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GROUND TEST PROGRAM FOR NEW ATLAS PAYLOAD FAIRINGS

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Introduction

An extensive ground test program is currently being undertaken by General Dynamics/Space Systems Division to verify the design of the metal payload fairings for the new family of Atlas launch vehicles, the first of which will be launched this summer. Two new designs, an 11-foot and a 14-foot diameter version of the payload fairings (see Figure 1), are now available to mission planners seeking to accommodate the widest variety of mission requirements. While the 14-foot diameter version was developed for the commercial Atlas I program, and the 11-foot diameter fairing was developed for the U.S. Air Force Atlas II vehicle, once both production lines are at full capacity, the selection of a fairing will be dictated by the size of the satellite payload. These new fairing designs replace the 10-foot diameter, honeycomb fiberglass payload fairings which were flown on previous Atlas/ Centaur launch vehicles. The new metal fairings feature a larger payload envelope, greater ease of manufacturing and modification, have more consistent quality control properties, provide better EMI shielding for the satellite payload, and do so at costs and weights comparable to the old fiberglass fairing.

Both the 11-foot and 14-foot diameter designs are of aluminum skin, frame, and stringer construction and are built at the General Dynamics Services Company plant in Harlingen, Texas. The main structural purposes of the payload fairing are to protect the satellite payload during the ascent phase and to provide an aerodynamic forward surface for the launch vehicle. After the vehicle has cleared the atmosphere, the payload fairing is no longer required, and it is jettisoned both to save weight and to allow for the separation of the Centaur upper stage and the spacecraft. Both the 11-foot and 14-foot designs use a method of separation similar to that originally used for the 10-foot fiberglass fairing. At the moment of jettison, which occurs about 3 1/2 minutes after

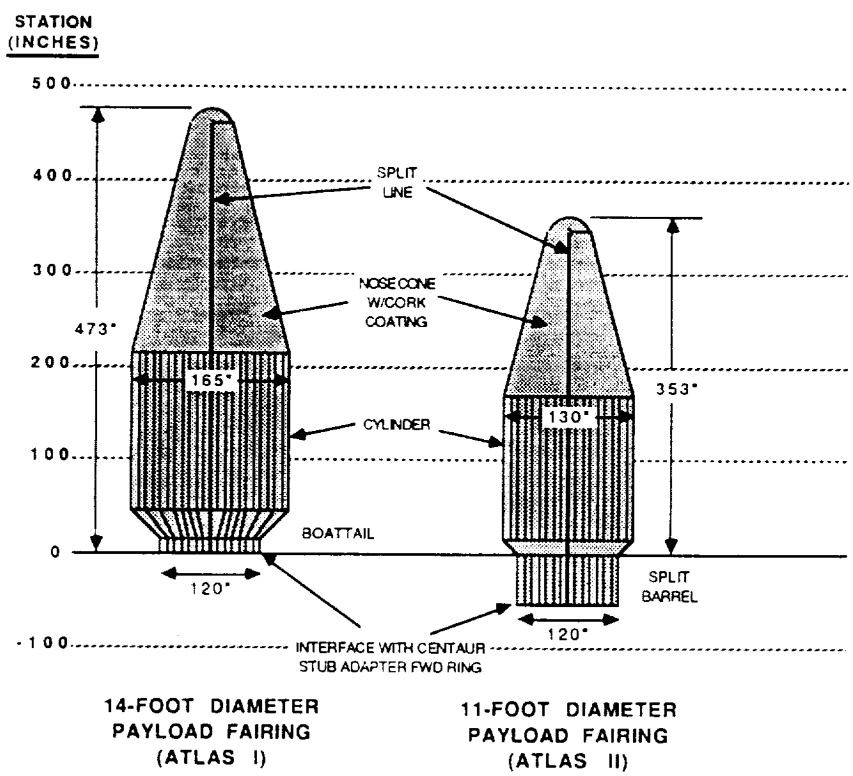

Figure 1. Atlas 11-Foot and 14-Foot Diameter Payload Fairings.

liftoff, explosive bolts fire which allow the two 180-degree halves of the fairing to begin separation. Spring loaded actuators at the top of the cone section push the halves apart, while the aft end of each fairing half begins to rotate on hinges located on the stub adapter. After the fairing halves have rotated about 70 degrees, the hinges allow the fairing to safely and completely separate from the vehicle. Both fairing halves fall back to Earth, where they land in the Atlantic Ocean. No attempt is planned to recover these items.

Five separate ground tests, one of which has already been completed, were planned to gather the necessary data to qualify these new designs for flight. All tests planned will be performed on full-scale payload fairing structures (either dedicated test articles or flight articles). Three tests have been planned for the 14-foot diameter payload fairing and two tests have been planned for the 11-foot diameter payload fairing. All tests of the 14-foot diameter payload fairing must be complete by the planned June 1990 launch for the Combined Release and Radiation Effects Satellite (CRRES) and all tests of the 11-foot diameter payload fairing must be complete in time to support stress and dynamics analyses which must be performed prior to the January 1991 Initial Launch Capability (ILC) date for the Atlas II system.

I. 14-Foot Diameter Payload Fairing Jettison Test

Description: Of the three ground tests planned for the 14-foot diameter version of the new payload fairings, the jettison test is the only one which has been completed as of this writing. This test was successfully performed in December 1989 - January 1990 at the Space Power Facility (SPF) operated by NASA/Lewis Research Center at the Plum Brook Station near Sandusky, Ohio. This site was chosen because it is the largest vacuum chamber in the world, and is the only one in which a full jettison of at least one full payload fairing half could be accomplished. The interior of the chamber consisted of a metal-walled pressure vessel with a 100-foot diameter circular floor and a 120-foot high, domed ceiling. This was surrounded by a thick concrete-walled containment building with a profile which betrays the original intent of the building: to house nuclear powered satellites during test and checkout. Because the facility had not been used since a 1974 Skylab test, a substantial effort was required to reactivate the chamber. Now that the chamber has been proved to be operational, several other jettison tests of payload fairings, including one of the giant Titan IV fairing, have been planned for the NASA Plum Brook SPF.

The test article for the jettison test was a dedicated test fairing which was manufactured to the same engineering prints and quality standards as a regular flight fairing. This article was the first payload fairing completed at the General Dynamics Services Company, Harlingen, Texas assembly plant. From its interface with the Centaur upper stage's stub adapter to the tip of its nose, the new fairing stands 39 1/2 feet high. In the SPF, atop its base fixture and stub adapter, the test article measured in with an impressive height of 52 1/2 feet. Before each completed payload fairing is shipped from its assembly plant, an acceptance test, consisting of a stackmate and a "rotation" test, is conducted to verify that manufacturing tolerances were maintained throughout the entire structure. The rotation test consists of splitting the fairing halves (by a total of no more than one foot at the top of the cone) using a manually activated screwjack in place of the spring loaded actuators. As the fairing halves are gradually rotated on the jettison hinges, clearances at various locations along the splitline longerons are recorded to verify all shear pins are disengaging smoothly.

The jettison test was a simulation of the event described above, wherein the two halves of the payload fairing separate after the launch vehicle clears the Earth's atmosphere. The test program consisted of performing two separate payload fairing jettison events at a simulated altitude of 85,000 feet (chamber pressure = 17 torr). After the inner metal door and the outer concrete chamber doors were closed, an approximately five hour pumpdown was performed, and after a short countdown a switch was flipped, immediately supplying power to the explosive bolts, initiating the jettison event. For each event, one half of the fairing (capped half) was fully jettisoned, while the other half rotated only fifteen degrees before impacting the catch net (see Figure 2). Both halves were slowed from initial net impact to a full stop by hydraulically actuated brakes which were an integral part of the catch net system. The force used to initiate the jettison event was varied by using only one spring-loaded jettison actuator for the first event, and the full complement of two actuators for the second jettison event. This provided analysts with two data points against which to compare the analytically predicted behavior of the test fairing. After the first jettison event was completed, only a few days were required to reconfigure the fairing assembly for the second event.

Purpose: The primary purpose of the jettison test was to demonstrate that the analytical NASTRAN computer model being used by structural dynamicists and stress analysts to predict fairing behavior during vehicle flight environments is able to accurately predict the behavior of the payload fairing under the jettison test conditions. Pre-test predictions of all test data (pyro shocks, rigid-body motion, fairing half-breathing modes) were made using the analytical computer model. Comparison of test data with these analytical predictions will indicate if any corrections are necessary to the model. Another purpose was to simply demonstrate that the fairing jettison hardware (actuators, hinges, explosive bolts, shear pins, harness disconnects, etc.) functioned properly together. An important element of proper jettison functioning is the mechanical clearance between the fairing hardware as it rotates on the hinges and other critical items on the Centaur upper stage and the satellite payload. Because the fairing half "breathing" or "pinching" mode effectively reduces the static clearance, the intent was to design a fairing which was as stiff as possible. The items which represented potential rotation interferences were simulated during this test, and dynamic clearances were checked to allow comparison with pre-test predictions. In addition to exercising generic payload fairing hardware, the jettison test article subsets of two mylar installations which have been designed for mission-peculiar applications, a thin thermal shield which covers the interior of the cone and cylinder regions, and the pillow-like acoustic blankets for interior noise reduction, were installed inside the fairing test article to verify that the

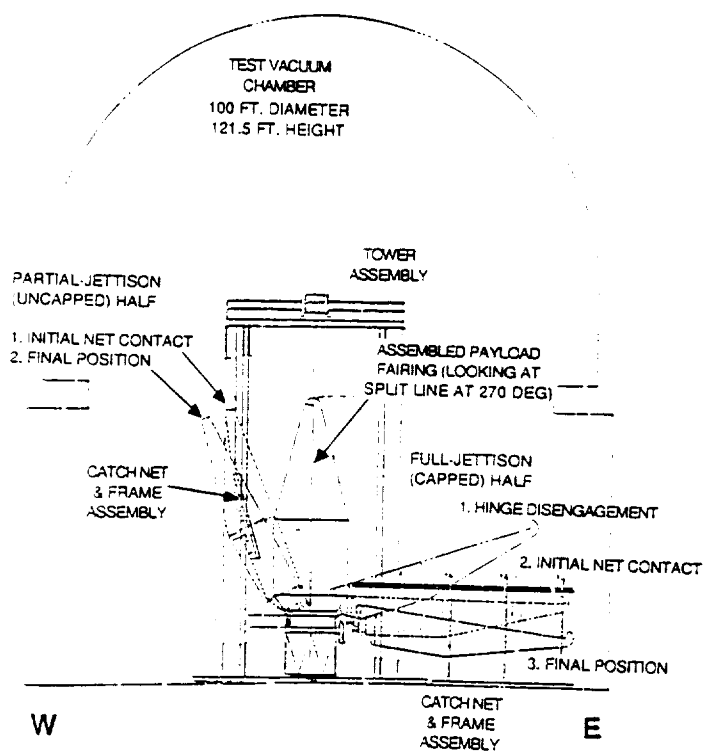

Figure 2. Payload Fairing Jettison Test Catch Net System.

bending associated with the jettison event would not damage either the mylar components or their fastening hardware. It was felt that this verification was necessary to eliminate the possibility that loose mylar could damage the encapsulated spacecraft during the jettison event.

Data Acquisitions: Test instrumentation for the jettison test included 31 channels of low-frequency accelerometer data, intended to measure the lowest vibration modes of the fairing halves and larger scale, rigid-body motions, 21 channels of high-frequency accelerometer data, which measured the shock environment (generated by the 28 explosive bolts) at various sensitive locations on the vehicle structure, and 44 channels of strain gage data, which measured the structural loads in the jettison hinges on which the fairing halves rotate. An analog FM-based data acquistion system was used to record all test data. Events were recorded by fourteen high-speed motion picture cameras and three video cameras. The video cameras were installed mainly to present to the test conductor a real-time image of what was occurring inside the chamber, realizing that there are no windows through which to look. Exactly half of the fourteen high-speed film cameras were focused on clearly visible targets mounted on fairing hardware. This film was later run through a film motion analyzer to produce deflection, velocity, and acceleration data. Clearance indicators, made of thin solder wire, were used to detect any infringement of the payload fairing structure during its jettison rotation into sensitive areas surrounding avionics packages or into the satellite payload envelope.

II. 14-Foot Diameter Payload Fairing Structural Test

Description: This test is currently under way at the Sycamore Canyon test site operated by General Dynamics just north of San Diego, California. During this structural test, the fairing will undergo a series of static test conditions which will determine if the fairing structure will yield at predicted design limit loads (based on loads experienced during the transonic condition) or will fail at design ultimate loads (125% of design limit loads). Because the test article is to be exposed to ultimate structural loads, the dedicated test fairing which was used for the jettison test described above, and which will never fly on an Atlas vehicle, will be used for this test. Four different test configurations (see Figure 3) will be used in order to completely test all of the major structural elements of the payload fairing: upper and lower nose cone (crush pressure and side load), nose dome (crush pressure only), cylinder and boattail (burst pressure and vent fin loads), and the all-up system level configuration (bending moments, shear loads, and axial loads). The last two configurations will be performed in a new test tower constructed last year specifically for the purpose of performing payload fairing testing. Included as part of the all-up system level testing will be test conditions which will reveal stiffness data on the payload fairing structure. It is planned that 27 separate test conditions will be required to fully accomplish the objectives of this test. The following paragraphs describe the major test configurations and the purpose for each of these:

Nose Cone Test Conditions: For the nose cone tests (see Figure 3a), the cone section (21 feet high) will be removed from the fairing cylindrical section and mounted on an airtight base fixture. A negative pressure differential will be established across the nose cone skin which will simulate worst-case crush pressures experienced by this structure during the ascent phase of flight. While the fairing structure is vented at the bottom of the cylinder section, pressure differentials are still experienced during flight at different fairing stations due to the varying aerodynamic pressure profiles. Pressures in the cone region during vehicle ascent are of the crush variety due to the aerodynamic nature and purpose of this structure. A shear load will also be introduced at the top of the cone during these test conditions in order to observe and characterize post-buckling behavior and load carrying capability of the monocoque (no external stringers) cone structure. It should be mentioned that buckling of the structure is expected at high loading conditions and is not to be considered a failure of the structure. There will be a total of four test conditions devoted to nose cone testing.

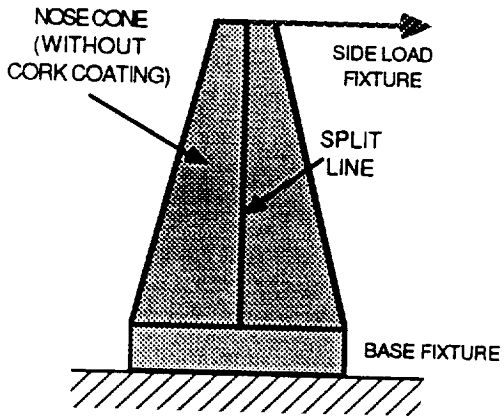

Figure 3a.
Nose Cone Crush Tests.

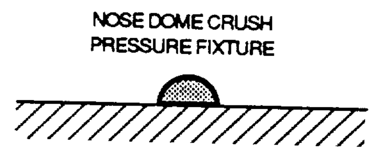

Figure 3b.
Nose Dome Crush Tests.

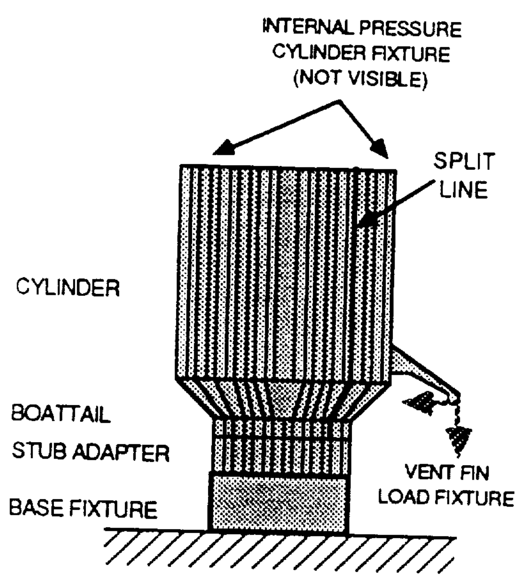

Figure 3c.
Cylinder Burst Tests.

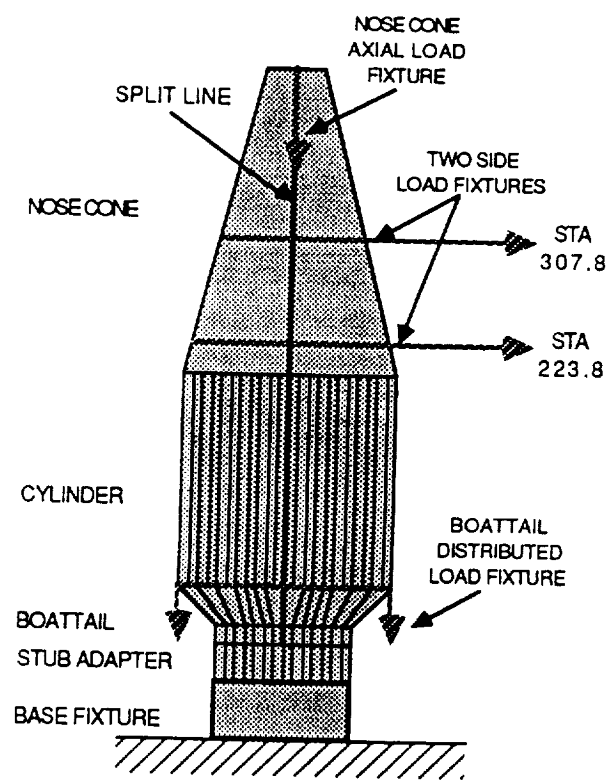

Figure 3d.
All-Up System Tests.

Figure 3. Payload Fairing Structural Test Configurations.

Nose Dome Test Conditions: The nose dome crush pressure test conditions are fairly straightforward, involving only the creation of a negative pressure differential across the nose dome structure, simulating the crush pressures seen during the ascent phase of the vehicle's flight (see Figure 3b). No shear, bending, or other structural loads will be imparted into the nose dome during these tests. There are only two nose dome test conditions.

Cylinder and Boattail Test Conditions: A unique test fixture was required for the cylinder and boattail burst pressure test conditions (see Figure 3c). Pressurizing the entire volume of the cylinder using a flat disk to seal the top of the cylinder (about 22,100 square inches) was not an option because this would have imparted large axial tension loads into the cylinder skin. Instead, a cylinder of a slightly smaller radius will be inserted inside the fairing cylinder, and the small annulus between the two cylinders will be pressurized. The primary goal in these test conditions is to observe the behavior of the explosive bolts and the split line longerons. Gapping of the longerons in the areas between bolts will be measured to characterize this behavior. No shear loads will be imparted to the cylinder or boattail structure during this test, but there will be small loads input into the vent fin structure to observe how flight loads from the vent fin are distributed into the cylinder skin and the backing frames and stringers. There will be a total of four cylinder and boattail test conditions.

All-Up System Level Test Conditions: There are 17 test conditions to be conducted in the fully assembled, all-up test configuration (see Figure 3d), including five stiffness test conditions. In this configuration, the test article will be assembled in exactly the same way that the fairing will sit on top of the Centaur upper stage during the boost phase of flight. Axial loads will be imparted both at the top of the nose cone and at the boattail/ cylinder interface, and side loads will be able to be input at two different stations on the nose cone. The 12 non-stiffness test conditions are constituted by combining three test configurations in four variations: using design limit loads, using design ultimate loads, loading parallel to the split line, and loading perpendicular to the split line. The three configurations are side loading at the upper fixture on the cone (which tests the upper portion of the cylinder), side loading at the lower fixture on the cone combined with maximum axial compression loads, and side loading at the lower fixture on the cone with minimum axial compression loads (both of which test the lower portion of the cylinder, the boattail, and the stub adapter). The maximum axial load condition imparts worst-case compression loads into the skin, longerons, and explosive bolts on the compression side of the fairing, and the minimum axial load condition imparts worst-case tension loads into the skin and longerons on the tension side of the fairing.

Test Instrumentation: About 300 strain gage channels and about 45 deflection transducers will be present on the test article. The strain gage locations are distributed evenly on the various components of the test article structure, but typically only half of the gages will be read for a given test condition. The strain gages are intended to provide an indication of how loads are distributed throughout the test article structure. Deflection transducers are present mainly to provide data on the stiffness of the test article and to monitor deflections of the test article to ensure safe test operations. Load cells on test fixtures and pressure transducers in the test setup will also be monitored to obtain an accurate picture of loads and pressure differentials being input into the test article. A set of digital data loggers will be used for data acquisition system, and data will be delivered to the stress department in personal computer compatible spreadsheet formats.

III. 14-Foot Diameter Payload Fairing Acoustic Test

Description: The acoustic test of the payload fairing will be conducted during May 1990 in General Dynamics/Space Systems Division's Acoustic/Thermal Test Facility (ATTF) at the Kearny Mesa plant in San Diego, California. The ATTF is a dual chamber containing separate acoustic and thermal test chambers. Both chambers are maintained as 100,000 class clean facilities. Its acoustic chamber is one of the largest acoustic test facilities with a floor measuring 33 x 40 feet and a ceiling height of 50 feet (65,000 cubic feet). The chamber is fully reverberant, having a 25-Hz horn, a 50-Hz horn, and two 100-Hz cutoff horns, all mounted on the north wall of the chamber (see Figure 4). The frequency range of the chamber is 25 - 10,000 Hz, and the rated overall sound pressure level is 154 dB. Chamber environments and data acquistion are controlled from the control room on a mezzanine above the chambers. The primary purpose of the ATTF is the environmental testing of large space structures. Currently, the major emphasis of the chamber is on the rigorous checkouts required prior to delivery of the Centaur upper stage of the USAF Titan IV launch vehicle. This checkout includes a full exercise of Centaur avionics control systems while the vehicle LO2 tank is filled with liquid nitrogen and subjected to launch acoustic levels. The vehicle with empty propellant tanks was later subjected to thermal cycling ranging from -40 F to 185 F.

During the acoustic test of the Atlas 14-foot diameter payload fairing, a fully assembled fairing will be subjected to acoustic levels representative of both the launch and Max Q environments. External sound pressure levels for both conditions will approach the rated capacity for the chamber. Empty chamber calibrations will be performed prior to arrival of the test article to better characterize the obtainable sound pressure levels. Various re-configurations of the test article will be performed in order to characterize an 1.) empty, generic fairing, 2.) a generic fairing with a satellite payload, 3.) an empty fairing with the acoustic blanket installation, and 4.) a fairing with the acoustic blanket installation and a satellite payload. Other design features which will be tested are the noise mufflers which are placed over the vent holes in the fairing cylinder section. The flapper doors in the muffler structure (designed to prevent payload contamination and noise intrusion but still allow for venting of internal burst pressures) will be alternately opened and closed to determine their effect on internal noise levels. The noise reduction properties of the fairing structure and the acoustic blanket installation will be fully tested by the completion of the ten test conditions planned (8 at launch levels and 2 at Max Q levels). In order to fully characterize the fairing acoustics, sound decay measurements will be taken inside the fairing structure prior to testing, both with the acoustic blankets installed and with them removed, to determine the reverberant component of the measurements which will be taken internal to the fairing during the actual testing.

Also of interest to the structural dynamicists are the vibrations induced in the fairing structure by this acoustic energy. To investigate this phenomena, accelerometers will be placed on mass simulated avionics packages mounted on the forward end of the Centaur upper stage and on areas of payload fairing skin. By placing microphones very near the avionics packages and the payload fairing skin on which accelerometers are placed, data are gathered which will allow transmissibility studies to be performed. The vibration environments, while significant for the purposes of this test, are expected to be mild enough to allow the use of flight hardware for this test. The second flight payload fairing and the third 14-foot diameter article to come off the line at Harlingen will be used for this test in order to help acheive some schedule compression (the dedicated test article will be committed to the structural test at this time), and because the standard cork and paint installation, which was incompatible with the goals of the structural test, is a requirement for the acoustic test. It was felt that the cork and paint on the nose cone section, bonded on as an ablative for thermal control, would have a significant impact on the acoustic transmissibility of the nose cone skin.

Data Acquisition: Acoustic levels internal to the payload fairing structure will be fully characterized through the use of about 20 microphones positioned both in and around the test article. Several control microphones will also be used to monitor chamber conditions in real time. Vibrational levels associated with the acoustic energy will also be recorded by about 10 triaxial accelerometer placements on sensitive areas of vehicle structure. A state-of-the-art data acquisition

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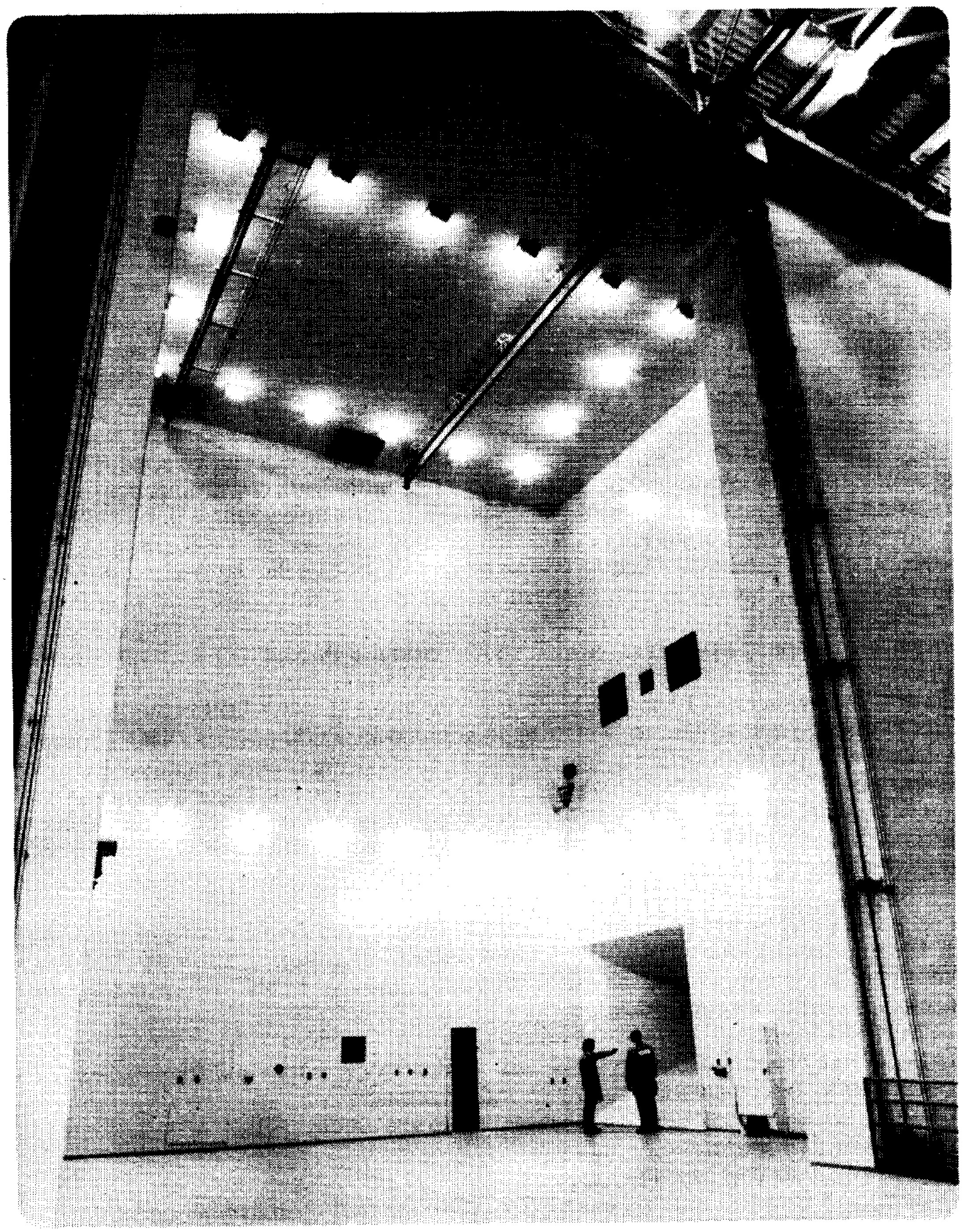

Figure 4. General Dynamics Acoustic Chamber, San Diego, California.

system in the ATTF control room will record all test data and will allow for a wide variety of data presentation formats; 1/3 Octave Band Center Frequency Plots shall be produced for all microphones. Power Spectral Densities (PSDs) will be produced for all data microphones and Accelerometer Spectral Densities (ASDs) of all accelerometer data will also be produced, as will transmissibility plots showing the relationship between microphone and accelerometer data. Because this test is currently scheduled for completion less than one month prior to launch of AC-69, the first commericial Atlas flight, prompt data reduction and presentation will be of utmost importance.

IV. 11-Foot Diameter Payload Fairing Modal Survey Test

Description: This first test of the smaller 11-foot diameter fairing, developed for the USAF Atlas II, will be conducted in two major segments: a "free-free" test condition in which only one half of the fairing will be tested, and a "fixed base" test condition which will be performed on a fully assembled and erected fairing. The free-free conditions will be performed at the General Dynamics operated U. S. Air Force Plant 19 near downtown San Diego, and the fixed base test conditons will be performed at the Sycamore Canyon test facility. The fixed base testing will immediately follow the 14-foot diameter payload fairing structural test and be conducted in the same test tower. The test article will be a dedicated 11-foot diameter test article, constructed to the same engineering prints and quality control criteria as a flight article. This will be the first 11-foot diameter fairing completed by the Harlingen assembly plant and will be the fourth aluminum payload fairing off the production line. Because of suspicions that the thermal control cork coating on the nose cone would introduce significant modal damping, it was determined that it should be included on the test article in order to accurately reflect the properties of the flight article. The 11-foot diameter payload fairing is somewhat shorter than the 14-foot diameter version, measuring 34 feet in height, 5 1/2 feet less than its larger brother. While it is large enough to accommodate the DSCS-III spacecraft, the 11-foot diameter payload fairing is some 1,500 pounds lighter than the 14-foot diameter payload fairing, weighing in at just over 3,000 pounds. This allows for a dramatic increase in payload-weight-to-orbit. The 11-foot fairing is even slightly lighter than the comparably sized 10-foot diameter fiberglass fairing, showing the inherent efficiency of the aluminum skin, stringer, and frame construction. In addition to supplying data on fairing vibrational modes, this modal test will be the primary source of stiffness data on the 11-foot diameter payload fairing structure.

General Dynamics will be assisted in this test effort by Structural Dynamics Research Corporation (SDRC), which is headquartered in Milford, Ohio. SDRC Engineering Services Division, based convieniently in San Diego, will be the primary contract agency. SDRC, which has a great deal of experience in the modal testing field, will:

- perform a pre-test analyses, which will predict mode shapes and frequencies
- determine instrumentation quantities and placements
- install the instrumentation and shakers on the test article
- perform all test operations
- perform all data acquisition
- perform a post-test analysis intended to refine the fairing analytical model
- prepare a test report which presents all test data

Free-Free Test Requirements: The free-free test condition, in which a single fairing half will be excited, is being performed to determine the vibrational modes of a fairing (and split barrel) half which has been separated from its twin half and is free to vibrate at all boundaries. This test condition is being run in lieu of conducting a separate (and very expensive) jettison test of the 11-foot diameter payload fairing. This test condition will provide information on the primary breathing modes and the modes which will load the stub adapter hinges during jettison rotation. About 200 low-frequency accelerometers will be present on the test article to monitor vibration during this condition. The fairing will be suspended from the ceiling in a concave down (inverted canoe, see Figure 5) orientation and will be supported at three locations by bungee cords. Exciters will be mounted on the floor and will be attached to the split line longerons. Multiple input random excitation will be the primary method of excitation, providing information on all modes below 50 Hz, but for the major modes of interest, sine-sweep excitation will be used to obtain more specific information (linearity, orthogonality, damping, etc.). Orthogonality requirements for the free-free condition are that all off-diagonal terms of the modal mass matrix be less than 0.10. Up to 12 total retakes of contaminated target modes will be permitted to satisfy these requirements.

Fixed Base Test Requirements: In order to determine the vibrational modes of the fully assembled fairing as it sits on the Centaur upper stage for the first 3 1/2 minutes of flight, the fixed base modal configuration will be performed at Sycamore Canyon. The modes of primary interest are the first three bending modes in the vehicle pitch and yaw axes, the first two axial modes, and the first torsional mode. If any of these modes is above 64 Hz, a shell mode pair will be substituted. It is anticipated that about 250 low-frequency accelerometers will be required to monitor vibration during this test condition. As in the free-free condition, multiple input random excitation will be the primary source, characterizing all modes below 50 Hz, and sine-sweep will be used to isolate the specified target modes. Orthogonality requirements are, as in the free-free condition, that all off-diagonal terms of the modal mass matrix be less than 0.10. A total of 18 retakes will be allowed in order to satisfy these requirements for all contaminated target modes.

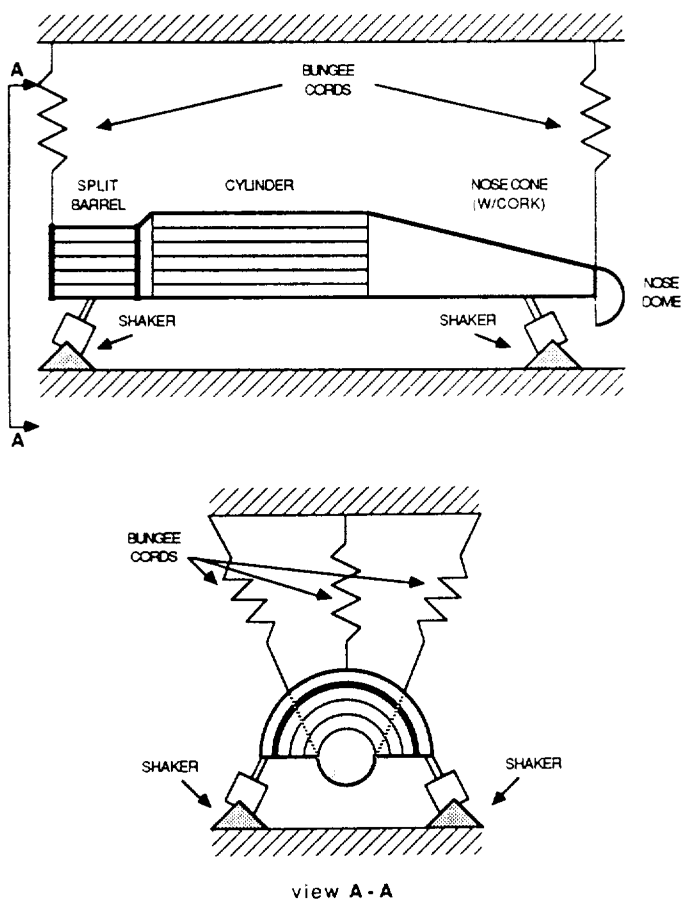

Figure 5. 11-Foot Diameter Payload Fairing Modal Test Free-Free Condition.

V. 11-Foot Diameter Payload Fairing Structural Test

Description: The 11-foot diameter payload fairing structural test will be the last fairing test to be conducted in the Sycamore Canyon test tower. There will be no special setup required for this test as the configuration and the test article for this test are exactly the same as the fixed base configuration for the modal survey test, which it will immediately follow. The goals of this test are very similar to those established for the 14-foot diameter payload fairing structural test: 1.) the fairing structure shall not yield under design limit loads and 2.) the fairing structure shall not fail under design ultimate loads (125% of design limit). As with the 14-foot diameter structural test, there will be a series of static test conditions designed specifically to satisfy the above requirements and additionally to determine the stiffness of the payload fairing structure, serving as a verification of the stiffness data obtained during the previously mentioned modal survey test. This structural test, however will not incorporate any of the component level tests which the 14-foot structural test program did, mainly because some of the structural components tested at that time (upper and lower nose cone, nose dome, and stub adapter) are common between the 11-foot and 14-foot designs and need not be demonstrated again. The only configuration for this test is the fully assembled fairing. No burst or crush pressures will be required during any of the test conditions to be performed in this test program.

Test Conditions: Like the all-up system level tests conducted during the 14-foot diameter structural test program, loading of the 11-foot diameter test article will be accomplished through a combination of axial and side loading. There will be axial loading available through a fixture at the top of the nose cone and side loading available at three locations: the top of the nose cone, near the base of the nose cone, and near the middle of the fairing cylinder section (see Figure 6). By inputing incremental side loads at three stations, a very good approximation of flight shear and bending moment profiles can be obtained, avoiding any seriously overloaded structure. A total of eleven test conditions will be required to complete the structural test program. There will be four standard conditions using maximum axial compression loads combined with design limit and ultimate shear

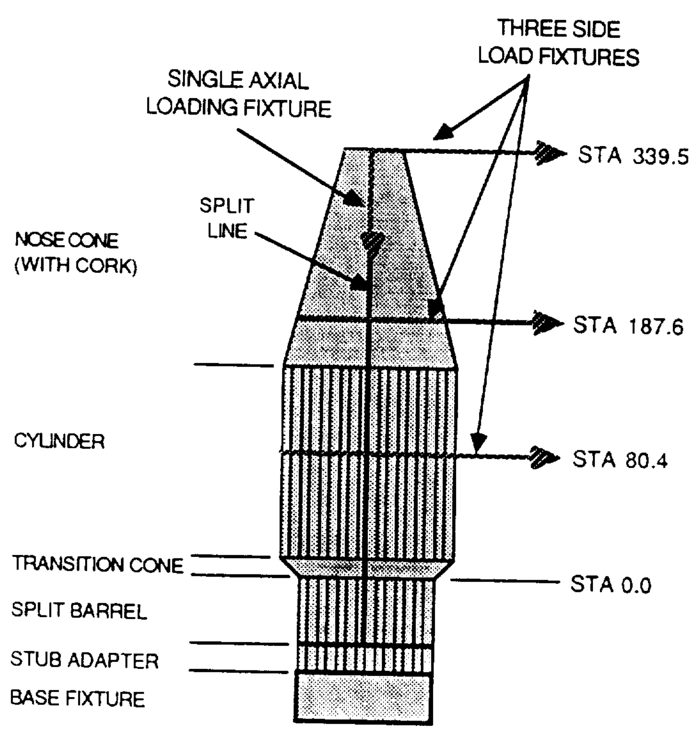

Figure 6. 11-Foot Diameter Payload Fairing Structural Test Loading Fixtures.

loads/bending moments conducted both parallel and perpendicular to the fairing split line. There will also be two test conditions which use mimimum axial compression loads in conjunction with side loads (design limit and ultimate) parallel to the fairing split line. Maximum axial compression relates to the Max Q flight condition and the minimum axial compression case corresponds to loading on the Atlas vehicle at the transonic flight condition. Two test conditions (design limit and ultimate loads) will require that the axis of compression be off the standard axes which are parallel/perpendicular to the split line. This is required because of an air conditioning duct door which is located 30 degrees off the split line. Because of the location of this door at the very top of the fairing cylinder, this structure cannot be designed to a factor of safety of 2.0, and as such must be tested to ultimate loading conditions per the USAF contract. An axis of compression which is off the standard axes requires that a resultant load be reacted, dictating that twice as many load cells be used to impart the test loads. The final three test conditions are the stiffness tests, one each in the standard side load axes (parallel and perpendicular to the split line) using pure side load, and one pure axial load condition.

Data Acquisition: Test instrumentation for the 11-foot diameter payload fairing structural test includes about 80 strain gages and about 35 deflection transducers. Strain gages will be placed in circumferential patterns at the bottom of the lower cone and at the mid-point of the small transition cone between the cylinder and the split barrel. Several explosive bolts shall also be instrumented with strain gages. Deflection transducers will be used mainly to collect stiffness (deflection versus load) data and to monitor test safety during high loading conditions. Load cells connected to the hydraulic load cylinders will also be monitored (maximum of seven hydraulic load cylinders operating during off-axis air conditioning door test conditions) to verify the loads input into the test article. The data acquisition system used on this test will be identical to that used during the 14-foot diameter payload fairing structural test program. A digital data logger will record data on the 3 1/2 -inch floppy disks in standard personal computer spreadsheet format.

Conclusions

To establish the competitiveness of the revitalized family of Atlas launch vehicles (I, II, IIA, and IIAS) a new series of payload fairings, an 11-foot and a 14-foot diameter version, were designed to accommodate the widest possible variety of satellites. Because these aluminum fairings are new designs, the plant at which they are produced is new, and launch customers are very anxious to fly their payloads, an ambitious and efficient test program is essential. Five major tests have been planned for completion within the span of one calendar year. One of these has been completed, with every indication that it was a success, one is currently under way, and two more are scheduled to start in the month of April. Through effective use of test assets, facilities, and personnel, all testing will be completed, allowing the fairing design to be completely characterized and then qualified through analysis prior to first launch of each of the fairings.