



## 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. So-

phisticated 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.**

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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 be-

tween 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 at-

tached 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 bear-