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BEHAVIOR OF NOZZLES AND ACOUSTIC LINERS IN THREE-DIMENSIONAL ACOUSTIC FIELDS

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the manufacturing of the various mechanical components (with the exception of the acoustic liners) and the installation of the mechanical hardware is completed. In addition the necessary instrumentation has been purchased and installed and the set up of the appropriate electrical networks has been completed. At present the whole experimental facility, including both the mechanical and electrical hardware, is undergoing a thorough check out as it is being prepared for the actual testing, which is expected to take place in the very near future.

B. Theoretical Studies

During the third quarter of this program the theoretical efforts continued in two directions. As reported in our previous progress reports work continued on the analysis of three dimensional wave propagation in a circular duct containing a through steady state flow and attenuating side walls. Although this is a very difficult problem it is believed that its solution, once obtained, will enable engineers to develop more effective procedures for the design of acoustic liners.

Our other theoretical effort is directed towards obtaining admittance functions for nozzles of arbitrary shape. Presently available theories are only applicable to nozzles with slowly converging walls whose mean flow may be assumed to behave in a quasi one dimensional manner. As is well known, most practical nozzles are not slowly converging and the applicability of existing theories to calculate their admittance functions is at best questionable. In the analysis of the case when the nozzle walls are slowly converging solutions can be obtained by means of separation of variables technique. This is no longer the case when the convergence of the nozzle walls is fast so that

the steady state flow cannot be assumed to be one dimensional. We are presently exploring the possibility of obtaining numerical solutions for this case. Once obtained these solutions will be of considerable use in the analysis of various combustion instability problems. It is believed that the analysis and solution of this problem will require a considerable amount of time.

C. Test Facility

The installation and preliminary checkout of the entire system has been completed; however, the final checkout is still underway. At the outset of this program it was planned that at this point in the program the facility would have been completed and testing would be underway. Unfortunately failures in various components of the system (e.g., system dryer and valves) and delay in deliveries of major system components resulted in unexpected delays. In February, 1969, two valves were ordered for the system. One of these valves controls the air flow into the chamber of the rocket motor while the other controls the air flow through the sound generating system. The manufacturer promised delivery of these valves in mid-July whereas the actual delivery occurred at the end of October. As a result our whole working schedule had to be changed in order to minimize delays in the planned program.

The final installation of the system was completed when the valves arrived. Initial operation of these valves disclosed two discrepancies: (1) the hydraulic power unit for these valves (also purchased from the same manufacturer) had an output pressure of 1500 psig instead of 3000 psig; (2) the electric controller for the valve had a faulty printed circuit. Two weeks were

required to correct the difficulty with the hydraulic power unit and one week to repair the electric controller. Once these difficulties were corrected the valve functionals were completed. The delays and difficulties encountered with the delivery, installation and operation of the valves are the main reasons for the slippage in the program schedule. It is hoped that through a concentrated effort we shall be able to make up for this delay.

When the valve functionals were completed, the new air pressurization and storage facility was activated for the first time. Additional minor problems that resulted in minor slippage were encountered. These problems included leakage of compressor intake valves, leaks in the discharge system and clogged air dryers. To date all of these problems have been resolved. The experimental facility is undergoing its final checkout and is being prepared for the initiation of the nozzle testing.

In addition to the effort required to develop the hardware and its associated systems, a similar effort was required for the instrumentation associated with this experiment. Both the steady state and the dynamic circuits had to be designed, developed, and installed into an area where no instrumentation had previously existed. Major instrumentation items such as an automatic tracking filter, tape recorder, oscillograph, strip-chart recorders, and dynamic pressure transducers had to be purchased, calibrated, and installed into the system. Special attention was given to calibration, recording, and data processing techniques.

All of the instrumention and its circuitry have been installed. The majority of the circuits have been checked out. As to be expected, some problems with ground-loop currents, faulty cables, and guard loop modes were encountered; however,

these were eliminated as they appeared. A few circuits remain to be checked but these will be ready when nozzle testing is begun.

II. PROGRESS DURING NEXT REPORT PERIOD

Final checkout of the entire experimental facility will be completed. Testing of the nozzles will be completed and nozzle data analysis will be performed during the time that the acoustic liners will be tested. All data reduction will then be completed. The final report will follow thereafter.