ENGINEERING RESEARCH INSTITUTE
SUPERSONIC WIND TUNNEL
UNIVERSITY OF MICHIGAN

# SUMMARY OF ACTIVITIES OF THE 8-INCH BY 13-INCH SUPERSONIC WIND TUNNEL FOR

# PROJECT WIZARD
(MX 794)

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## SUMMARY

The activities and accomplishments of the 8-inch by 13-inch Supersonic Wind Tunnel for project Wizard are summarized. Design, construction, calibration, and preliminary testing were carried out from September 1946 to July 1948. From July 1948 to August 1951 the wind tunnel has conducted active testing for project Wizard as follows: 33 test programs were completed providing aerodynamic data for the project, 11 basic research programs have been accomplished, 1 major program was accomplished for a Guided Missile contractor, and all necessary calibration and instrumentation performed.

## HISTORICAL

In June of 1946 the design and construction of a Supersonic Wind Tunnel was started as an integral part of the basic Wizard contract. This Supersonic Wind Tunnel was to supply much needed supersonic aerodynamic data for the University of Michigan and other Air Force contractors, as well as to provide a pilot facility for the unique type of wind tunnel circuit under consideration. Construction of this wind tunnel was started in a large hangar at Willow Run Airport in September of 1946. The tunnel was initially operated in June of 1947. A summary of the experiences gained in construction and operation up to May 1948 was issued as reference 1. By July of 1948 the wind tunnel and its associated equipment had been developed, improved, and calibrated to a state where active test programs were underway.

Early in 1950 it became apparent that the need for aerodynamic supersonic data for the Wizard project was gradually decreasing. Since then several new wind tunnel projects have been initiated and, as of today, the wind tunnel is fully occupied with new research projects sponsored by the U. S. Air Force, U. S. Navy, and the University of Michigan.

## DESCRIPTION OF WIND TUNNEL

The wind tunnel is of the intermittent flow type, operated by the pressure differential between an atmospheric air reservoir and a 13,000 cu ft vacuum tank. Interchangeable nozzle blocks provide for Mach numbers of 1.4, 1.9, 2.8, and 3.8 with supersonic run times up to 20 seconds duration. The test section is 13 in. high, 8 in. wide, 54 in. long and has 16-in. diameter windows. A large variety of fixed and moveable support struts are available to support models for either pressure distribution or force testing. Pressures can be measured by manometers or pressure capsules while forces are measured by strain gage balance systems. Balance systems capable of measuring force and pitching moment, normal force, pitching moment and axial force, and flap hinge moment, pitching moment and normal force are available. Optical equipment is available to make visual or photographic Schlieren and shadowgraph observations. The light-scattering technique as well as visualization of the boundary layer flow by means of a modified china-clay technique have been successfully used. A high-speed motion picture camera is available for taking up to 5000 frames per second. Strain gage and pressure capsule data can be read visually and simultaneously recorded on a recording oscillograph, while manometer data are recorded photographically.

A more detailed description of the Wind Tunnel and its equipment and facilities is given in references 2 and 3.

## ACTIVITIES AND ACCOMPLISHMENTS OF WIND TUNNEL

During its active participation in the Wizard project the Wind Tunnel staff has maintained, operated, and improved the Supersonic Wind Tunnel and its associated equipment for the following activities.

a) Aerodynamic tests on specific models for the Wizard Aerodynamics Group of the Willow Run Research Center of the University of Michigan. This included the instrumentation of the models and the data reduction as well as the writing of internal test reports.

In this field the Wind Tunnel has accomplished the complete testing of thirty-three (33) different test programs on either pressure distribution or force models, or both.

b) Basic theoretical and experimental research on problems related to the Wizard project including design and development of the models, instrumentation and testing techniques, as well as data reduction and evaluation.

Under this group the wind tunnel has carried out eleven (11) experimental basic research investigations including the necessary theoretical work.

c) Aerodynamic tests on models of Guided Missile contractors selected and approved by the Air Materiel Command.

One (1) major test program was carried out for a Guided Missile contractor of the Air Materiel Command.

d) Calibration, modification, and instrumentation of the tunnel, and development of new techniques to properly perform the tests listed under (a), (b), and (c) above.

The four available nozzle blocks have been calibrated and the force and pressure measuring instrumentatior has been developed and calibrated. The various optical techniques and necessary instrumentation have been developed and refined. A variable geometry supersonic diffuser has been designed and operated resulting in sufficient increase in run length at the higher Mach numbers to permit normal testing. Numerous other calibrations, and improvements, and new techniques have been accomplished.

These efforts have resulted in a facility suited to many types of test programs. Research as well as routine test programs have been and can be carried our in an economical and expeditious manner. The repeatability and accuracy of the test data obtained has been found to be equal to the best obtainable at the present state of the art of supersonic wind tunnel testing.

The results of these accomplishments have been published in various external reports of the Engineering Research Institute of the University of Michigan, as well as numerous internal reports which are on file with the Air Materiel Command, and the University of Michigan.

## OPERATIONAL STATISTICS

Two analyses of wind tunnel occupancy have been made. The first covered a one year period from the middle of 1949 to 1950 and the other a one-year period from April 1950 to April 1951. During the 1949/1950 period the wind tunnel was operated at 76.4 per cent occupancy; this means that 76.4 per cent of a years time was used in actual testing in the tunnel while only 23.6 per cent was idle due to tunnel modifications, improvements, breakdowns, model changes, and other delays. The corresponding average of runs made per occupancy day is 10 and the work performed included model design, construction, testing, data reduction and writing of a test report.

In the second period analyzed, 1950/1951, the wind tunnel operated at 70.8 per cent occupancy with an average of 10 runs per day of occupancy.

During this period a higher percentage of research testing was done than in the previous period. Since tests of a research nature require more frequent model changes and the ultimate of thoroughness and accuracy as compared to routine and developmental testing, the decrease in per cent occupancy noted is almost negligible.

As a result of various improvements of the wind tunnel and its operation, a gratifying decrease in operational costs of 10 per cent has been accomplished over the last 2 years.

## REFERENCES


1. Schneyer, R. I., "Interim Report, Intermittent Supersonic Wind Tunnel," University of Michigan ERI Report EMP-16, 1 June 1948.

2. Garby, L. C., and Nelson, W. C., "University of Michigan 8-Inch by 13-Inch Intermittent Flow Supersonic Wind Tunnel," University of Michigan ERI Report UMM-59, June 1950.

3. "Supersonic Wind Tunnel Research Facilities," University of Michigan ERI Report WTM-185, November 1950.