

VORTEX RESEARCH FACILITY

BUILDING 720-B

# VORTEX RESEARCH FACILITY

Area of Experimental Interest:

Far Field Study of Trailing Vortices

Objectives:

Provide insight into the basic flow field phenomena through flow visualization

Obtain the detailed data needed for the validation of computational fluid dynamic methods

Unique Facility Capability:

2 Component Laser Velocimeter

## FACILITY DESCRIPTION

The primary objective of this facility is to study the effects of wing vortex created by large aircraft, Reference Figures 1 and 2, and to determine methods of controlling or reducing these effects on lighter aircraft. This facility consists of a vehicle propelled down a track, towing a primary model aircraft and trailing secondary models, Reference Figures 3 and 4. The models and separating distances are scaled to simulate actual conditions as much as one mile between aircraft. These models are towed at a predetermined velocity through a test section that contains smoke, where cameras record the vortex visually. The models are instrumented to determine the effects of various wing tip designs as to surface pressures, tensions, etc. To facilitate a more detailed discussion, the subsystems are discussed individually as follows:

## A. Vehicle

The vehicle consists of an automobile engine, transmission and front end in a no lift design body. It is equipped with a two gallon fuel tank. Normal operation of the engine is limited to a maximum of 5500 RPM. The transmission is limited to second gear in the forward direction and the normal reverse gear. At 4300 RPM in second gear the vehicle towing the trailers and models will achieve 100 ft/sec. The engine will not exceed 1600 RPM in reverse. Normal wheel brakes are used in the reverse

mode and for emergency purposes in the forward mode. The caliper brakes that use a rail for braking surface are the primary braking system. A safety laser system (laser beam) is used for emergency shutdowns, in that turning off the laser beam transmitter, the vehicle will shutdown. Loss of electrical power or air pressure also results in vehicle shutdown.

The model support system has an adjustable strut capable of changing model height and angle of attack. The pitching angle is limited between  $+13^{\circ}$  and  $-5^{\circ}$ . The model weight is limited to 100 lbs.

#### B. Emergency Restraining Devices

The emergency restraining devices consist of a Mark IV arresting gear and an 8000 pound blast mat. These devices are intended to back up the normal braking system to protect against the vehicle impacting the adjoining shop area. The arresting gear is designed to absorb four million foot pounds of energy. The vehicle at full speed will represent approximately 620 thousand foot pounds of energy. The arresting gear is set up to stop the vehicle at a 3g rate in approximately 50 feet and a cable force of 13,300 pounds. The cable has a breaking strength of 40,000 pounds. The blast mat is 15 feet by 27 feet, weighs 8000 pounds and is an added safety device in the event all other means of stopping the vehicle fail. Another blast mat (6' x 6', approximately 700 pounds) has been added at the shop end of the track.

WING TIP VORTEX

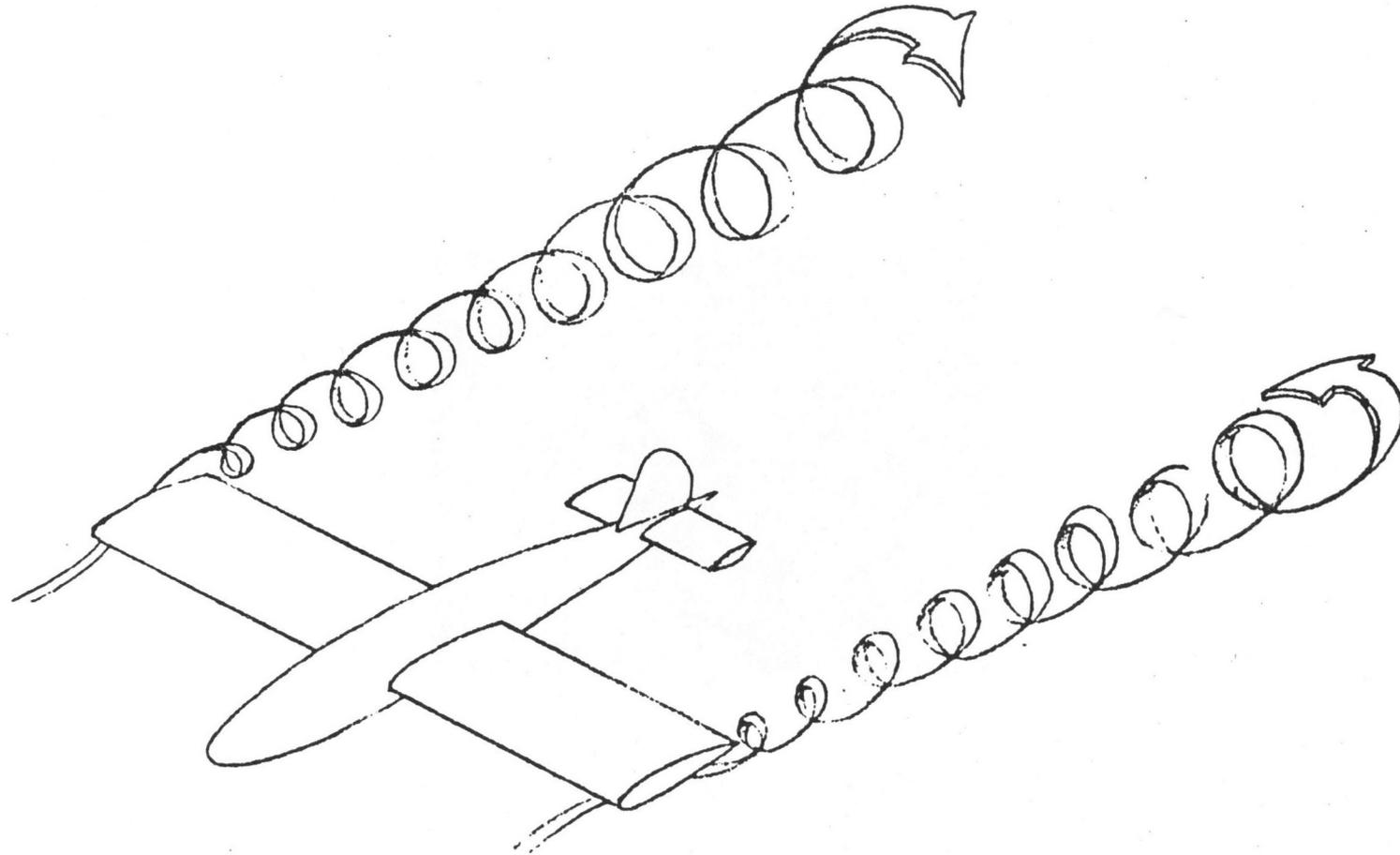
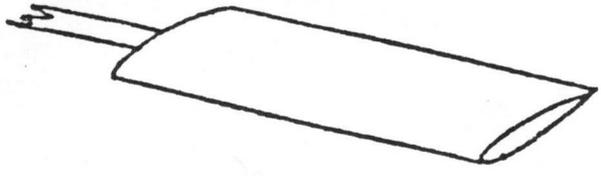
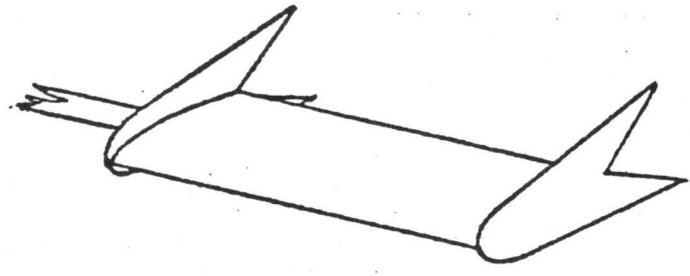


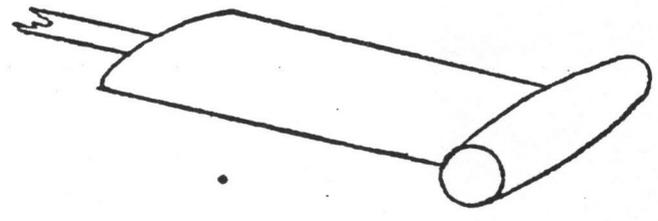
FIG. 1



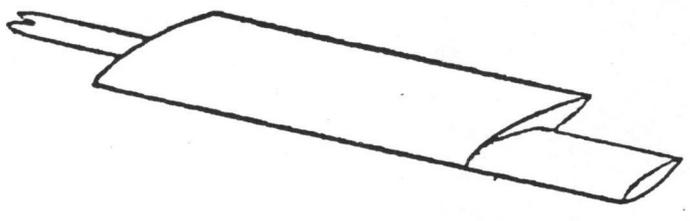
BASIC WING



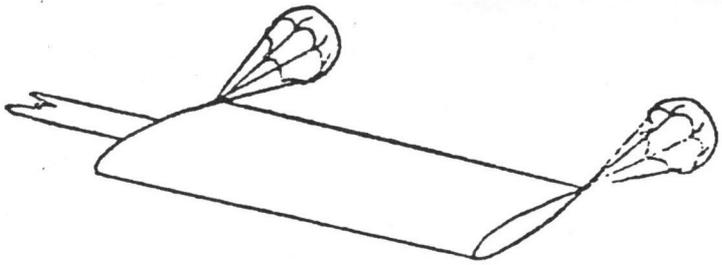
END PLATES



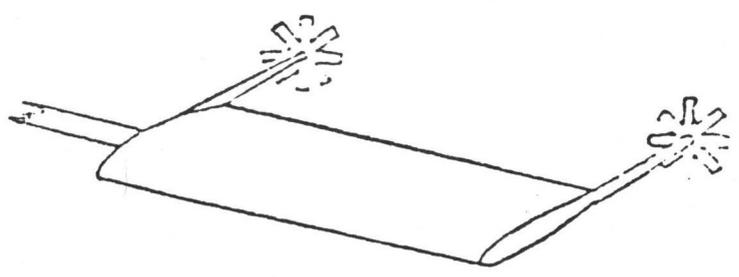
FLOW-THRU  
NACELLE



WING-TIP  
EXTENSION

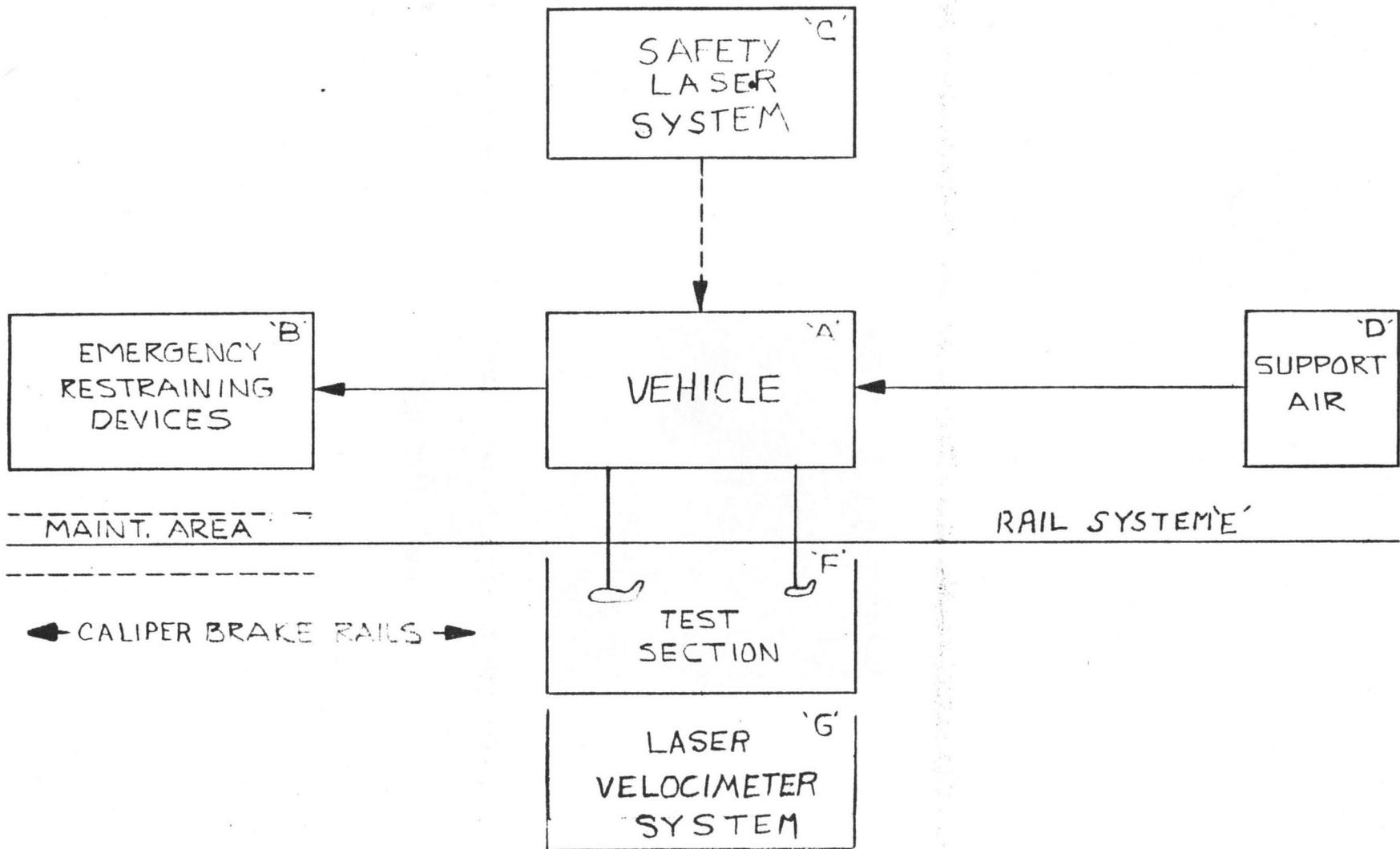


DECELERATING  
CHUTES



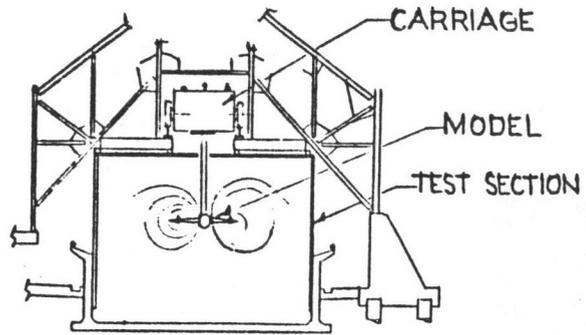
DECELERATING  
SPLINES

FIG. 2



FACILITY BLOCK DIAGRAM

FIG. 3



UTILIZATION OF TANK AREA  
OF BLDG. 720-B FOR WING VORTEX  
STUDIES

SEC. THRU TANK AT  
COVERED TEST AREA

← TEST RUN

→ N

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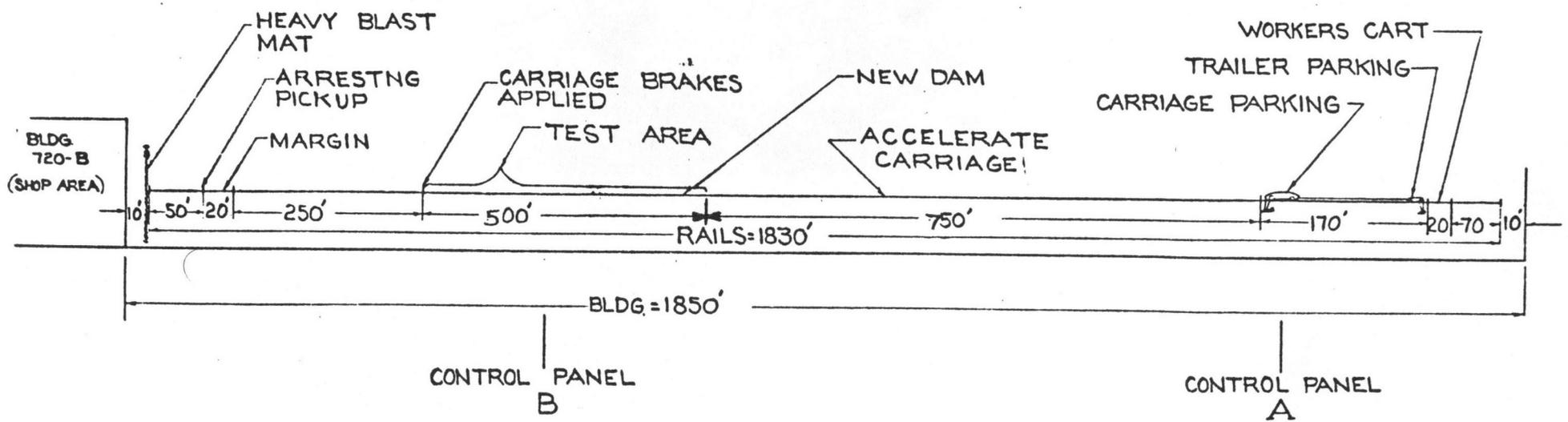


FIG 4

### C. Safety Laser System

The safety laser system, Reference Figure 5, is a low power, 3 milliwatts continuous wave type transmitter located at the north end of the track and a receiver aboard the vehicle. It is used as an emergency shutdown system. Switches for turning off the laser signal for vehicle shutdown are located at each station and are manned by operators during each test run.

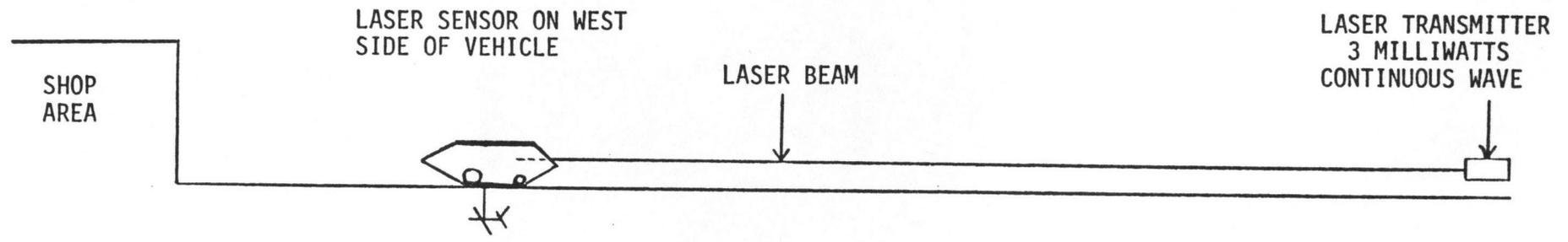
### D. Support Air System

This system consists of an air compressor capable of delivering 13.9 cu/ft of air per minute at 2000 psig. The compressor is equipped with a low oil level switch, high air temperature switch, safety valves on all stages, splash lubrication and a discharge line check valve. Output of the final stage is limited to 2200 psig. This unit is equipped with an air dryer to remove moisture before pumping into vehicle high pressure bottles.

### E. Rail System

The 1850 feet long track consists of two (2) parallel I beams used to support and guide the Wing Vortex vehicle. A maintenance area is located at the shop end of the track. Platforms and access stairs are available. Normal maintenance, fueling, repairs, etc., is conducted in the maintenance area.

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SAFETY LASER SYSTEM

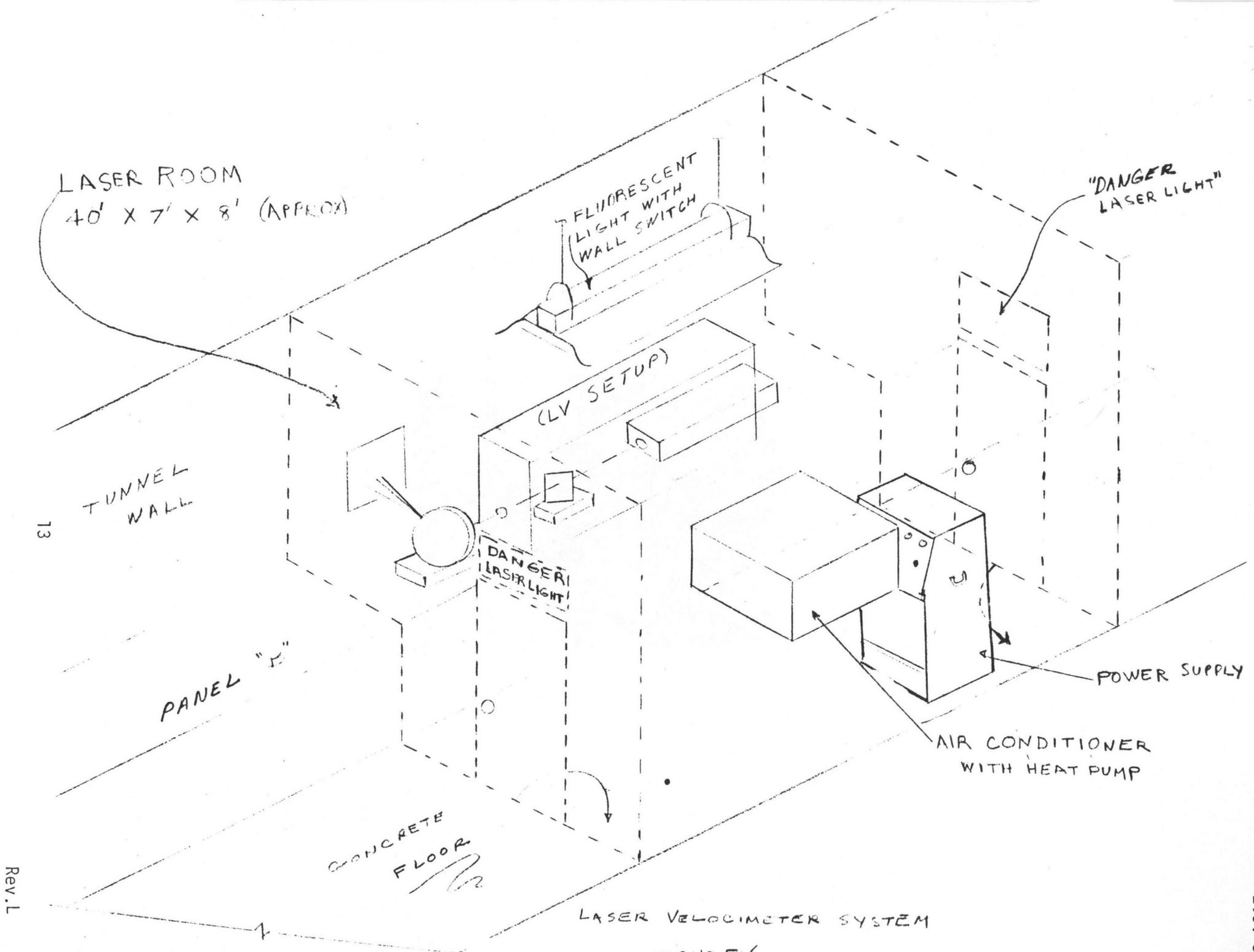
FIGURE 5

#### F. Test Section

The test section is a metal enclosed area approximately 500 feet long where the cameras record the visual effects of the wing vortex as the models pass through the dust filled test section. The dust particles used to seed the test section are ASP-200 manufactured by Englehard (Minerals and Chemical Division). Particle sizes range between 0.6 to 2 microns in diameter.

#### G. Argon Laser System

The Argon laser system, Figure 6, consists of a Spectra-Physics Model 170 Ion Laser capable of 6 watts of continuous wave power (Class IV) and Model 270 Exciter; a cooling water system specified at 3.5 gpm at 35°C temperature with a differential pressure of 65 psi, and the water must be sufficiently deionized so that the water flowing in 10 feet of 1/2" hose will have a resistance of 100 kohms or greater, and a power supply, 3-phase, 480 volt  $\pm$  8%, rated at 60 amp (45KVA). The Argon laser system measures Vortex Velocity Profiles at Panel B.

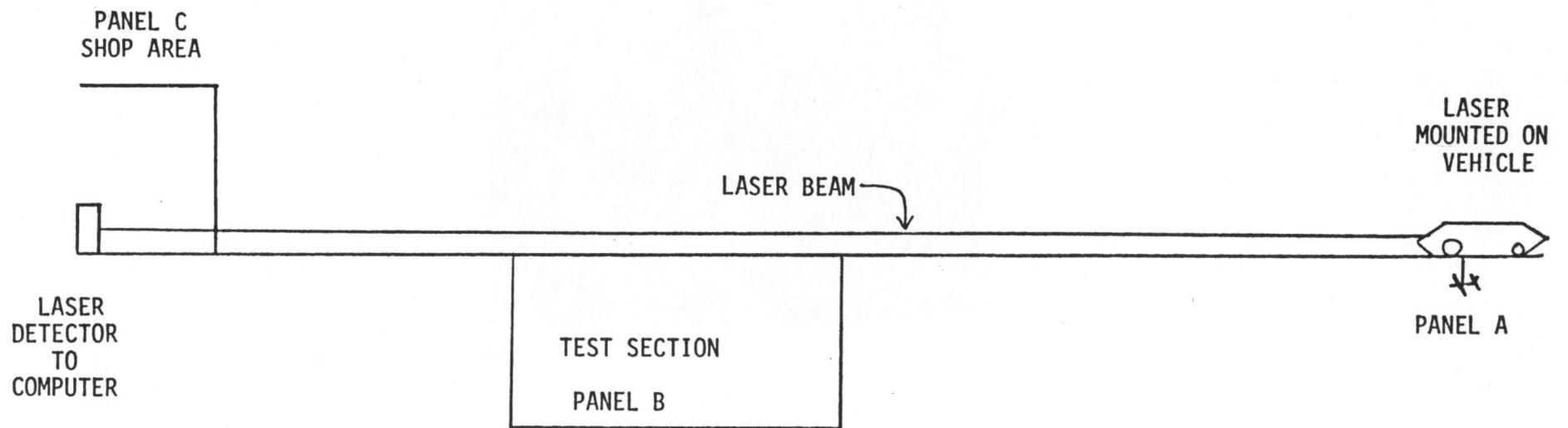


Rev. 1

#### H. Telemetry Laser System

The Telemetry Laser System (Fig. 7) mounted on the Vortex Test Vehicle consists of a Hughes model 3225H-C-47 10 milliwatts continuous wave class 3B laser, Pulse Code Modulator, Bragg cell and Laser Modulator. The receiving optics located at Panel C transmits the data signal to the PCM Decommutator and computer hardware in room 105-B. This system transmits 24 data channels from launch time until vehicle stops at end of high speed run. Normal operation requires the telemetry laser to be energized only during testing which isolates operational personnel and visitors from laser beam path.

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TELEMETRY LASER SYSTEM

FIGURE 7

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