piping, refer to the GD Structural Analysis Manual, Section 9.3, Reference 13.1-2. When analyzing brackets for support of systems, in addition to any other criteria, man loading should be considered. During the construction of the aircraft and, possibly during maintenance, brackets can make nice handholds or steps. This is generally a static loading criteria which is compared to the yield strength of the bracket material. In the absence of specific program guidance the following may be used. For brackets over 4 inches wide a 300 lb step load, if appropriate, or 150 lb load in any single direction are used. For smaller brackets, a 50 lb load in any single direction is appropriate. Note that these guidelines do require some engineering judgement in their application to minimize weight impacts. If a bracket or clip requires substantial thickness to meet this loading capability, it is likely that an alternative design might be a better solution, for instance a hat section rather than a cantilevered angle.

For high pressure and high temperature air systems, refer to LM Stress Memo Manual, SM113, Reference 13.1-1.

13.3 Weapon Systems/External Stores

This section reserved for future use.

[1] In 2003, MIL-HDBK-5 was superseded by the Metallic Materials Properties Development and Standardization (MMPDS) Handbook, Battelle Memorial Institute, Secreteriat (2003).

13.4 Wiring Attachment

When designing bracketry for support of systems, in addition to any other criteria, man loading should be considered. During the construction of the aircraft and, possibly during maintenance, brackets can make nice handholds or steps. This is generally a static loading criteria which is compared to the yield strength of the bracket material. In the absence of specific program guidance the following may be used. For brackets over 4 inches wide a 300 lb step load, if appropriate, or 150 lb load in any single direction are used. For smaller brackets, a 50 lb load in any single direction is appropriate.

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13.5 Avionics and "Black Box" Installations

Refer to program specific or customer generated guidance for inertia loading and crash load levels. These installations, in addition to static and fatigue considerations often have maximum deflection under load criteria, may require shock mounting or impose high cycle fatigue stress on attachment points and back up structure.

If shock mounted, an important consideration is providing sufficient sway space, so that under the maximum load condition there is no possibility that the unit will impact adjacent structure and systems.