Mechanics/Machinery

Force Limit System

This system protects the operator, specimen, system, and fixtures from overload damage.

John H. Glenn Research Center, Cleveland, Ohio

The Force Limit System (FLS) was developed to protect test specimens from inadvertent overload. The load limit value is fully adjustable by the operator and works independently of the test system control as a mechanical (non-electrical) device.

When a test specimen is loaded via an electromechanical or hydraulic test system, a chance of an overload condition exists. An overload applied to a specimen could result in irreparable damage to the specimen and/or fixturing. The FLS restricts the maximum load that an actuator can apply to a test specimen. When testing limited-run test articles or using very expensive fixtures, the use of such a device is highly recommended. Test setups typically use electronic peak protection, which can be the source of overload due to malfunctioning components or the inability to react quickly enough to load spikes. The FLS works independently of the electronic overload protection.

In a standard test system, an actuator moves in a uniaxial direction to apply load to a fixed-position specimen in a very controlled fashion. The actuator, usually capable of very high loads, is normally driven by an electromechanical motor or hydraulic power supply. Sophisticated electronic/software packages command the movement of the actuator based on transducer input and operator requirements. This is all independent of the FLS.

The Force Limit Cylinder is preset to a calibrated amount that equals the safety factor or protection value desired by the operator. The maximum force is determined by a precision dynamic mechanical control that has a very high relief rate. The load values and relief rates are dictated by test requirements. The Force Limit Cylinder is attached to the actuator on one end, and test specimen contact on the other end (usually the cylinder push rod). Standard fixture alignment procedures should be used prior to specimen loading.

Before applying load to the specimen, the Force Limit Cylinder should be preset to the desired value to equal the desired load limit. Once this is completed, the Force Limit Cylinder push rod will not permit the actuator to exceed the preset load to the specimen. If the actuator increases load to the point of the FLS set point, the Force Limit Cylinder push rod will retract as the mechanical control relieves force. If the actuator continues to move downward, the Force Limit Cylinder will allow this until the actuator contacts its internal mechanical stops.

The unique features of this device are that it has an independent, fully adjustable load limit using mechanical design, and it has the ability to change test frame control channels with minimal risk by applying load while in position control. For simplicity, the FLS uses readily available parts.

The FLS can also be used in a test system that has no provision for control mode switching to an advantage. When a test system is switched between position control and load control, there is an increased risk of overload during this operation. The FLS can be used to apply a very low load to a specimen while controlled in position. This allows a safe control mode switch and avoids an open-loop situation.

This work was done by Ralph Pawlik, David Krause, and Frank Bremenour of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18678-1.

Levitated Duct Fan (LDF) Aircraft Auxiliary Generator

This all-electric design eliminates mechanical bearings and enables more efficient aircraft electrical systems.

John H. Glenn Research Center, Cleveland, Ohio

This generator concept includes a novel stator and rotor architecture made from composite material with blades attached to the outer rotating shell of a ducted fan drum rotor, a non-contact support system between the stator and rotor using magnetic fields to provide levitation, and an integrated electromagnetic generation system. The magnetic suspension between the rotor and the stator suspends and supports the rotor within the stator housing using permanent magnets attached to the outer circumference of the drum rotor and passive levitation coils in the stator shell. The magnets are arranged in a Halbach array configuration.

The electromagnetic generation system also uses permanent magnets attached to the outer circumference of the drum rotor with coils placed in the stator shell. The generation system uses the same magnets as the levitation system, but incorporates generator coils in the stator that are interwoven with passive levitation coils. The levitation system is inherently stable, is failsafe, and does not require active control as required by traditional magnetic bearings. Also, the overall efficiency of the suspension system improves with speed, whereas the performance of conventional bearings degrades as speed increases.

This innovation will greatly advance aircraft electrical power systems with the development of an efficient, reliable, maintenance-free, and safe electrical generation system. The use of magnetic suspension minimizes concerns associated with traditional bearings, such as active lubrication, contact wear, and limited rotational speed. The ducted hardware can translate into improved efficiency and reliability. The concept lends itself to a configuration in which the units can be used individually or clustered for distributed power applications. In addition, the concept can be readily scaled into a variety of sizes for specified power delivery with similar geometric configuration. The rotor operates in compression, which results in a 2× improvement in fatigue life, and the extensive use of composites minimizes weight and reduces noise due to the higher dampening properties of composites.

A prototype stator and assembly and rotor have been designed and developed to study and evaluate subsystem level characteristics of the generation and levitation systems in a laboratory environment, and to verify theoretical predictions. The test setup has been used to measure successfully the flux density emanating from the rotor, the induced current in the stator winding as the rotor is driven at various speeds, the associated induced current, and the generated repulsive force. Experimental results correlate well with performance characteristics predicted using the derived theoretical equations. The goal of the final design is a self-contained suspension and electrical generation system free from mechanical couplings. The use of magnetic suspension minimizes concerns associated with traditional bearings, such as active lubrication and limited rotational speeds.

This work was done by Dennis J. Eichenberg, Dawn C. Emerson, Christopher A. Gallo, and William K. Thompson of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18658-1.

Compact, Two-Sided Structural Cold Plate Configuration

Lyndon B. Johnson Space Center, Houston, Texas

In two-sided structural cold plates, typically there is a structural member, such as a honeycomb panel, that provides the structural strength for the cold plates that cool equipment. The cold plates are located on either side of the structural member and thus need to have the cooling fluid supplied to them. One method of accomplishing this is to route the inlet and outlet tubing to both sides of the structural member. Another method might be to supply the inlet to one side and the outlet to the other. With the latter method, an external feature such as a hose, tube, or manifold must be incorporated to pass the fluid from one side of the structural member to the other. Although this is a more compact design than the first option, since it eliminates the need for a dedicated supply and return line to each side of the structural member, it still poses problems, as these external features can be easily damaged and are now new areas for potential fluid leakage.

This invention eliminates the need for an external feature and instead incorporates the feature internally to the structural member. This is accomplished by utilizing a threaded insert that not only connects the cold plate to the structural member, but also allows the cooling fluid to flow through it into the structural member, and then to the cold plate on the opposite side. The insert also employs a cap that acts as a cover to seal the open area needed to install the insert. There are multiple options for location of o-ring style seals, as well as the option to use adhesive for redundant sealing. Another option is to weld the cap to the cold plate after its installation, thus making it an integral part of the structural member. This new configuration allows the fluid to pass from one cold plate to the other without any exposed external features.

This work was done by Mark Zaffetti of Hamilton Sundstrand for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809.

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act {42 U.S.C. 2457(f)} to Hamilton Sundstrand. Inquiries concerning licenses for its commercial development should be addressed to:

Hamilton Sundstrand
Space Systems International,Inc.
One Hamilton Road
Windsor Locks, CT 06096-1010
Phone No.: (860) 654-6000

Refer to MSC-24880-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

AN Fitting Reconditioning Tool

John F. Kennedy Space Center, Florida

A tool was developed to repair or replace AN fittings on the shuttle external tank (ET). (The AN thread is a type of fitting used to connect flexible hoses and rigid metal tubing that carry fluid. It is a U.S. military-derived specification agreed upon by the Army and Navy, hence AN.) The tool is used on a drill and is guided by a pilot shaft that follows the inside bore. The cutting edge of the tool is a standard-size replaceable insert. In the typical Post Launch Maintenance/Repair process for the AN fittings, the six fittings are removed from the ET's GUCP (ground umbilical carrier plate) for reconditioning. The fittings are inspected for damage to the sealing surface per stan-