the temperature and measured rate of increase of pressure.

An unusual feature of this system is a heating/cooling subsystem that includes a tube embedded in the flexible adhesive seal. A heating or cooling liquid can be circulated through this tube to maintain the seal at or near room temperature, where it is most effective, regardless of the temperature of the test object or the environment. The heating/cooling subsystem is essential, for example, for maintaining an effective seal for testing a tank, pipe, valve, or other object that contains liquid hydrogen or other cryogenic fluid. The heated/cooled seal enables testing at temperatures from –455 to +350 °F (about –271 to +177 °C), even in the presence of distortions caused by mechanical and thermal loads applied to the test object.

This work was done by H. Kevin Rivers and Joseph G Sikora of Langley Research Center and Sankara N. Sankaran of Lockheed Martin Space Operations. Further information is contained in a TSP (see page 1). LAR-16139

Free-to-Roll Testing of Airplane Models in Wind Tunnels

Causes of, and cures for, wing-drop/rock behavior can be evaluated.

Langley Research Center, Hampton, Virginia

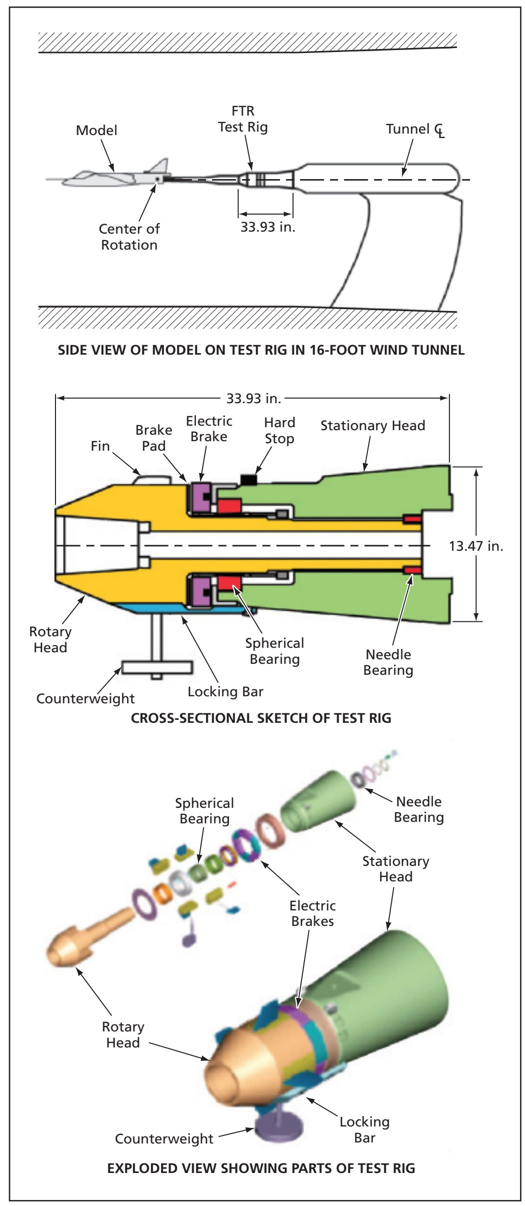
A free-to-roll (FTR) test technique and test rig make it possible to evaluate both the transonic performance and the wing-drop/rock behavior of a high-strength airplane model in a single wind-tunnel entry. The free-to-roll test technique is a single degree-of-motion method in which the model is free to roll about the longitudinal axis. The rolling motion is observed, recorded, and analyzed to gain insight into wing-drop/rock behavior.

Wing-drop/rock is one of several phenomena symptomatic of abrupt wing stall. FTR testing was developed as part of the NASA/Navy Abrupt Wing Stall Program, which was established for the purposes of understanding and preventing significant unexpected and uncommanded (thus, highly undesirable) lateral-directional motions associated with wing-drop/rock, which have been observed mostly in fighter airplanes under high-subsonic and transonic maneuvering conditions. Before FTR testing became available, wing-rock/drop behavior of high-performance airplanes undergoing development was not recognized until flight testing. FTR testing is a reliable means of detecting, and evaluating design modifications for reducing or preventing, very complex abrupt wing stall phenomena in a ground facility prior to flight testing.

The FTR test rig was designed to replace an older sting attachment butt, such that a model with its force balance and support sting could freely rotate about the longitudinal axis. The rig (see figure) includes a rotary head supported in a stationary head with a forward spherical roller bearing and an aft needle bearing. Rotation is amplified by a set of gears and measured by a shaft-angle resolver; the roll angle can be resolved to within 0.067° at a rotational speed up to 1,000°/s. An assembly of electrically actuated brakes between the rotary and stationary heads can be used to hold the model against a rolling torque at a commanded roll angle. When static testing is required, a locking bar is used to fix the rotating head rigidly to the stationary head. Switching between the static and FTR test modes takes only about 30 minutes. The FTR test rig was originally mounted in a 16-ft (≈4.0-m) transonic wind tunnel, but could just as well be adapted to use in any large wind tunnel.

In one series of tests on the FTR rig, static and dynamic characteristics of models of four different fighter airplanes were measured. Two of the models exhibited uncommanded lateral motions; the other two did not. A figure of merit was developed to discern the severity of lateral motions. Using this figure of merit, it was shown that the FTR test technique enabled identification of conditions under which the uncommanded lateral motions occurred. The wind-tunnel conditions thus identified were found to be correlated with flight conditions under which the corresponding full-size airplanes exhibited uncommanded lateral motions.

This work was done by Francis J. Capone, D. Bruce Owens, and Robert M. Hall of Langley Research Center. Further information is contained in a TSP (see page 1). LAR-17153-1



The **FTR Test Rig** allows free rotation of the airplane model around the centerline. Optionally, brakes can hold the model at a commanded roll angle, or the rig can be locked against rotation for conventional static testing.