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Lawrence Livermore Laboratory

SHOCK AND VIBRATION TESTING OF AN MX-MISSILE
UPPER-STAGE SOLID PROPELLANT ROCKET MOTOR
[PROJECT ORDER NO. SAMSO/ERDA-5-MNN-51]

MASTER

PROGRESS REPORT FOR PERIOD

June 11, 1975 through January 31, 1976

Dennis K. Fisher
February 20, 1976

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1. INTRODUCTION

The work being performed by Lawrence Livermore Laboratory (LLL) for SAMSO under Project Number SAMSO/ERDA-6-MNN-03 is the preparations necessary to conduct the shock and vibration testing of an MX upper-stage motor beginning December 1976. During the current fiscal year LLL is responsible for the fixture design, development of test procedures, and facility preparations. Aerojet is responsible for the technical specification of the testing to be performed, review of the fixture design, and procurement of the test fixtures. All work by LLL is being performed on a cost reimbursement basis.

2. TECHNICAL REVIEW

During the subject reporting period, there were a total of six joint meetings between representatives of ASPC, LLL, and Kimball Industries, Inc., whom ASPC has retained as a consultant with respect to the fabrication of the fixtures. These meetings were held for the purpose of (1) reviewing and coordinating the LLL fixture design with the needs of the test program, (2) to insure a fixture design that can be fabricated at an acceptable cost, and (3) refine the detailed test specification to reflect the capabilities of LLL's computer-controlled test facilities.

The complete shock and vibration test sequence involves five different fixturing configurations. Detailed engineering layouts of the fixturing were prepared by LLL, and then LLL and ASPC jointly performed dynamic-stress analyses of the structures. The final design review took place January 28, 1976 at a joint meeting between LLL and ASPC. As a result of this meeting, LLL has received approval from ASPC to proceed with detailing of the fixture components in preparation for fabrication.

Typical testing configurations are illustrated in Fig. 1 (Z-Axis motor vibration) and Fig. 2 (X-Axis motor shock). In all cases the motor is supported

at the wye joint by split rings which are secured to the motor by clamps at the fore and/or aft skirts as appropriate. The rings are connected by a split torque tube which maintains the proper spacing of the rings and gives the assembly a very high structural rigidity. By using a split ring-and-tube design the top half of the fixture can be removed to permit radiography of the motor while still in the fixture.

During vibration testing (Fig. 1), four 25×10^3 -lb thrust hydraulic actuators are connected directly to the wye-joint rings through hydrostatic swivel couplings. The movement of the actuators is linearly constrained by hydrostatic guide bearings located on the supports attached to the vertical abutments of the reaction mass. For Z-axis vibration testing the dead weight of the motor/fixture assembly is carried by air springs, thereby permitting the full output of the actuators to be used for dynamic vibration inputs.

A 400,000-lb thrust "HYGE" pneumatic actuator (Fig. 2) is used to conduct the shock tests. The wye-joint ring/torque-tube assembly is mounted to a table which rides in an enclosed guideway. The HYGE actuator pushes the table during the acceleration phase of a shock pulse and then, as the table slides free of the HYGE, pre-actuated friction brakes slowly bring the motor to a stop. All three motor axes will be shock tested by simply rotating the motor in the rings, or rotating the entire assembly on the shock table.

3. SCHEDULE

The original test plan called for the shock and vibration testing of two motors, the first referred to as the "Critical Stress"(CS) motor, and a second called the "Environmental Test" (ET) motor. Aerojet has informed us that the plans to test the ET motor have been dropped. Since the same fixturing was to be used for both motors, the only significant effect on our program

FIG. 1- Z-AXIS VIBRATION TESTING

FIG. 2.-X-AXIS SHOCK TESTING

has been to translate the schedule slightly and to shorten the period of actual testing. A revised program plan, reflecting the deletion of the ET motor, is shown in Fig. 3.

4. FINANCIAL STATUS

The revised cost estimate for the testing of the MX Critical Stress motor is shown in Table 1. These figures reflect the deletion of the ET motor and associated schedule changes, and revised costing data.

TABLE 1

<u>Fiscal Year</u>	<u>Period</u>	<u>Estimated Expenditure</u>
1975	July 1, 1974 - June 30, 1975	\$ 15 K
1976	July 1, 1975 - June 30, 1976	135 K
1976/1977 T	July 1, 1976 - Sept. 30, 1976	45 K
1977	Oct. 1, 1976 - Oct. 1, 1977	165 K
TOTAL		\$360 K

The increase in the estimate for FY 1976 is based on our incurred costs to date and an assessment of the work yet to be done. Through FY 1976, the total funding/expenditures are as follows:

<u>Funding</u>	<u>Expenditures</u>
FY 75 - \$15 K	FY 75 \$ 10 K
	FY 76 (through Dec. '75) 86 K
<u>FY 76 - \$120 K</u>	<u>FY 76 (est. Jan.-June '76) 54 K</u>
TOTAL \$135 K	TOTAL \$150 K

This total is higher than originally proposed due to the inclusion of preliminary investigations regarding MX Full-Scale Development program environmental testing (performed at the request of SAMSO), and unplanned development work required to complete the fixture design. We will therefore require an additional \$15 K funding for FY 76 in order to maintain the schedule ASPC has requested.

Fig. 3 - Program schedule for shock and vibration testing of critical stress motor.

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5. SUMMARY

The engineering design of the shock and vibration fixtures has been completed. Detail drawings of the individual components are now in progress, and fabrication of the fixtures is expected to begin in April 1976.

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SAMSO

Major Jerry N. Mason
MNNPX/M
Space & Missile Systems Organization
Air Force Systems Command
NSF
Norton AFB, CA 92409

ASPC

R. J. Oliver
Aerojet Solid Propulsion Company
PO Box 13400
Sacramento, CA 95813

SAN

D. R. Picasso
W. A. Whitsell
U. S. Energy Research & Development Admin.
San Francisco Operations Office
1333 Broadway, Wells Fargo Building
Oakland, CA 94612

TIC, OAK RIDGE (27)

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