230/Leadbetter October 18, 1971

TO: Marshall Space Flight Center
Attn: S&E-AERO-D, Robert S. Ryan, Chairman, Ad Hoc Dynamic Test Committee of the Space Shuttle Dynamics and Aeroelasticity Technology Committee

FROM: Langley Members of Ad Hoc Dynamic Test Committee

SUBJECT: Current Langley Programs Relevant to Shuttle Dynamic Testing

The structural dynamic characteristics of aerospace structures must be predictable and understood during the vehicle's development cycle as well as during flight. Adequate knowledge of vibration modes, frequencies and damping is an essential ingredient for the prevention of servo-elastic, aeroelastic and pogo instabilities and for the prediction of dynamic loads during ground and flight operations. Analytical methods are normally used to determine these structural dynamic characteristics but usually must be verified with experimental data from ground vibration surveys of the proper full-scale hardware or with adequately scaled dynamic models of the same structure. The approach to be used to obtain needed test data is the prime concern of the Dynamics Testing Committee of the Shuttle Dynamics and Aeroelastic Working Group. It is not the intent of this memorandum to answer the question of what is the best approach for dynamic testing of space shuttle vehicles. It is the intent only to indicate ongoing work at Langley that will provide the technology on which this question can be intelligently answered by the Dynamic Testing Committee.

A 1/15-scale dynamic model of an early space shuttle concept (the MSC mini-shuttle) has been fabricated and is currently undergoing vibration studies at Langley to obtain structural dynamic data needed to evaluate analytical procedures and to study parametric trends of coupled multibody structures. Studies are being conducted to define the coupled modal behavior of multi-body structures as a function of staging arrangement, interface elasticity, and propellant loading; and to develop test and analysis methods for more complex future models derived from more substantive configuration definition. At the present time, the analytical approach includes NASTRAN and for one case, SNAP/Dynamics methods. The 1/15-scale model will be utilized during studies of component synthesis or substructuring analytical approaches.

Contractual efforts being conducted relative to the attached work statements are of interest.

a. The Preliminary Shuttle Dynamic Model Study is being conducted by a GAEC and TRW effort under a Langley structural dynamic master agreement. The initial work, defined as part B under the statement of work, has been completed and a copy of the resulting document is included for your information. Further work under the contract has been delayed since the effort is considered to be configuration dependent.

b. The Study of Modal Coupling Procedures for the Shuttle contractual effort is being negotiated under the above-mentioned master agreement. Data from the 1/15-scale shuttle dynamic model will be used to evaluate the various component synthesis methods.

c. The Thermal-Dynamic Modeling Study is being conducted under the above-mentioned master agreement. Results from this study will be valuable for both model and full-scale testing where thermal effects must be considered.

d. The Impulse Transfer Function Technique is a contractual study under the above-mentioned master agreement. This effort will provide basic data needed for follow-on contractual work to be monitored by Tom Modlin of MSC.

e. The contractual effort for studies of the influence of vibration modes on control system stabilization for space shuttle-type vehicles is being conducted by DD/C.

f. There are several contractual efforts involving either response, vibroacoustics or flutter of metalic TPS type panels.

It is felt that the following proposed contractual efforts are of interest and may be a part of the 1972 budget.

a. A study to define vehicle free body modes from measured forces of constraint. The results from this study can contribute to the selection of test methods. A proposal for an initial study has been received from Kaman Corporation.

b. The development of a computer program to study effects of fluid-structure interaction in vibration problems. A proposal has been received from M/DAC.

c. A proposal has been received from SwRI to study some propellant dynamic coupling problems with the use of an existing parallel stage tank model.

d. A study to develop pulsed holography techniques for measuring the vibratory response of heated panels. This would be follow-on work to earlier holography studies conducted by TRW.

e. A laser vibration measurement system from LMSC.

f. The development of a flow meter to measure unsteady fluctuations in vehicle fluid lines is needed to better understand Pogo problems. Contractor not known at this time.

g. A proposal has been received from GD/C for a launch transient loads parametric study to better understand booster-orbiter interface structural loads.

h. A contractual effort may be undertaken to evaluate various company substructures or component synthesis techniques.

Other pertinent research efforts, not yet clearly defined and including an improved understanding of instrumentation requirements and data analysis methods, are either underway or will be undertaken.

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Enclosures:
Statement of Work
Grumman Report

cc (w/o Encl.):
242/LD
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