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NASA LEWIS 8- BY 6-FOOT SUPERSONIC WIND TUNNEL

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GENERAL TUNNEL DESCRIPTION

The 8 X 6 Foot Supersonic Wind Tunnel is capable of attaining test section flow in the Mach number range from 0.36 to 2.0. The change in Mach number is continuous up to 1.3 and in increments of 0.1 between 1.3 and 2.0. The tunnel may be operated in either of two modes; aerodynamic cycle or propulsion cycle.

Aerodynamic Cycle

During the aerodynamic cycle the tunnel is operated as a closed system with dry air added only as required to maintain the desired tunnel conditions. This cycle is used primarily for aerodynamic flow studies where contaminants are not introduced into the airstream. Figure 1(a) illustrates the air flow path for the aerodynamic cycle.

Propulsion Cycle

During the propulsion cycle the tunnel is operated as an open system with the air continuously drawn through the air dryer and exhausted to the atmosphere. This cycle is used for models which introduce contaminants into the airstream. Figure 1(b) illustrates the air flow path for the propulsion cycle.

Tunnel Components

Major components of the Lewis 8 X 6 Supersonic Wind Tunnel are illustrated in figure 2. These components are:

Air dryer.- The air dryer removes moisture from atmospheric air prior to its introduction into the tunnel. It contains 1.14×10^{6} kg (1250 tons) of activated alumina in eight beds each 0.61 m (2 ft) thick. The dryer is designed to pass 998 kg/sec (2200 lb/sec) of air entering at 21° C (70° F) with a dewpoint of 14° C (58° F) and leaving with a dewpoint of -29° C (-20° F) for a 2 hour period. Reactivation of the activated alumina requires 4 hours heating and 4 hours cooling. Figure 3 shows the total adsorption capacity of the dryer versus the temperature of the entering air.

Compressor.- The tunnel air is driven by a 7 stage axial-flow compressor, rated at a volume of 1600 m^3 (56 600 ft^3) of air per second at a pressure ratio of 1.3. It is driven by three wound-rotor induction motors having a total power capacity of 65 000 kw (87 000 hp).

Flexible-wall nozzle.- The flexible-wall nozzle produces supersonic flow through the test section; it consists of two flexible side walls of stainless steel 2.44 m (8 ft) high, 10.82 m (35 ft 6 in.) long, and 2.54 cm (1.00 in.) thick which are actuated by hydraulically operated screwjacks. The top and bottom plates are fixed.

Test section.- The test section is 2.44 m (8 ft) high, 1.83 m (6 ft) wide and 7.16 m (23 ft 6 in.) long. It is made of 2.54 cm (1.00 in.) thick stainless steel plates.

Acoustic muffler.- The acoustic muffler is used to quiet the discharge air of the tunnel when it is operated on either the aerodynamic or the propulsion cycle.

Cooler.- The cooler is a finned-tube water type heat exchanger, used to cool the air entering the air dryer during aerodynamic cycle operation. It is designed to cool the air to 29° C (85° F) by removing the heat of compression.

TUNNEL AERODYNAMIC PERFORMANCE

Operating characteristics of the tunnel for both the aerodynamic and propulsion cycles are given in figure 4 which shows the test section total temperature, total pressure, static pressure, dynamic pressure, altitude, Reynolds number, and mass flow versus the test section Mach number over the tunnel operating range. The discontinuity between Mach 0.50 and 0.55 is caused by varying compressor speeds to avoid overpressurization of the balance chamber surrounding the test section.

For Mach numbers below 0.36 it is possible to take transient data. However, because of the rapidly changing tunnel condition, a fast responding data system is required.

TEST SECTION DESCRIPTION

The test section plan and elevation views are shown in figures 5 and 6. The test section is 2.44 m (8 ft) high and 1.83 m (6 ft) wide with parallel side walls for a total length of 7.16 m (23 ft 6 in.). For 0.69 m (2 ft 3 in.), downstream of the test section, the side walls diverge to 1.93 m (6 ft 4 in.) to compensate for the blockage of the transonic strut. The top and bottom plates are parallel to each other. The walls and top and bottom plates are made of 2.54 cm (1.00 in.) thick stainless steel.

The test section is perforated on four sides. Perforations start 2.77 m (9 ft 1 in.) from the upstream end of the test section and extend 4.39 m (14 ft 5 in.) downstream. These perforations provide approximately 6 percent porosity, however, this can be reduced and varied along the length of the test section by selective use of inserts in the 2.54 cm (1.0 in.) diameter perforations.

Models are installed through an access door in the bottom of the tunnel diffuser downstream of the test section. The opening is 4.86 m (16 ft) long and 1.83 m (6 ft) wide. Two 1800 kg (2 ton) overhead cranes are provided in the ceiling of the diffuser section. Models, on spec[illegible] dollies, are lifted into the diffuser section and rolled to the test section for installation.

The top and bottom plates of the test section are removable for installation of small model supports and auxiliary apparatus. The opening may vary up to 3.048 m (10 ft) long by 30.48 cm (12 in.) wide depending upon the selection of insert plates and location in the test section. The tunnel insert plates cannot be altered, therefore, new inserts are required if modifications are necessary. Model mountings, described under the section on MODEL SUPPORTS, are installed through these openings.

Two pairs of schlieren windows are located in the side walls. These 0.673 m (26.5 in.) diameter windows are located 0.203 m (8 in.) eccentric in steel disks. The centers of the disks are on the tunnel centerline. Rotating the disk enables the window to cover any portion of a 1.08 m (42.5 in.) diameter circle about the disk center.

A personnel access door 0.71 x 2.13 m (28 in. x 7 ft) is located at the downstream end of the test section.

MODEL SUPPORTS

Ceiling Strut Assembly

A ceiling strut assembly with a typical model installed is shown in figure 7. This assembly consists of the strut proper to which the model is attached, and the anchoring structure and angle-of-attack mechanism which are outside the test section.

Strut thickness may vary up to 7.62 cm (3 in.), and the chord length up to 1.80 m (5 ft 11 in.). The maximum chord length is determined by the angle-of-attack requirement.

Angle of attack of the model is controlled by a hydraulic mechanism which rotates the strut around a 5.08 cm (2 in.) diameter pin located 10.16 cm (4 in.) above the inside surface of the tunnel top plate. The angle-of-attack range is between -5° and +15°.

The center of rotation of the strut may be positioned along the top of the test section in 11.43 cm (4-1/2 in.) increments between 1.20 m (3 ft 11.3 in.) and 2.34 m (7 ft 8.3 in.) from the downstream end of the test section. This is without special insert plates.

Allowable strut loads are indicated in figure 12.

Transonic Strut

For transonic operation, sting-mounted models are mounted to the strut shown in figure 8. This strut is extended through the tunnel floor when supporting a model and when not in use is retracted below the tunnel floor. The strut centerline is at a fixed location 1.33 m (4 ft 4-1/2 in.) downstream of the test section.

The strut can be rotated in the vertical plane about a pin located 0.42 m (1 ft 4-1/2 in.) below the test section floor. The angle of attack can be remotely varied from 0° to +15°. The maximum radius of rotation is 1.94 m (6 ft 4-1/2 in.), and the minimum radius is determined by interference of the strut socket with the tunnel floor.

A terminal panel is located in the top of the strut for all electical and pressure connections from the model. This panel is accessible by removing the fairings from the sting socket.

Details of the sting end that mates with the strut are shown in figure 8. Allowable sting loads are also indicated in this figure.

8-1/2" Jet Exit Strut

The 8-1/2" Jet Exit Strut is a ceiling mounted unit designed for testing exhaust nozzles requiring high pressure air flow. The strut contains ducts for a primary air flow of 31.8 kg/sec (70 lb/sec) at $6.9x10^{6}$ N/m² (1000 psi) and a secondary air flow of 0.9 kg/sec (2 lb/sec) at $6.9x10^{5}$ N/m² (100 psi).

This strut has a thrust measuring system with a capacity of 22 200 N (5000 lb) and an alternate thrust/drag measuring system with a capacity of 8900 N (2000 lb). The strut has no angle-of-attack capability.

Figure 9 shows the strut assembly with a typical nozzle model attached. Allowable strut loads are also indicated in this figure.

Wall Mounting

Models too large or unusual in shape to be mounted on a sting or strut may be mounted to a wall of the test section. An example is shown in figure 10 of a model attached to the tunnel wall by use of the perforations.

AUXILIARY SYSTEMS

Air Systems

<u>High pressure air</u>.- A storage facility is available with a capacity of 4110 m³ (145 000 ft³) of standard dry air at $1.83x10^{7}$ N/m² (2650 psi) for use in the 8x6 Wind Tunnel. In addition, two other air storage facilities are interconnected with the 8x6 Wind Tunnel. These are 6120 m³ (216 000 ft³) for the 10x10 Wind Tunnel and 17 600 m³ (620 000 ft³) for the 9x15 Test Section. The three

facilities together provide a total capacity of 27 800 m^3 (981 000 ft^3) of standard dry air for use at the 8x6 Wind Tunnel. They are charged by a single 0.24 m^3/sec (500 ft^3/min) standard air pump. Total charging time from 2.76×10^6 N/m^2 (400 psi) to 1.83×10^7 N/m^2 (2650 psi) is approximately 28 hours. A heater for this high pressure system is capable of raising the temperature of the air 93° C (200° F) at a flow of 0.91 kg/sec (2 lb/sec).

Variable pressure air.- A variable pressure system is available up to 3.10×10^6 N/m^2 (450 psi). The system capacity is 15.9 kg/sec (35 lb/sec) at 3.10×10^6 N/m^2 (450 psi). A heater available with this system is capable of heating the air to 278° C (533° F) at a flow of 11.3 kg/sec (25 lb/sec) or to 371° C (700° F) at a flow of 6.8 kg/sec (15 lb/sec).

Service air.- The service air available is 8.62×10^5 N/m^2 (125 psi) air, with a capacity of 8.2 kg/sec (18 lb/sec) maximum continuous service.

Hydraulic System

A hydraulic system is available for actuation or positioning of a model and/or its components. This system is capable of a flow of 6.31×10^{-4} m^3/sec (10 GPM) at 2.07×10^7 N/m^2 (3000 psi).

Fuel System

The liquid fuel system has a storage capacity of 0.37 m^3 (97 gal) and a maximum flow to the test section of 2.84×10^{-4} m^3/sec (4.5 GPM) at 3.44×10^5 N/m^2 (50 psi). The maximum pressure available is 8.95×10^5 N/m^2 (130 psi) at a flow of 3.16×10^{-5} m^3/sec (0.5 GPM).

Photographic System

Photographic and television coverage of test section events may be obtained from several locations.

For side wall coverage, window assemblies (figure 11) are installed in the perforated section of the tunnel. These special windows are used in addition to the schlieren windows for cameras and lights. The window assemblies are available only for the side wall containing the personnel access door.

Figure 12 shows a camera and lighting arrangement used in the test section floor. The window assembly replaces a floor hatch at the downstream end of the test section. A similar arrangement can be made in the ceiling of the test section.

A model may also be photographed from a location downstream of the test section. Figure 13 shows a typical camera and light installation for this type of coverage.

High speed cameras (100 to 4000 frames per second) are available for use at the above locations. Because of the loss of perforated wall area, window assemblies may adversly affect aerodynamic data.

INSTRUMENTATION AND SUPPORTING EQUIPMENT

Force Measurement Systems

Sting strut.- To measure forces on models mounted on the sting strut there are three different size balance assemblies available. These are three-component bearing type strain gage balances incorporating Baldwin SR-4 strain gages mounted on cantilever beams. The three components measured are axial force, front normal force, and rear normal force. The balances contain interchangable strain gage links, resulting in a wide selection of capacities available. Figures 14, 15, and 16 show the 6.35 cm (2-1/2 in.), 10.16 cm (4 in.) and 12.70 cm (5 in.) diameter balance systems respectively.

The strain gage links can sustain momentary overloads up to 200 percent of rated capacity without damage to the strain gages. Structurally these links can take 500 percent of rated capacity before failure.

If it becomes necessary to reduce displacements or increase pitching moment capacity for a particular system two balances may be used in a model. However, such a system would have to be designed for the particular model with redundant force links made inoperative.

Following is a list of sting-mounted balance systems and alternate force measurement links available at Lewis Research Center.

Maximum Loads

Balance	2-1/2"	4"	5"
Lift lb	900	2500	6000
Drag lb	350	1800	4000
Pitching Moment in-lb	7200	30000	90000
Lateral Force lb	3600	8000	18000
Rolling Moment in-lb	3420	9000	25000
Yawing Moment in-lb	11700	30000	88000

Interchangable Links

Balance	2-1/2"	4"	5"
Lift Links lb	100 200 300 500 700 900	100 200 400 600 1000 1500 2500	250 500 1000 2000 3000 4500 6000
Drag Links lb	25 50 100 150 250 350	100 200 300 500 800 1200 1800	100 250 500 750 1000 1500 2250 3000 4000

Ceiling strut.- To measure forces on ceiling strut models a special balance is required. This balance should be part of the suspension system within the strut. Force measurements may be made by load cells or strain gages mounted on cantilever beams and must be designed for each strut and model installation.

Calibration.- Equipment is available to check out and calibrate the balances. It is possible to apply a combination of loads to the balance. Loads are applied by manually driven screwjacks and a strain gage link or load cell is used to measure the load applied. Equipment is also available for checking and calibrating strain gage links against dead weights. When possible, the complete assembled model is calibrated both in the shop and in the tunnel. A jacket, provided by Lewis Research Center, is installed around the balance to maintain a constant temperature during the tunnel run eliminating changes in calibration and zero shift due to temperature variations.

Angle-of-Attack Indicator

A model angle-of-attack indicator system is available to ascertain the true model attitude. This makes it possible to correct for sting and strain gage balance deflections. The system consists of an angle-of-attack transmitter, shown in figure 17, installed in the model, and a receiver located in the control room. The overall accuracy of the system is within 0.1°. The angle-of-attack range is between -45° and +45°. The wiring provided, in the model, for the transmitter should be four conductor shielded high temperature wire of size No. 18 or No. 22. Installation and calibration of this angle-of-attack indicator will be performed at Lewis Research Center by wind tunnel personnel.

A mock-up unit is available for fit checks and shop assembly of the model.

Thermocouples

Alloy wiring is connected from jacks on the upper and lower strut terminal panels to thermocouple junction reference units near the control room. The temperature of the wire junctions within these units is held to 101.1° C ±0.14° C (150° F ±0.25° F). Copper cables are run from these units to patchboards in the tunnel control room. A maximum of twenty-seven thermocouples of each type may be patched to each of three control room selector switches and read on digital temperature indicators. In addition, all thermocouples may be patched to inputs on the CADDE II data recording system (described in the section on DATA ACQUISITION AND PROCESSING).

Schlieren System

The tunnel is equipped with a schlieren system which may be located at either an upstream or downstream position. The system is capable of viewing the flow through all possible locations of the 0.673 m (26.5 in.) diameter windows whose centers may be positioned about a 0.406 m (16 in.) diameter. Figure 18 shows the plan view of the system.

Schlieren images are viewed using a remote optical system and photographs of the images are taken by an aircraft camera Type K 22. A total of 100 photographs 22.9 x 22.9 cm (9 x 9 in.) may be taken without reloading the camera. In addition, a Fastex 16 mm high speed motion picture camera is capable of taking 100 to 4000 frames per second pictures of any image shown through the remote optical system.

DATA ACQUISITION AND PROCESSING

A wide range of data acquisition and processing equipment is available as follows:

Central Facility Data Recording

CADDE II.- CADDE II (Central Automatic Digital Data Encoder) data recording system is a low speed voltage scanner and digitizer designed to convert steady state direct current signals to digital numbers at a rate of twenty five samples per second. The raw data is recorded on digital magnetic tape, which becomes the permanent data record. Optionally, the raw data can be sent to the central computing facility for further processing. A schematic diagram of the data system is shown in figure 19.

Up to 200 channels are available on the CADDE II system with an accuracy of ±0.05 percent of full scale. Full scale voltages, under programmed control, are as follows; ±10mv, ±20mv, ±50mv, ±100mv, ±200mv, ±10v, ±100v. These 200 or fewer channels can be scanned in one of four ways:

1. Single scan: Each channel is sampled once, after which the scan is terminated. This is the method most frequently used.

2. Continuous scan: Each channel is sampled once; the system then automaticly starts over and continues this process until a manual stop command is entered.

3. Discontinuous scan: Same as continuous scan, except that the scanning can be halted for an indefinite period and then resumed under manual control.

4. Intervalometer: Causes one scan of all channels and then halts for a pre-determined time (up to one hour) after which a new scan is initiated. The sequence is terminated by a manual stop command.

The raw data may be typed back to the facility control room for immediate inspection by the project personnel.

Multiple pressure scanning system.- Model pressures are sampled by means of Scanivalves. The Scanivalve unit contains a solenoid-actuated rotating pressure passage which sequentially connects 48 pressure lines to a single transducer. The CADDE system is used to step the Scanivalves and record the transducer signals. Up to eight of these Scanivalves are available for a test program. Of the available 48 ports per scanivalve, 5 are used for dynamic calibration signals and are thus unavailable for model instrumentation. Full scale pressure ranges available are; 1.03 N/m² (15 psia), 1.72 N/m² (25 psia), 3.44 N/m² (50 psia), and 6.90 N/m² (100 psia). An accuracy of ±0.15 percent of full scale is maintained due to the dynamic calibration mechanism.

Since this pressure measuring system uses the CADDE II system, the total number of pressure signals is subtracted from the total channels available (500) to obtain the number of other signals that can be recorded.

Central analog recording system.- The Central Analog System records data on magnetic tape in IRIG standard format. Data is recorded on 12 tracks and real time in IRIG B format is recorded on one track. Each of the 12 tracks can be used as for single wide band channel (10K Hz) or for 5 multiplexed, constant bandwidth (4K Hz) inputs. If all 12 channels are multiplexed, a total of 60 inputs are available. Full scale input voltages are ±10mv, ±20mv, ±50mv, and ±100mv, with an accuracy of ±1.0 percent. If multiplexing is used, all 5 channels for one tape track must have the same full scale input. Control of the recorder is remote at the facility.

For playback, up to 55 multiplexed (or 12 non-multiplexed) channels can be displayed on strip chart recorders or light beam oscillographs. Automatic tape search based on record time is available. A limited amount of analog signal processing equipment is also available depending on the type of analyses desired.

Local Analog Recording System

A 14 channel tape recorder is located in the facility control room. One of the channels is used for IRIG B time clock and one for tape speed control, leaving 12 channels available for data. These channels may use any combination of Direct Record [300 Hz to 600K Hz at 305 cm/sec (120 in./sec)] or FM [DC to 40K Hz at 305 cm/sec (120 in./sec)] inputs. The input voltage is 0.1 to 10 volts on Direct Record or ±1.0 volt to ±25 volts on FM. Tape speeds are 2.38 cm/sec (15/16 in./sec) to 305 cm/sec (120 in./sec). A variety of signal conditioning and monitoring electronics is also available in the control room.

Tape playback is accomplished either locally in the control room, or off-line at the central data facility.

Data Processing

The data recorded from a facility is reduced by a variety of high speed digital and analog systems located at the Lewis Central Computer Facility. Digital computer programs are usually coded in FORTRAN IV level G, but BASIC, PL-1, APL, and assembled coding is also used for special cases.

On-line time sharing.- Data recorded on the CADDE II system can be automatically sent to the Lewis Time-Shared Computer Facility for on-line analysis. The computers used are two IBM model 360/67 running in full duplex operation. The virtual memory hardware gives each user an apparent core size of four billion bytes (8 bits equal 1 byte), thus offering an almost unlimited capacity for data analysis. Raw data is stored on high speed disc storage units for use by the analysis programs. A flexible data analysis and control package is used to process the raw data, apply the calibrations, and present engineering units to the analysis program. This analysis program contains all the calculations desired for a given test program.

The results of this analysis are processed by the output section of the system for display in the facility control room, either on electric typewriters or on a variety of high speed graphic displays. Both listed numeric and graphic data can be presented. This data display is under control of the project engineer while the test is running. This allows computed data to be available for decision making concerning the next or future data points to be taken.

Off-line batch processing.- The bulk of data is processed after the tunnel run is completed. Typically, the same program as used for the on-line data is used in a batch mode on the time-sharing system. Data is then printed on high speed printers or processed on off-line microfilm. The microfilm will accommodate both listed numeric data and graphic output.

In addition to the time-sharing system, data can be analyzed on an IBM 7090 direct couple system or on a UNIVAC 1106 system.

Off-line analog processing.- Off-line processing of analog data is handled by a variety of interconnected signal processing systems. In addition to strip chart and light-beam oscillograph recording, a Federal Scientific UA-6A spectrum analyzer is available, as well as X-Y plotters, oscillographs and an analog computer. If digital processing is desired, data may be read from the analog tapes and digitized by the use of an SEL 810A computer with a 48 channel MUX and A/D converter. The output is a 9 track digital tape in the Lewis GIF format. This tape can be read on other Lewis digital computers for additional processing.

MODEL INFORMATION

Model Size

Figure 20 shows the approximate maximum projected frontal area (model plus support strut) for tunnel starting. Since the limiting model size is influenced by such factors as model shape and shock boundary-layer interaction, each model proposal must be evaluated independently. For more information see references 1, 2, 3, and 4.

Model Design Criteria

Tunnel test models should be designed for the following applicable load conditions:

Steady-state loads.- The allowable stresses for the maximum loading conditions should not exceed 1/5 of the ultimate stress or 1/3 of the yield stress, whichever is least. In addition, for members loaded as columns, the Euler critical load should be at least three times the applied load.

Supersonic starting loads.- For starting loads, the design should be based on a 10° air flow direction added to the angle of attack of the model at tunnel starting. The dynamic pressure used should be maximum tunnel dynamic pressure as given by figure 4d. When using this criteria the allowable stresses should not exceed 1/2 of the yield stress. This technique for considering starting loads is given as a general guide. Therefore; models, unusual in size, shape, or operation, may require special analyses.

All auxiliary parts of the model exposed to the air stream and nominally at zero angle of attack should be evaluated at 10° angle of attack.

Subsonic loads.- For subsonic loads, the design should be based on a 5° air flow direction added to the maximum angle of attack of the model during tunnel operation. The dynamic pressure used should be the maximum anticipated for the subsonic flow as given in figure 4d. The allowable stresses should not exceed 1/2 of the yield stress.

Pressure Instrumentation

The recommended pressure tubing size is 1.59 mm (1/16 in.) outside diameter and 0.30 mm (0.012 in.) wall thickness. Static pressure orifices should be flush with and perpendicular to model surfaces.

For sting-mounted models the tubing should extend at least 0.91 m (3 ft) downstream of the sting socket on the strut. For models mounted on a ceiling strut the tubing should extend at least 3.05 m (10 ft) above the top of the ceiling strut.

Rakes used to determine pressure recovery and pressure distribution should be designed to avoid resonance with model operating mechanisms. Any brazing required on rakes should be the silver-braze type. Rake tubes should be spaced to measure equal areas facilitating pressure integration. A filler plate should be provided to replace each removable rake.

Thermocouple Wiring

All model thermocouples should be made with high-temperature glass-insulated thermocouple wire of as heavy a gage as practical. Leads extending from the model should be long enough to reach the appropriate strut terminal panel and should terminate in the Thermo Electric Co. Type 2PSS plugs.

The following table lists the type and number of thermocouple circuits available.

Quan.	Wire Type (ISA)	
48	Iron/constantan	Type J
24	Chromel/alumel	Type K
48	Copper/constantan	Type T
24	Platinum, 13% Rhodium/Platinum	Type R

Actuators and Position Indicators

To accomplish remote positioning of wind tunnel model components, screwjacks and hydraulic cylinders are commonly used. Electrically driven screwjacks should be provided with limit switches to protect the model and mechanism from damage due to overtravel. Hydraulic cylinders should be sized so their travel cannot exceed safe limits and they should be of the cushioned type if they are to move rapidly. The hydraulic system available is rated at 1.26×10^{-3} m^3/sec (20 GPM) at 2.07×10^7 N/m^2 (3000 psi).

Remote position indication is often provided by a linear or rotational potentiometer. Each potentiometer should have a total resistance of 1000 ohms and be linear within 0.1 percent.

Electrical Cables

Electrical cables from the model are terminated in connectors which mate with an existing cable system extending between the tunnel test section area and the control room. The types of cables available are:

Power cables.- Type "A" cables are used for heavy power circuits (greater than 2 amperes at 28 volts or 5 amperes at 120 volts). Several of these circuits may be grouped in a single cable. Type "C" cables are used for small motors, limit switches, selsyns, and so forth. Several of these circuits may also be grouped in a single cable.

Signal cables.- Type "E" cables are used for strain gage type transducers, potentiometers, servovalves and other circuits requiring shielded wires. Type "K" cables are coaxial type and are used for piezoelectric transducers.

Each device should use an individual cable. Differential transformers should use separate cables for power and signal. The shield of each cable is fastened to the connector cable clamp.

The information necessary to supply model cables with connectors is given in the following tables:

Sting Strut Terminal Panel

Type	Quan.	Cable	Cable Terminal Connector	Required Mating Connector
A	6	6 conductor No. 9 AWG	MS 3100A-24-10S	MS 3106A-24-10P
C	10	12 conductor No. 16 AWG	MS 3100A-24-19S	MS 3106A-24-19P
B	48	6 conductor No. 20 AWG shielded	MS 3100A-14S-6S	MS 3106A-14S-6P
K	12	RG 62/U coaxial	BNC male	BNC female

Ceiling Strut Terminal Panel

Type	Quan.	Cable	Cable Terminal Connector	Required Mating Connector
A	3	6 conductor No. 9 AWG	MS 3100A-24-10S	MS 3106A-24-10P
C	5	12 conductor No. 16 AWG	MS 3100A-24-19S	MS 3106A-24-19P
B	54	6 conductor No. 20 AWG shielded	MS 3100A-14S-6S	MS 3106A-14S-6P

FACILITIES AVAILABLE TO USERS

Model Stand

A sting-mounted model stand is available for assembly and check-out of a model prior to tunnel installation. When mounted on the stand, the sting centerline is 1.22 m (4 ft) above the floor.

Machine Tools and Lifts

The balance chamber contains an overhead 2700 kg (3 ton) capacity crane. Also available is collection of machine tools including a lathe, a Do-All band saw and several drill presses and bench grinders. For sheet-metal work, a 0.91 m (3 ft) light gage roll, 0.91 m (3 ft) light gage bending brake, 1.22 m (4 ft) light gage shear, 0.61 m (24 in.) throat punch, and a throatless shear are available. Various size surface plates are available for setup and layout work. There are several types of hand trucks and a 0.61 x 0.91 m (2 x 3 ft) elevating table with a capacity of 900 kg (2000 lb).

A tool crib located in the tunnel area has a complete line ot hand tools including some hand power tools. Also available are acetylene, electric, and heliarc welding equipment as well as a small spot welder.

Electrical Systems

At either the model stand or the tunnel test section the following types of electrical power are available:

440 volt, 60 cycle, 3 phase, A.C.
208 volt, 60 cycle, 3 phase, A.C.
120 volt, 60 cycle, 1 phase, A.C.
120 volt, 400 cycle, 1 phase, A.C.
26 volt, 400 cycle, 1 phase, A.C.
28 volt, D.C.

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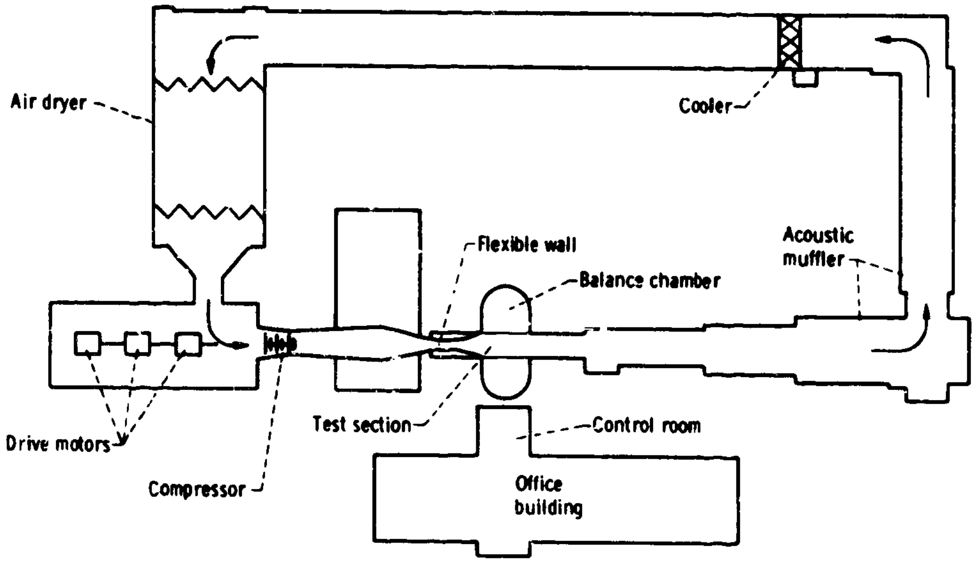
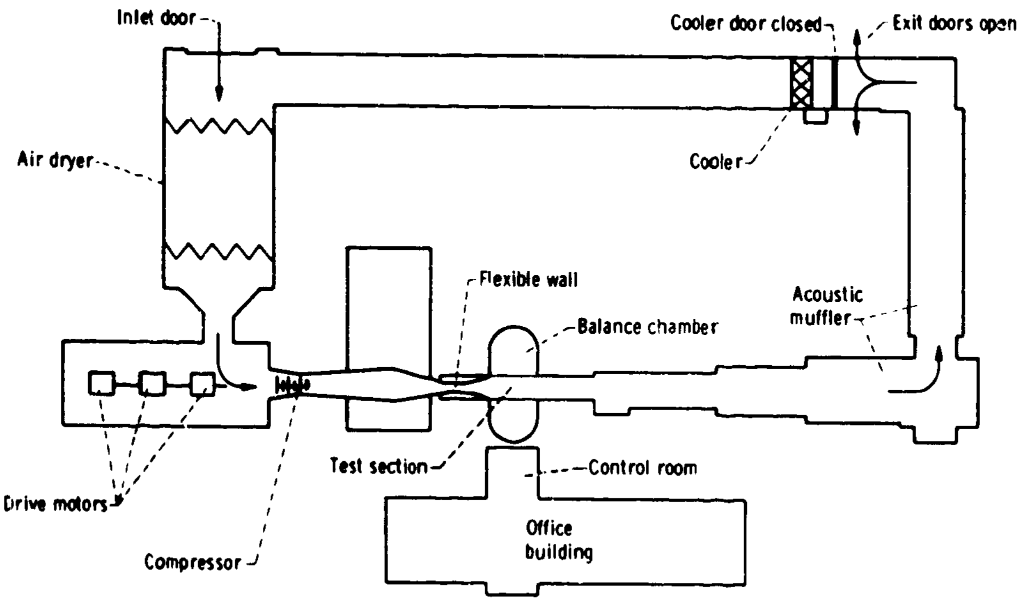


(a) Aerodynamic cycle.



(b) Propulsion cycle.

Figure 1.

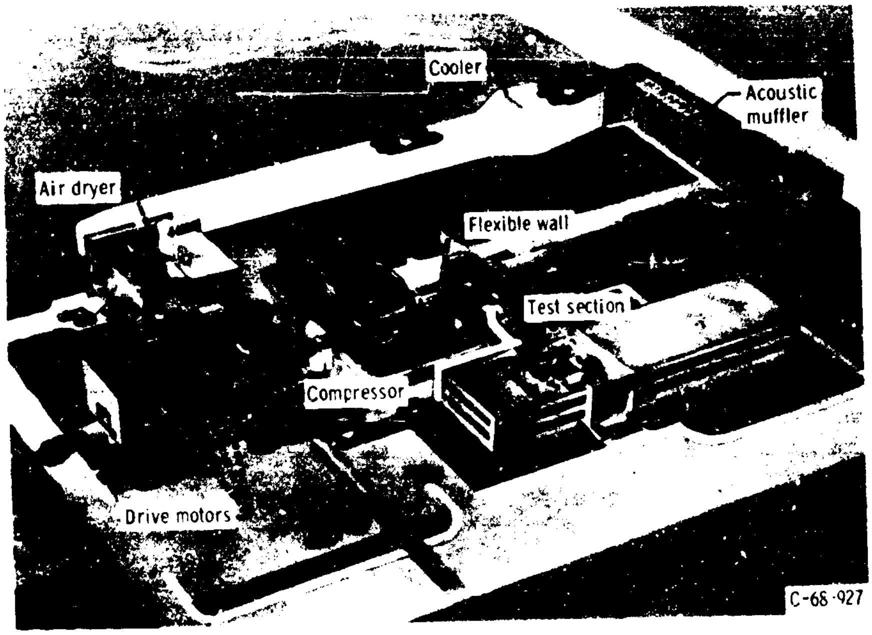


Figure 2.

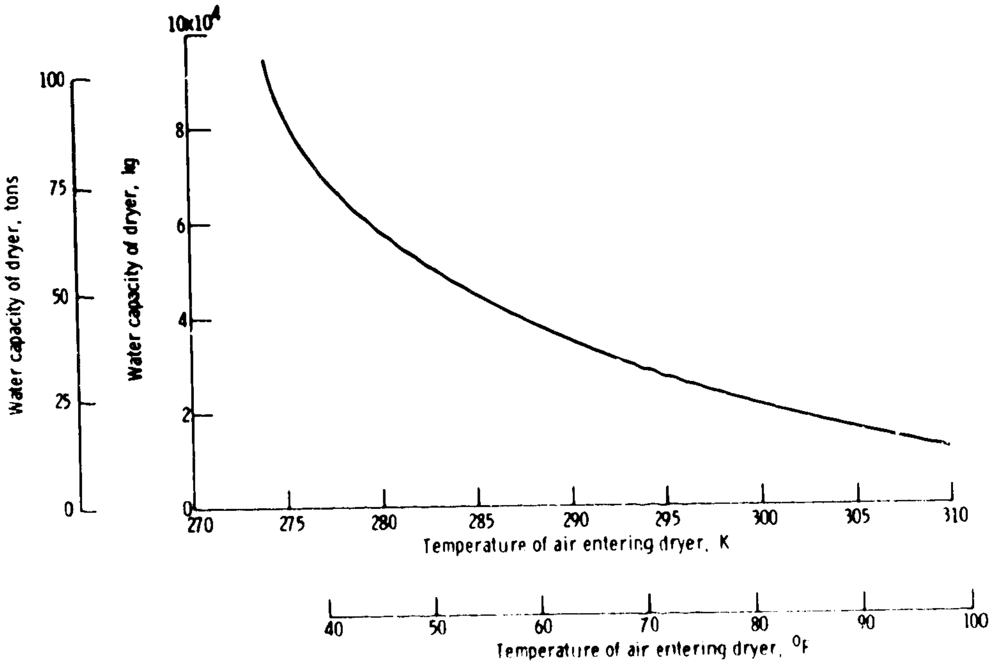


Figure 3. - 8- by 6-Foot Supersonic Wind Tunnel air dryer capacity.

E-7949

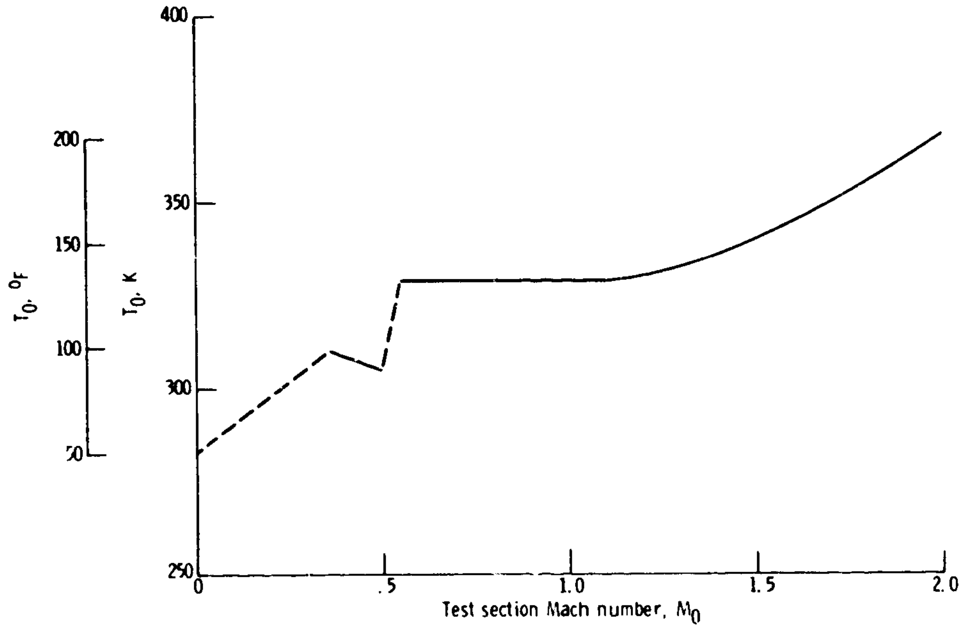


Figure 4a. - 8- by 6-Foot supersonic wind tunnel total temperature. Average temperature day.

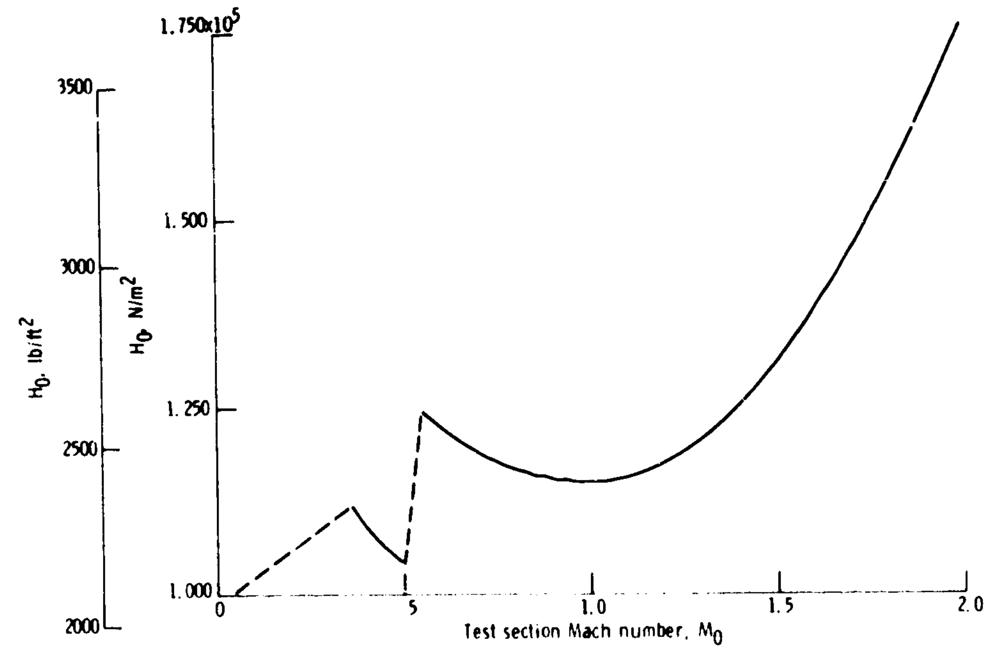


Figure 4b. - 8- by 6-Foot supersonic wind tunnel total pressure.

E-7943

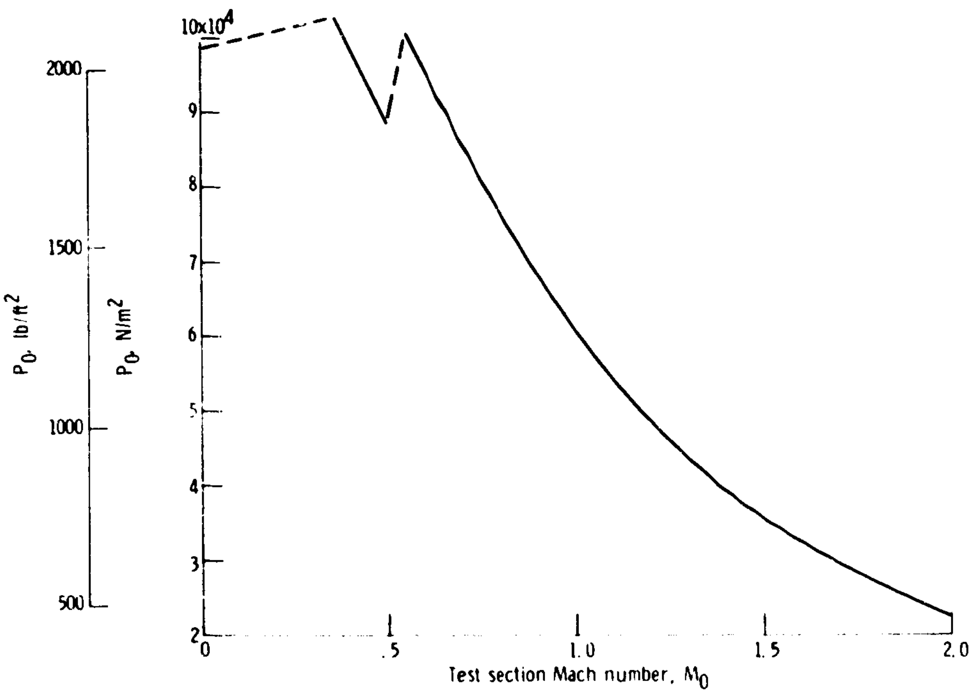


Figure 4c. - 8- by 6-Foot supersonic wind tunnel static pressure.

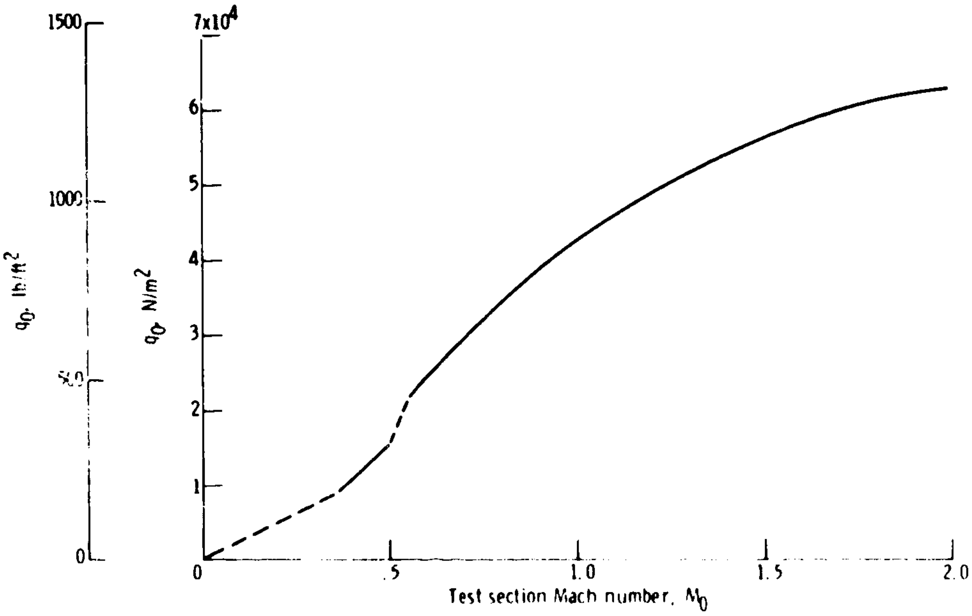


Figure 4d. - 8- by 6-Foot supersonic wind tunnel dynamic pressure.

E-7949

E-7949

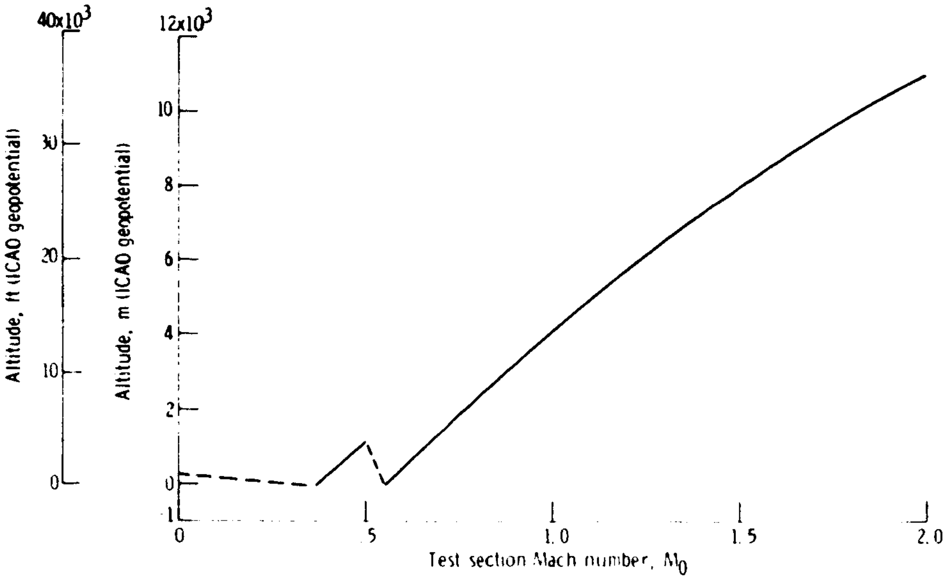


Figure 4e. - 8- by 6-Foot supersonic wind tunnel altitude.

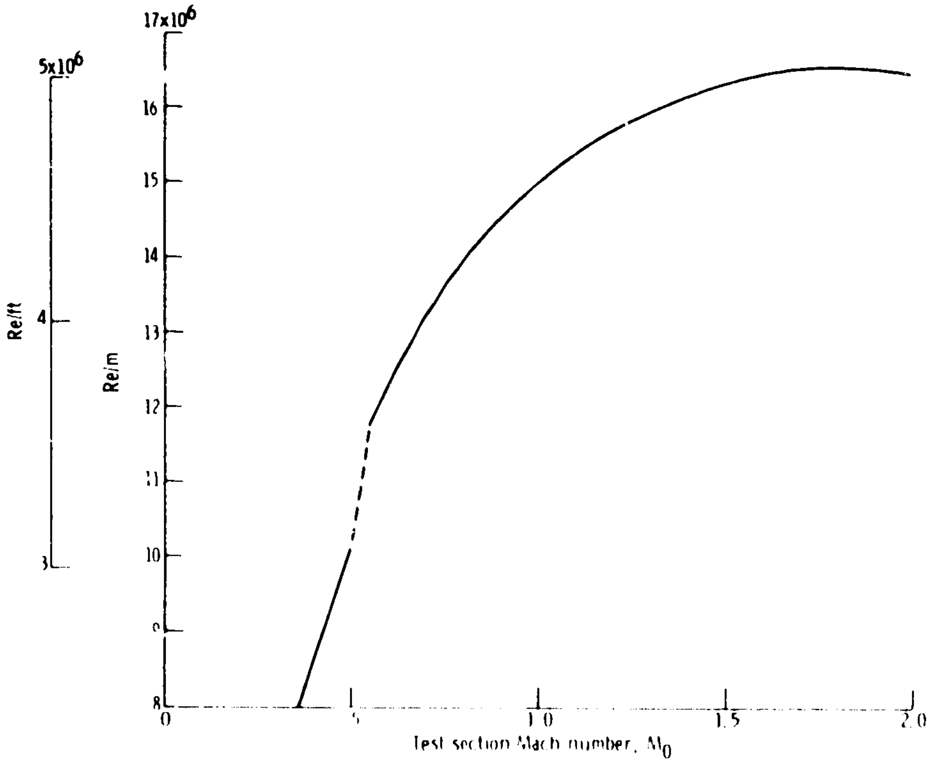


Figure 4f. - 8- by 6-Foot supersonic wind tunnel Reynolds number.

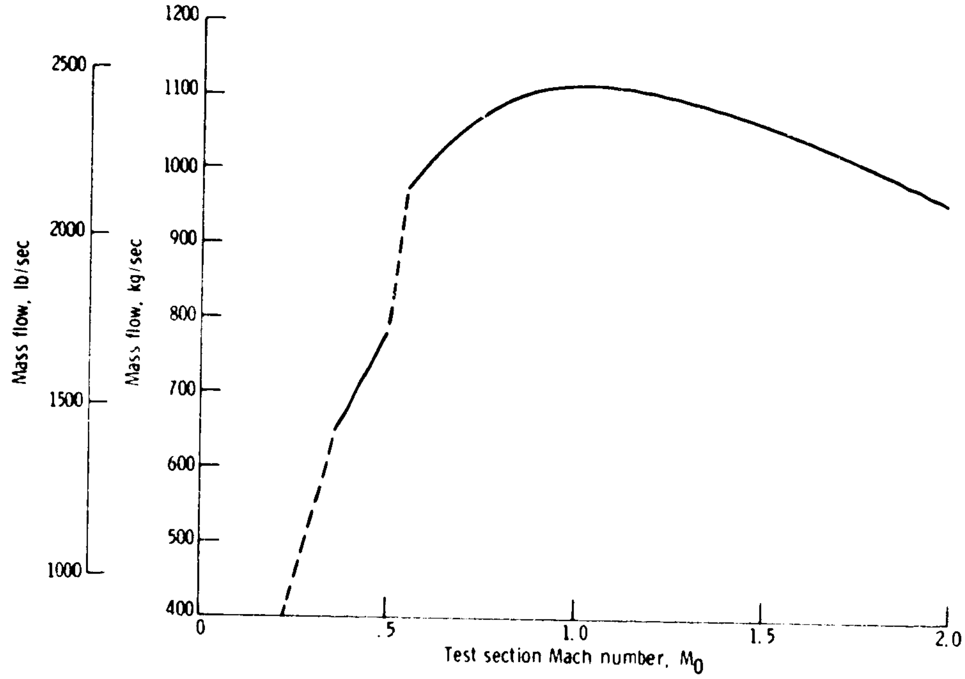


Figure 4g. - 8- by 6-Foot supersonic windtunnel mass flow.

E-7949

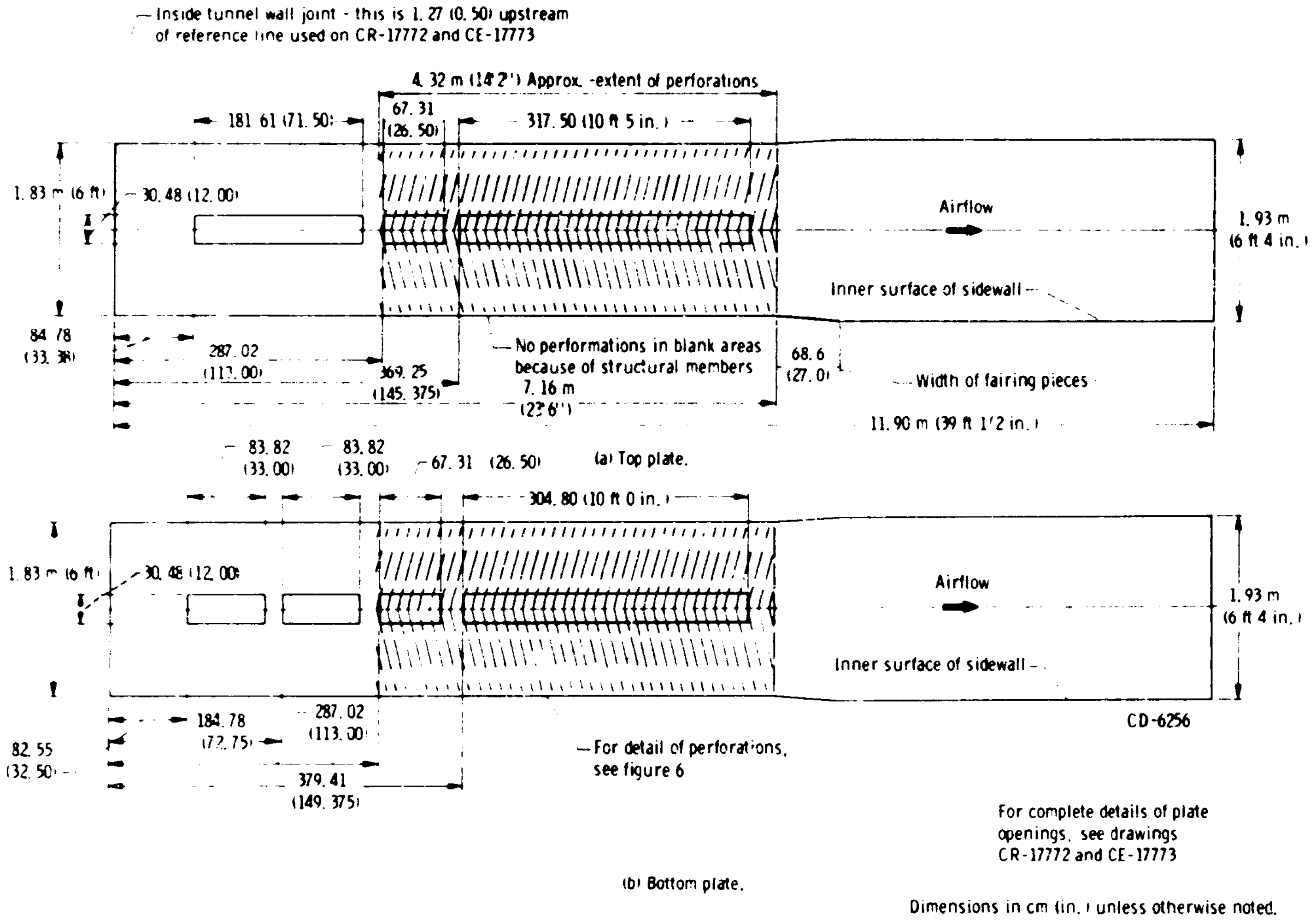


Figure 5. - 8x6 Foot test section plan view.

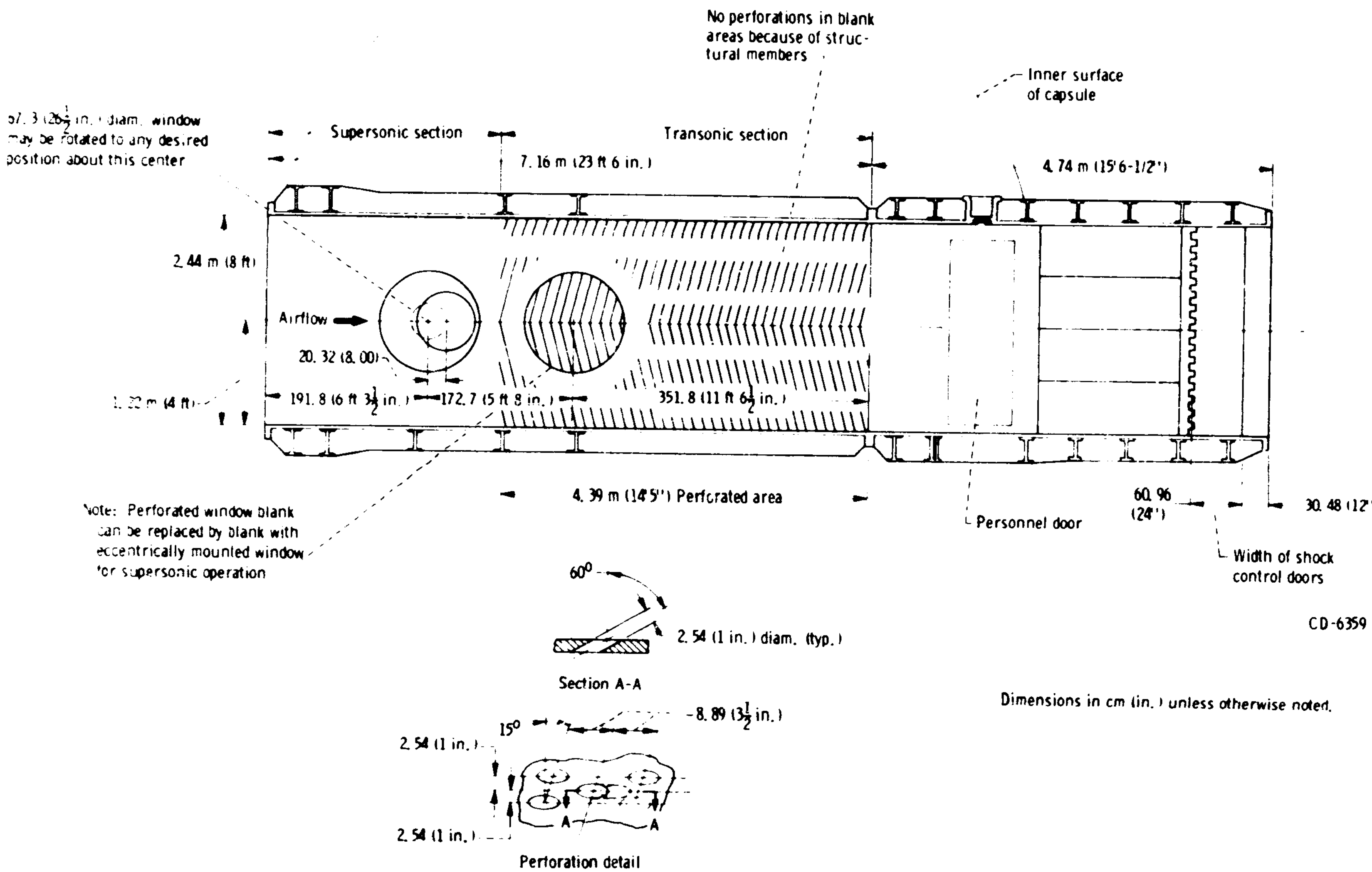


Figure 6. - 8x6 Foot test section elevation view.

E-7949

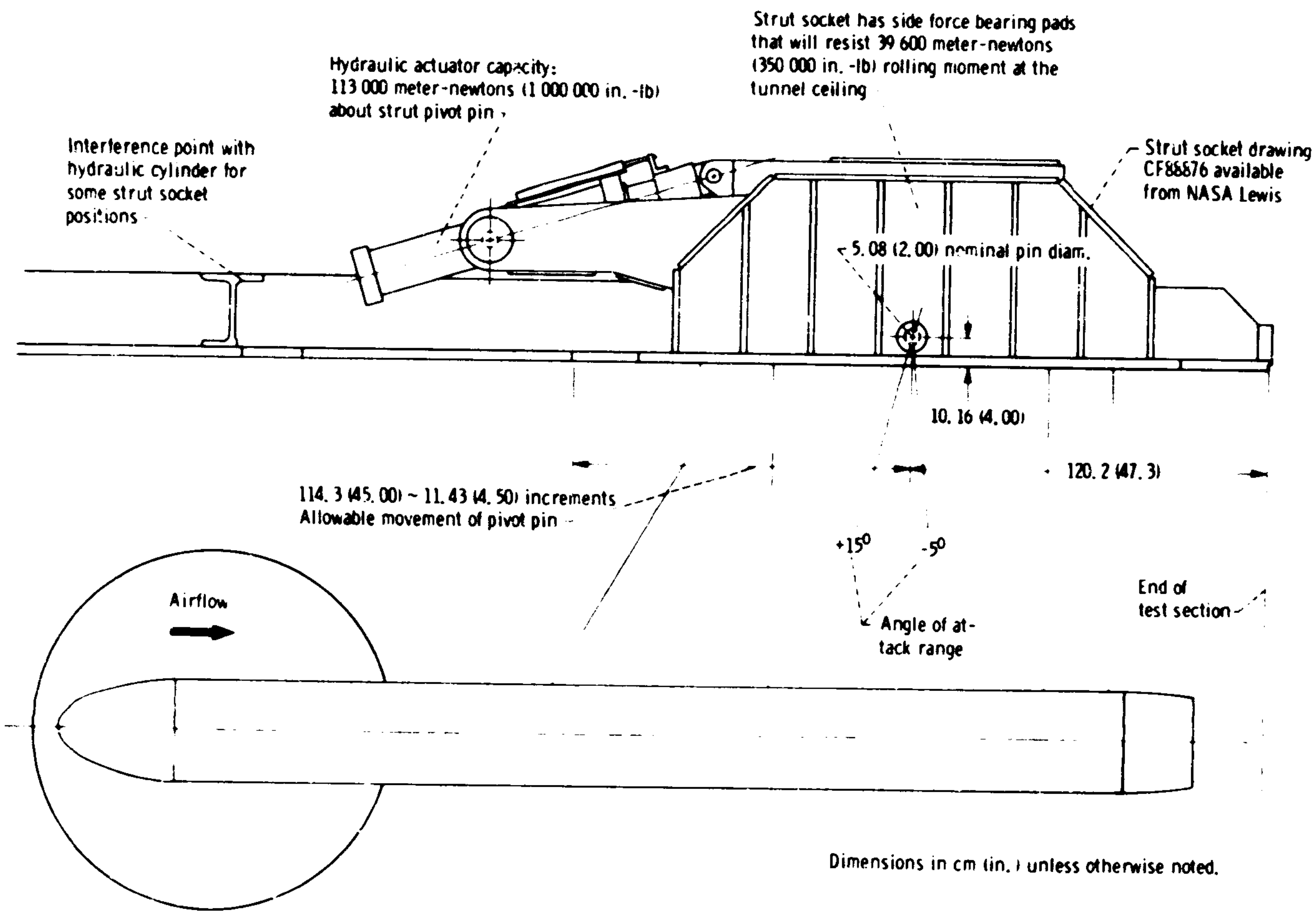


Figure 7. - Ceiling strut socket and actuator.

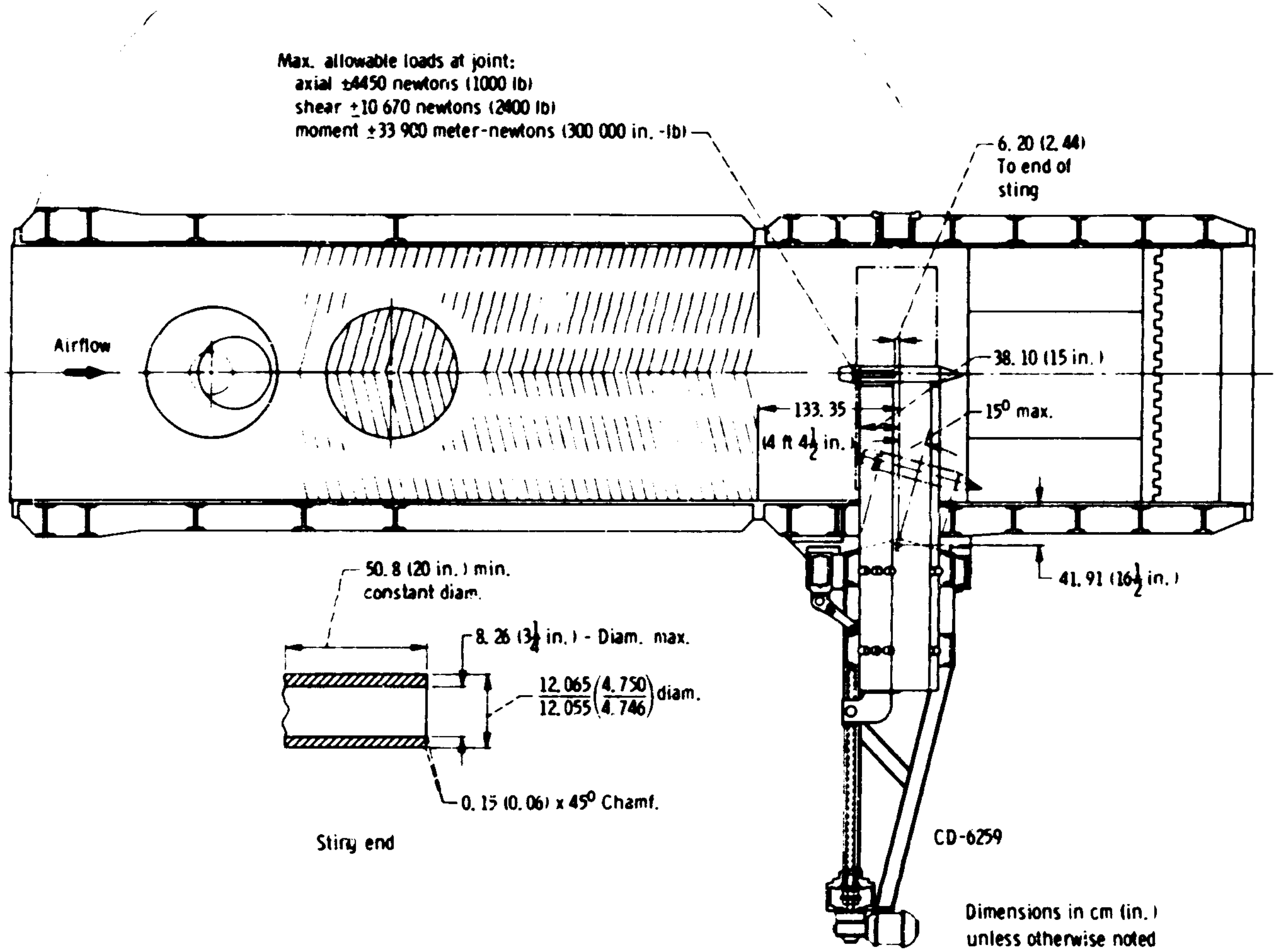


Figure 8. - Transonic strut for sting-mounted models.

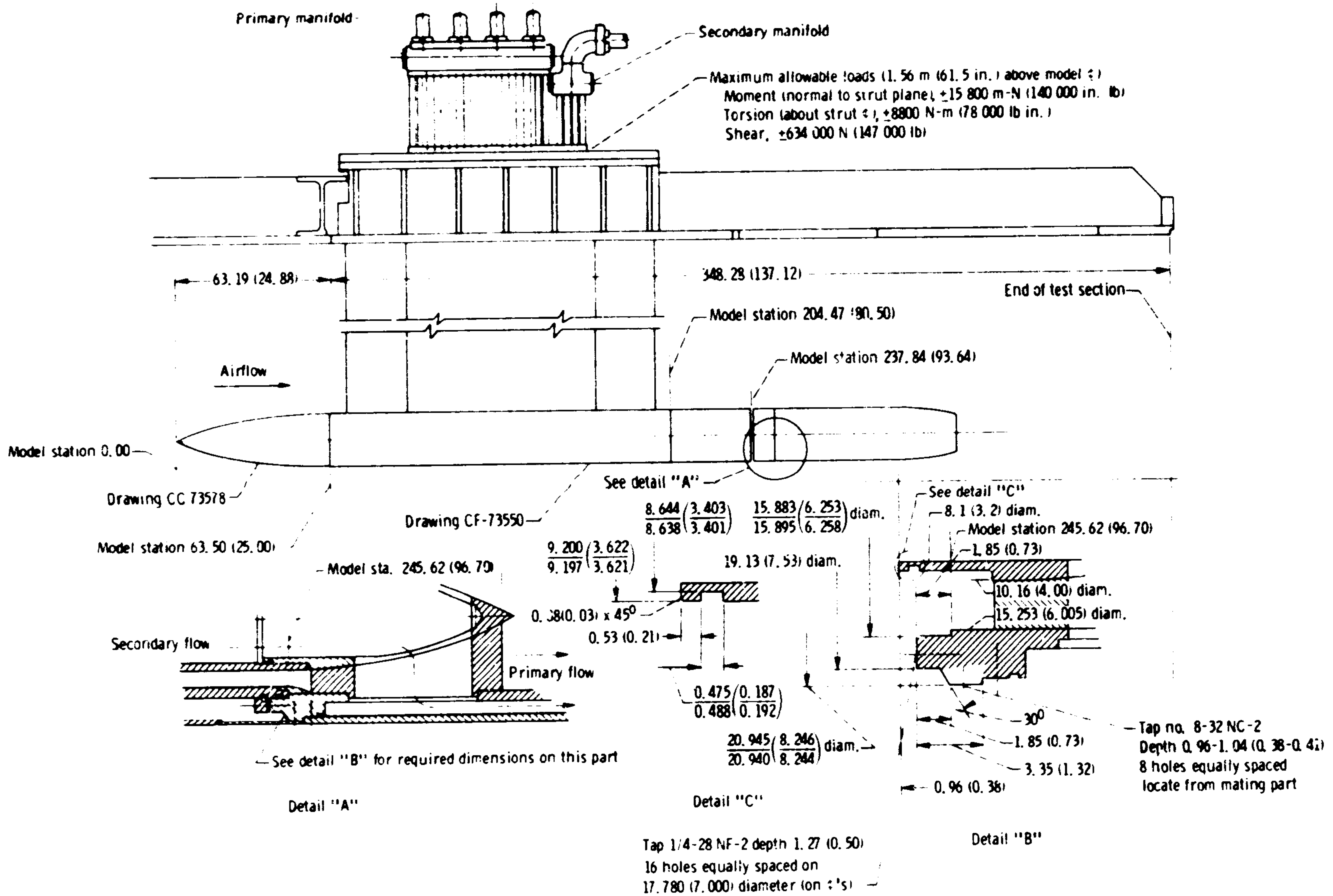
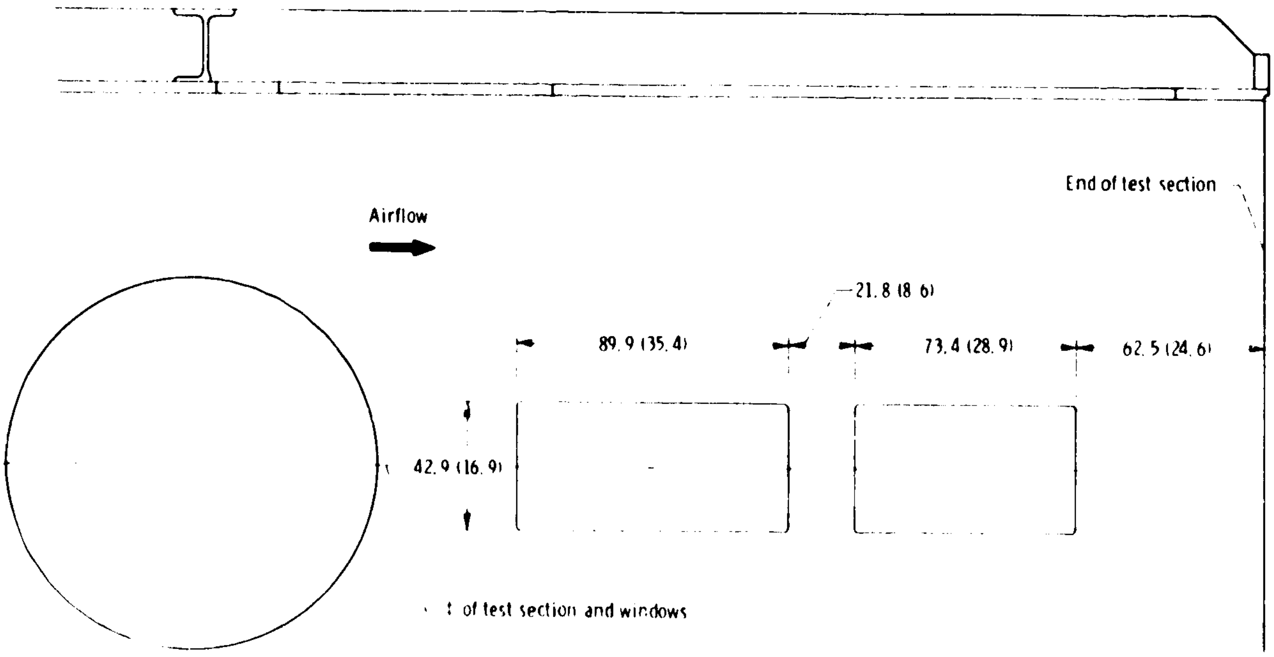


Figure 9. - $8\frac{1}{2}$ inch jet exit model.

Figure 10. - Wall-mounted model.



Dimensions in cm (in.) unless otherwise noted.

Figure 11. - Photographic window assemblies.

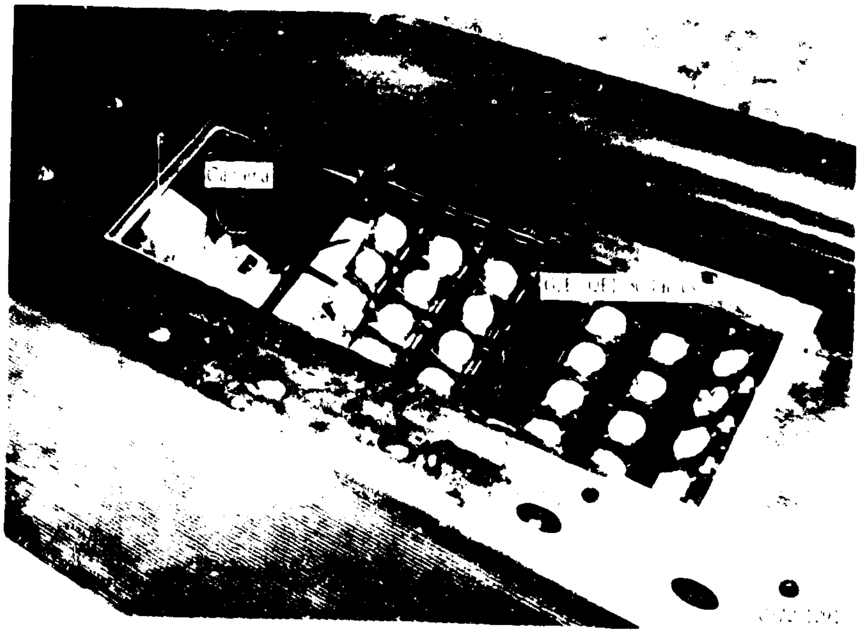


Figure 12. - Floor mounted camera and light system.

Figure 13. - Downstream camera and light system.

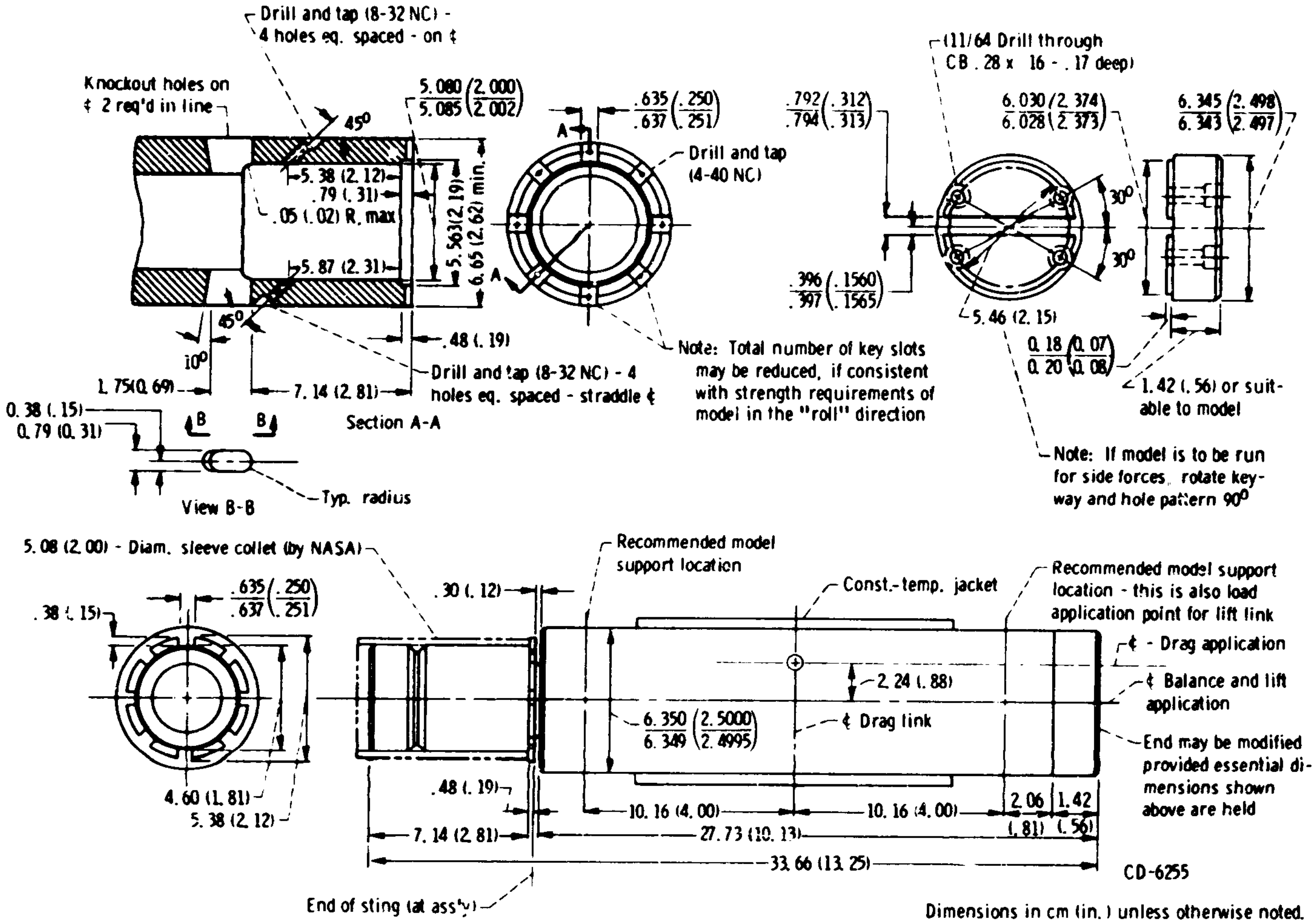


Figure 14. - $2\frac{1}{2}$ Inch strain gage balance

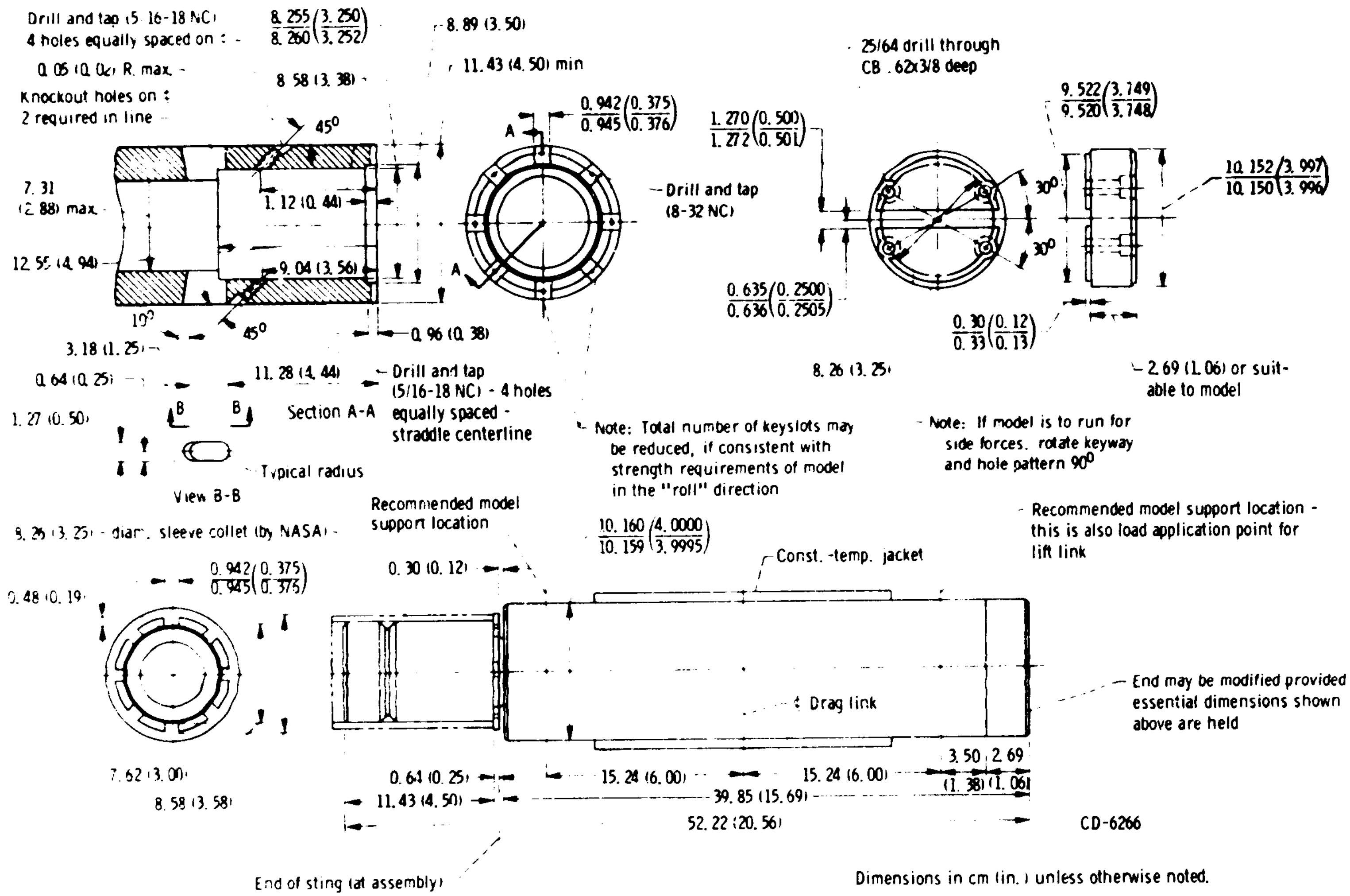


Figure 15. - 4 Inch strain gage balance.

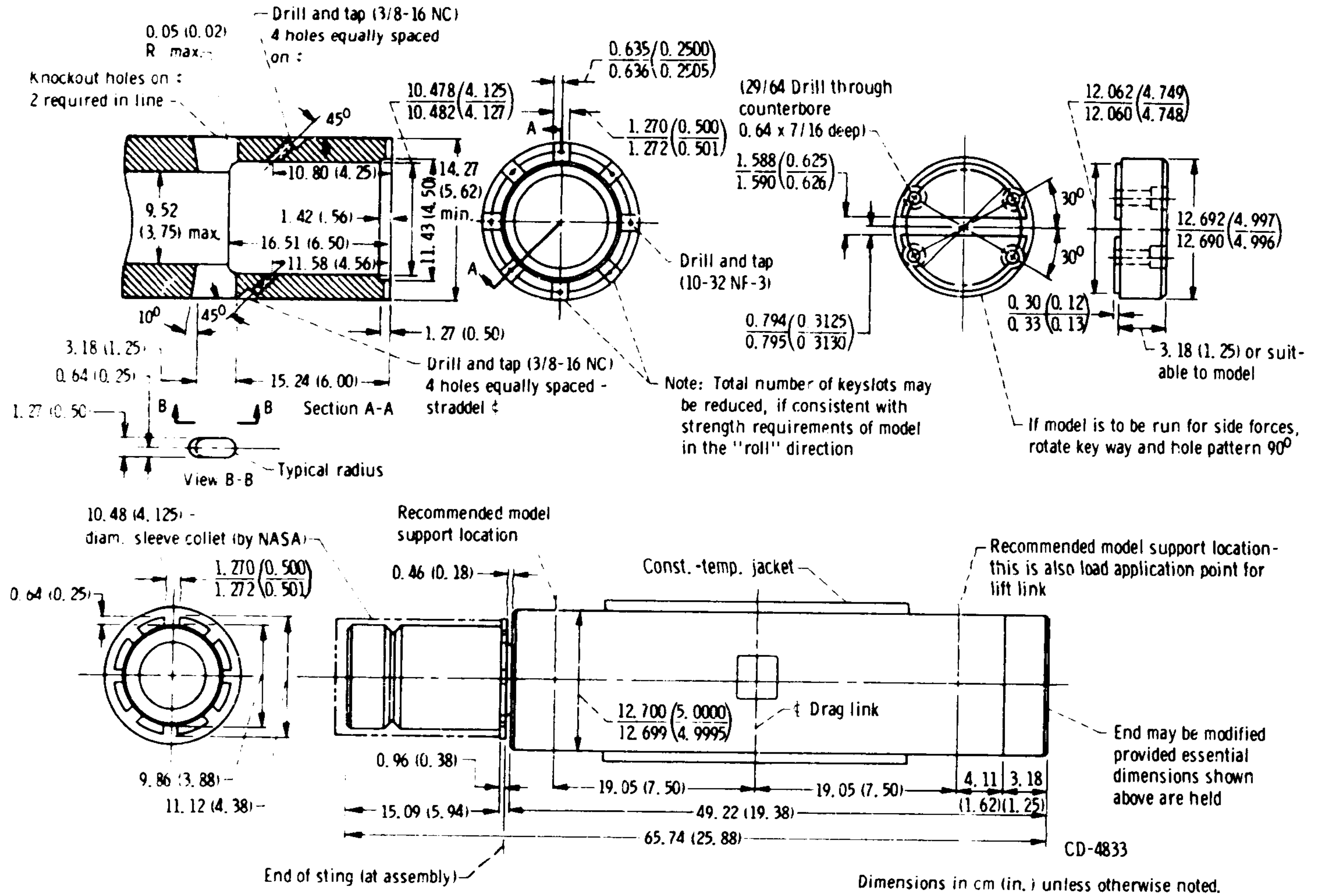


Figure 16. - 5 Inch strain gage balance.

E-7149

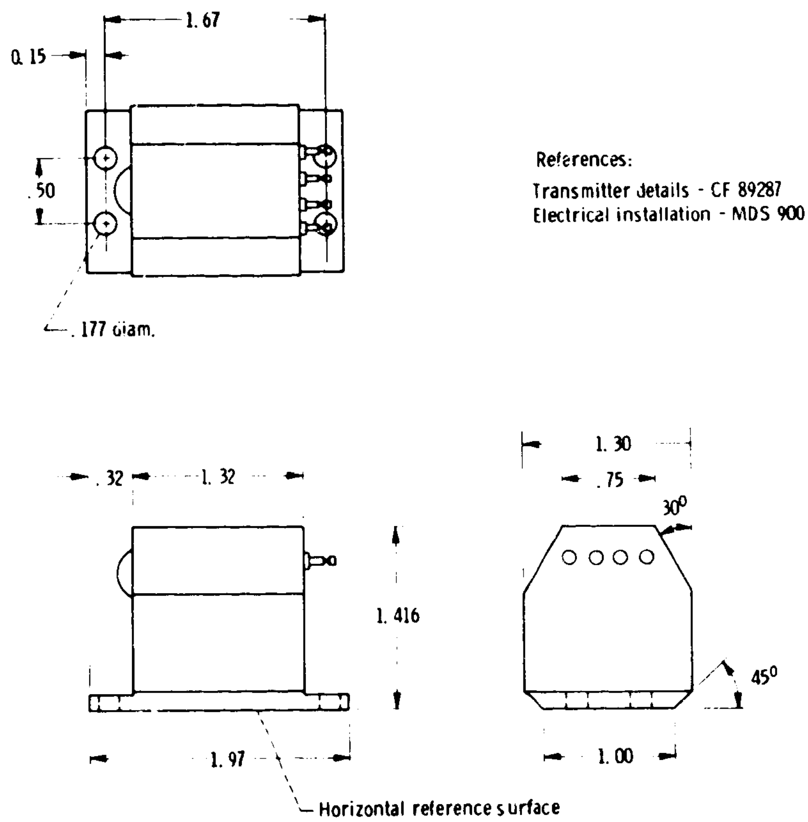
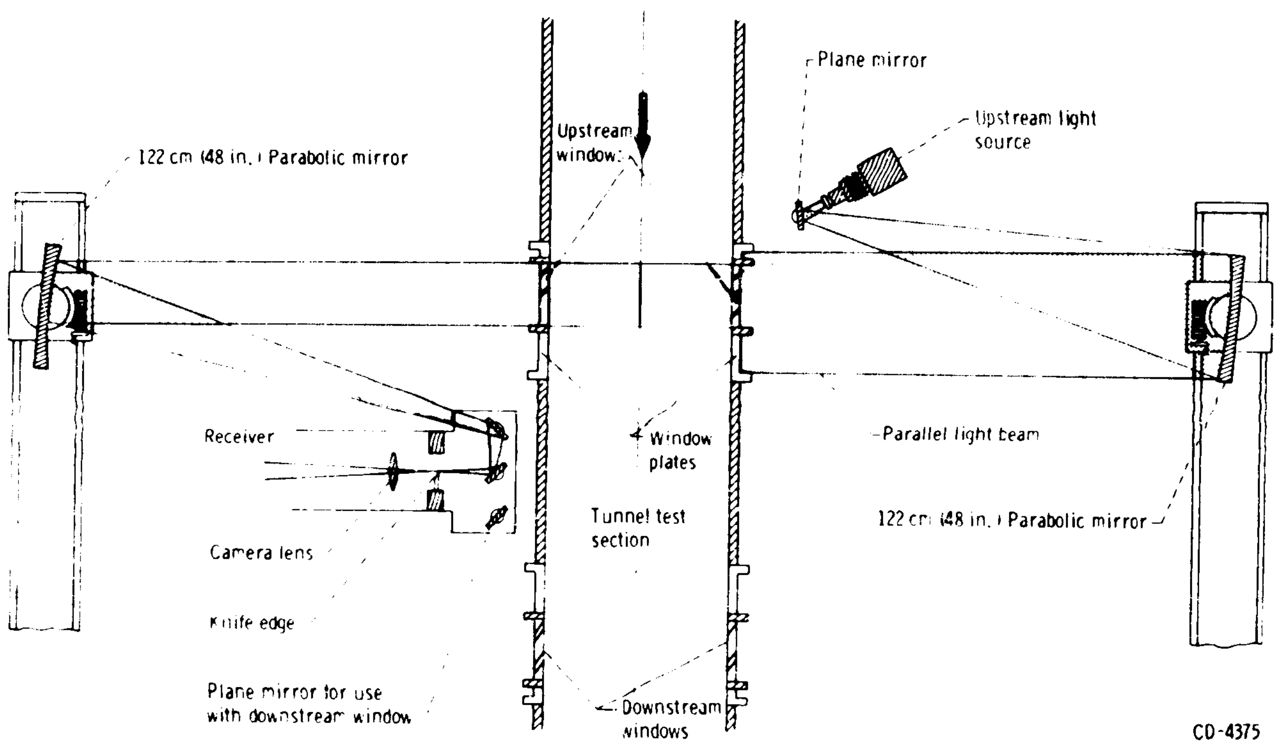


Figure 17. - Angle-of-attack transmitter.



Plan view of schlieren viewing system

Figure 18. Supersonic schlieren

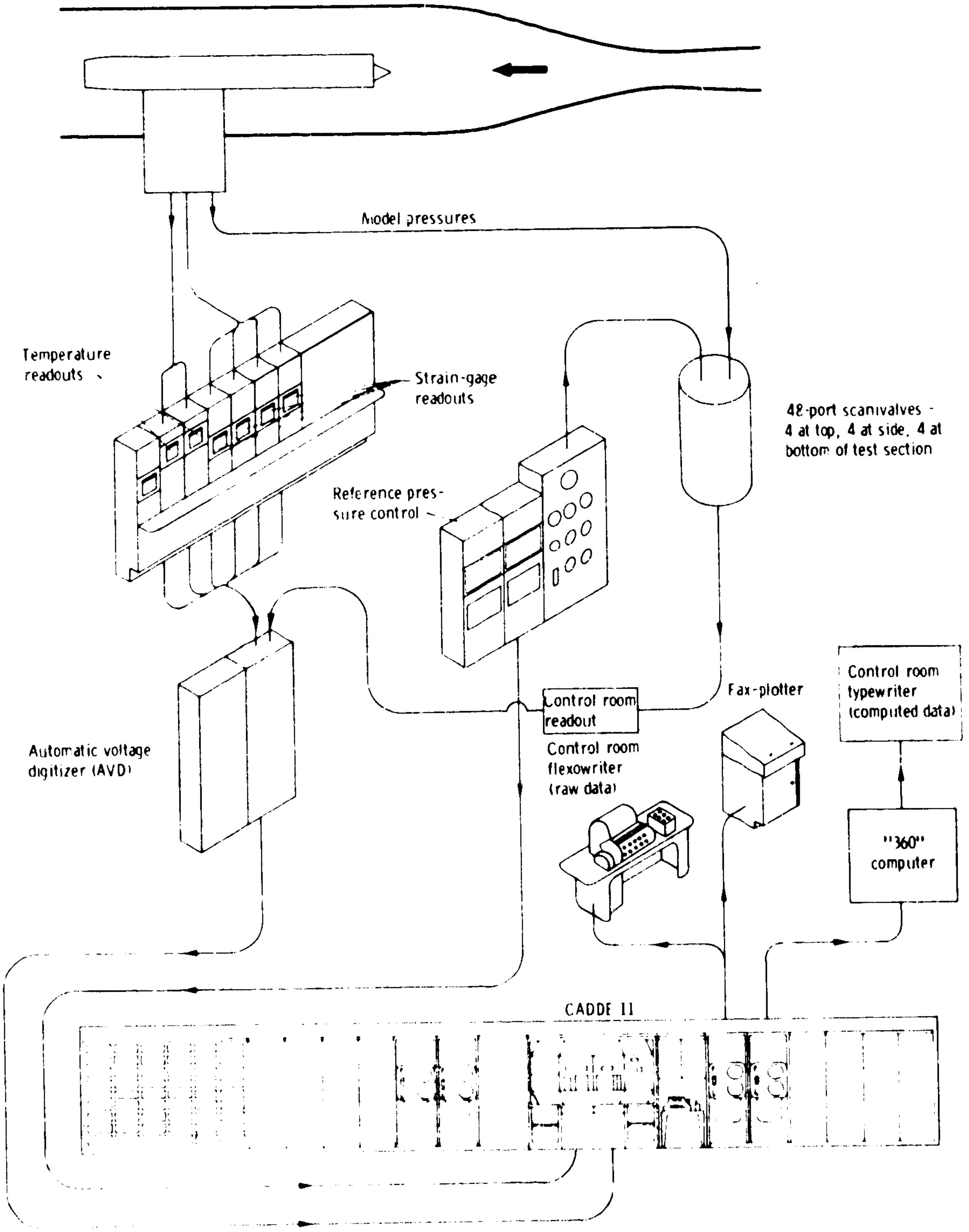


Figure 19. Automatic data recording and processing system.

E-7417

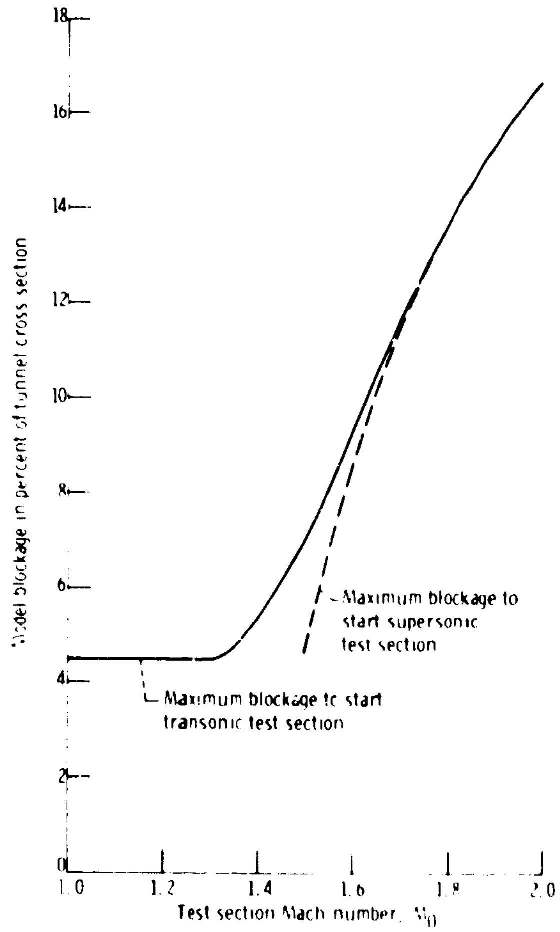


Figure 20. - 8- by 6-Foot Supersonic Wind Tunnel starting limitations.