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13. ABSTRACT *(Maximum 200 words)*

The university of Florida has completed the construction of an advanced aeroacoustics testbed to facilitate both existing and future Air Force/DOD research projects. The proposed facility consists of a versatile anechoic chamber processing a test volume of 18'0'L x 16' 6" W x 7' 8" H and a low-frequency cutoff of 100Hz. The facility leverages a recently completed high-pressure air facility to provide supersonic (and subsonic) jet flows. In addition, the chamber has removable floor wedges to provide either anechoic or semi-anechoic test environments. The facility is equipped with a 5 DOF traverse to allow a myrid of detailed flow, noise, and vibration measurements. In particular, the experimental capabilities of this facility include flow measurements via PIV, LDV, and hot-wire anemometry, automated sound-intensity mapping and source localization capabilities via beam forming arrays, and complete surface vibration characterization vibrometry.

The facility provides a unique capability to study fundamental aeroacoustic problems and structure-borne noise phenomena. The uniqueness stems from the combination of a low cutoff frequency (100 Hz), large chamber size, a high-speed flow capability, the ability to switch between a semi-and fully-anechoic chamber, and advanced instrumentation flow, acoustic, and vibration measurements. Most existing anechoic chambers, particularly the few available at universities, have only some of these features, thereby limiting their utility.

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In response to the delinquent awardee list, I am faxing a copy of the final report submitted by Dr. Louis Cattafesta for #F49620-00-1-0235.

If there are any questions, please feel free to contact me. (e-mail: jcm@aero.ufl.edu or the phone number below)

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FINAL REPORT: AN ANECHOIC AEROACOUSTIC TEST FACILITY

F49620-00-1-0235

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University of Florida

November 1, 2001

Summary

The University of Florida has completed the construction of an advanced aeroacoustics testbed to facilitate both existing and future Air Force/DOD research projects. The proposed facility consists of a versatile anechoic chamber (Figure 1) possessing a test volume of 18' 0" L x 16' 6" W x 7' 8" H and a low-frequency cutoff of 100 Hz. The facility leverages a recently completed high-pressure air facility to provide supersonic (and subsonic) jet flows. In addition, the chamber has removable floor wedges to provide either anechoic or semi-anechoic test environments. The facility is equipped with a 5 DOF traverse to allow a myriad of detailed flow, noise, and vibration measurements. In particular, the experimental capabilities of this facility include flow measurements via PIV, LDV, and hot-wire anemometry, automated sound-intensity mapping and source localization capabilities via beamforming arrays, and complete surface vibration characterization via scanning laser vibrometry.

The facility provides a unique capability to study fundamental aeroacoustic problems and structure-borne noise phenomena. The uniqueness stems from the combination of a low cutoff frequency (100 Hz), large chamber size, a high-speed flow capability, the ability to switch between a semi- and fully-anechoic chamber, and advanced instrumentation for flow, acoustic, and vibration measurements. Most existing anechoic chambers, particularly the few available at universities, have only some of these features, thereby limiting their utility.

Pertinent applications of the facility include aeroacoustics, structural acoustics, and industrial noise/vibration control. Aeroacoustic applications include jet noise and mixing, self-sustaining flow oscillations, fluid-structure interactions (e.g., flutter), and noise from, for example, rotating machinery. Potential structural acoustic applications include control of

radiated noise from vibrating structures and vibration control. Finally, industrial noise and vibration control studies of large machinery can be conducted in the facility. This report summarizes the completed and ongoing tasks and provides a detailed description of the facility and associated instrumentation.

Completed Tasks:

- Construction of the anechoic chamber facility
- Acquisition of test process, control and measurement instrumentation
- Installation of the microphone traversing and data acquisition system
- Installation of the jet flow reservoir, control valves, and process flow instrumentation

Current Tasks:

- Validation of anechoic chamber 100 Hz cut-off frequency performance
- Validation of jet-flow process control equipment and operation
- Validation and calibration of flow entrainment during jet-flow operation
- Modification to traversing system telescope
- Documentation of all operation and safety procedures

General Description

The Aeroacoustic Anechoic Chamber at the University of Florida's Department of Aerospace Engineering, Mechanics, and Engineering Science is the newest addition to its experimental research facilities. A top-view schematic of the facility is shown in Figure 1. The chamber, custom-designed and fabricated by Eckel Industries, is currently in a validation and calibration stage of operation. The inner dimensions (wedge tip to wedge tip) of the modular acoustic chamber are approximately 18 ft long by 16 ft 6 in wide by 10 ft 10 in high without floor wedge installation and 7 ft 8 in high with floor wedge installation. Figures 2 through 5 show the four interior walls with wedge treatment installed. The wedges are designed with a low-frequency cut-off of 100 Hz and are constructed from fiberglass with cloth covers to protect the wedge integrity. The anechoic zone (or area) at this frequency is 10 ft 10 in by 12 ft 4 in. A less stringent cut-off frequency affords a larger measurement area. The floor wedges are removable, allowing the facility to be run in either a full- or hemi-anechoic mode.

The chamber is designed to be utilized as either an aeroacoustic jet-flow facility or a more traditional calibration or industrial-equipment test facility. An intake and exhaust plenums (Figure 6) bound the south and north chamber walls, respectively, to properly handle entrained flow when run as an aeroacoustic facility. The plenums have built-in silencers to suppress outside noise transmission and perforated, insulated walls to suppress inside noise reflection. The wedges along the concurrent plenum/chamber walls have openings to allow entrained flow to pass through the chamber. The intake plenum houses the reservoir which is plumbed into the department's compressor facility. The dual-screw compressor (rated for 1000 SCFM at 210 psi) can continuously feed a perfectly expanded 1 in diameter Mach 2 jet. With 1200 cubic ft of storage tank capacity, larger nozzles or ducts can be tested in a blowdown manner. The nozzles connect to the reservoir via 6 in diameter pipe. The large diameter minimizes pressure loss and assures a large reservoir area to exit area ratios. Within the 6 in pipe and upstream of the nozzle, flow conditioning honeycomb and screens can be installed. Opposite of the nozzle is a large bell-mouth and muffler assembly to capture and exhaust the jet. Figure 7 shows an exterior view of the exhaust plenum, flow silencers, and control fan.

Outfitted on the ceiling of the chamber is a fully-automated, five component B&K microphone positioning system. It is integrate via software with B&K Pulse measurement and analysis system. Ambient chamber pressure and temperature are continually monitored on a separate data acquisition system. Specific characteristics of both systems are listed in the following section. The chamber has both 6 ft- and 3 ft-wide access doors as well as cable portals for instrumentation installed inside the facility.

Facililty Specifications:

Chamber

Manufacturer:	Eckel Industries
Interior Size (wedge tip to wedge tip):	18' 0" L x 16' 6" W x 7' 8" H
Frequency Cut-off:	100 Hz
Wedge Material:	Fiberglass with cloth cover

Additional Features

- Cold jet flow accommodations
- Five DOF traverse system
- Floor wedges on castors and designed with protect grates
- Perforated endwalls with ventilating wedges for jet flow entrainment
- Intake, exhaust, and A/C silencers
- Bell mouth and jet flow silencer
- Variable speed exhaust fan
- Instrumentation sleeves
- Single and double door access

Instrumentation:

- B&K microphone and pulse analyzer system
  Six ¼ in free-field microphones and preamplifers
  Six 1/8 in pressure field microphones and preamplifiers
  Eight channel portable PULSE (data acquisition and analysis) system
  PC controlled
- B&K positioning system
  Five degrees of freedom: 3 translation and 2 rotation
  PC controlled
- Heise two channel pressure measurement system
  Channel 1 0-30 psi absolute
  Channel 2 0-300 psi absolute
  PC controlled
- National Instruments data acquisition and signal conditioning system
  Eight channel differential analog input
  Two channel analog output
  16 channel multiplixer/signal conditioner
  PC controlled

Jet Flow Accommodations

The anechoic chamber has been designed to integrate a cold jet flow for fundamental aeroacoustic testing. A reservoir chamber, residing in the intake plenum, has been plumbed into the existing dual-screw compressor facility. A dedicated PC system is used to monitor and control system process parameters. These include flow rate, stagnation and ambient pressure and temperature, and entrained flow rate.

- Compressor facility
  - 210 psig maximum operating pressure
  - 900 SCFM flow capacity
  - 1200 ft^3 storage capacity

- Nominal jet flow design for continuous operation
  - Mach 2 perfectly expanded at ambient conditions
  - 1 in diameter nozzle

Figure 1. Top view schematic of the anechoic chamber.

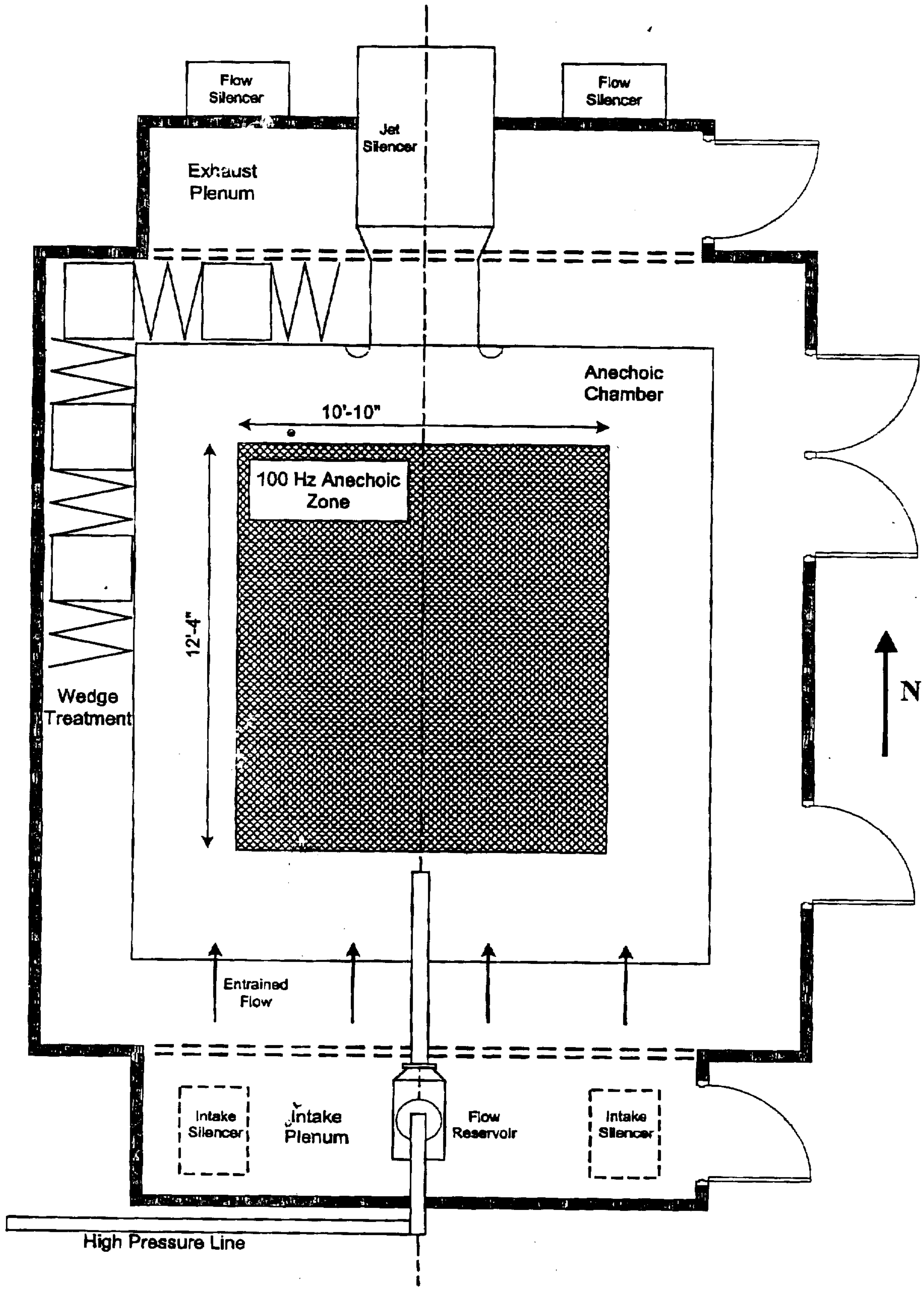


Figure 2. Interior South Wall with ventilation wedges. Floor wedges protected by expanded metal grates. Traverse system mounted to ceiling.

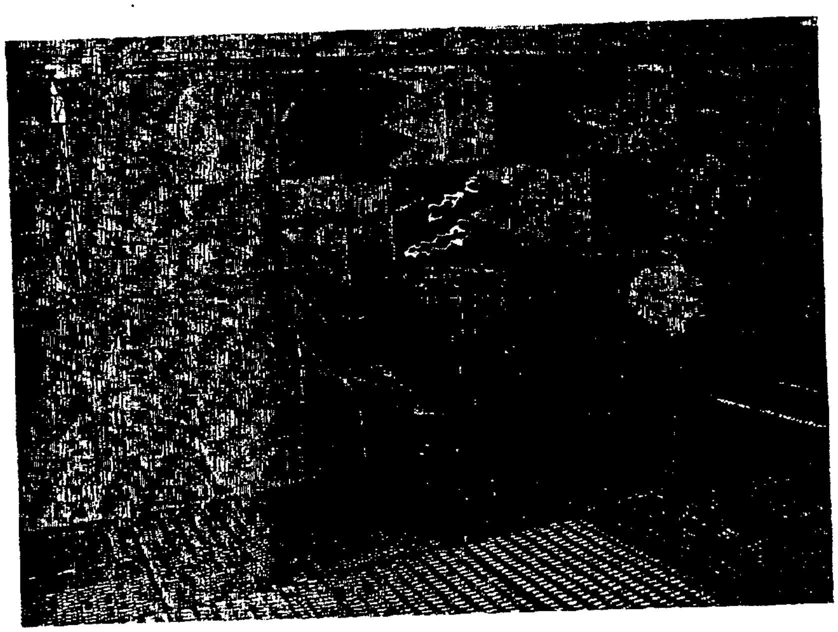


Figure 3. Interior West Wall.

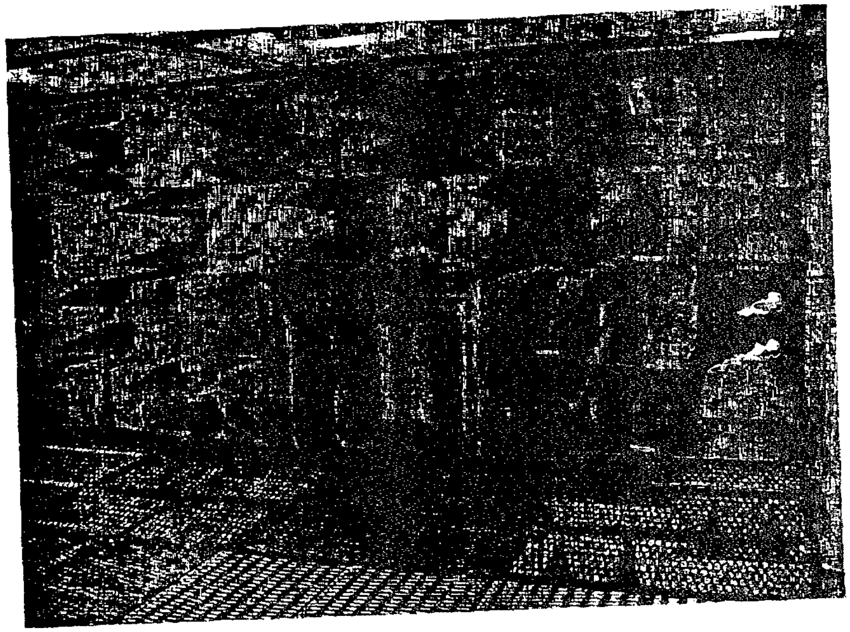


Figure 4. Interior North Wall with ventilation wedge and jet bell-mouth.

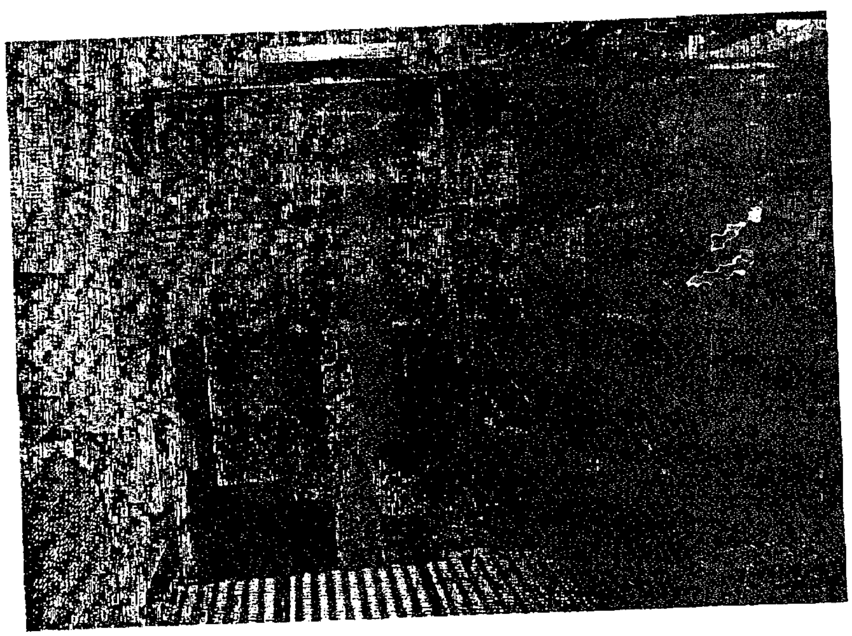
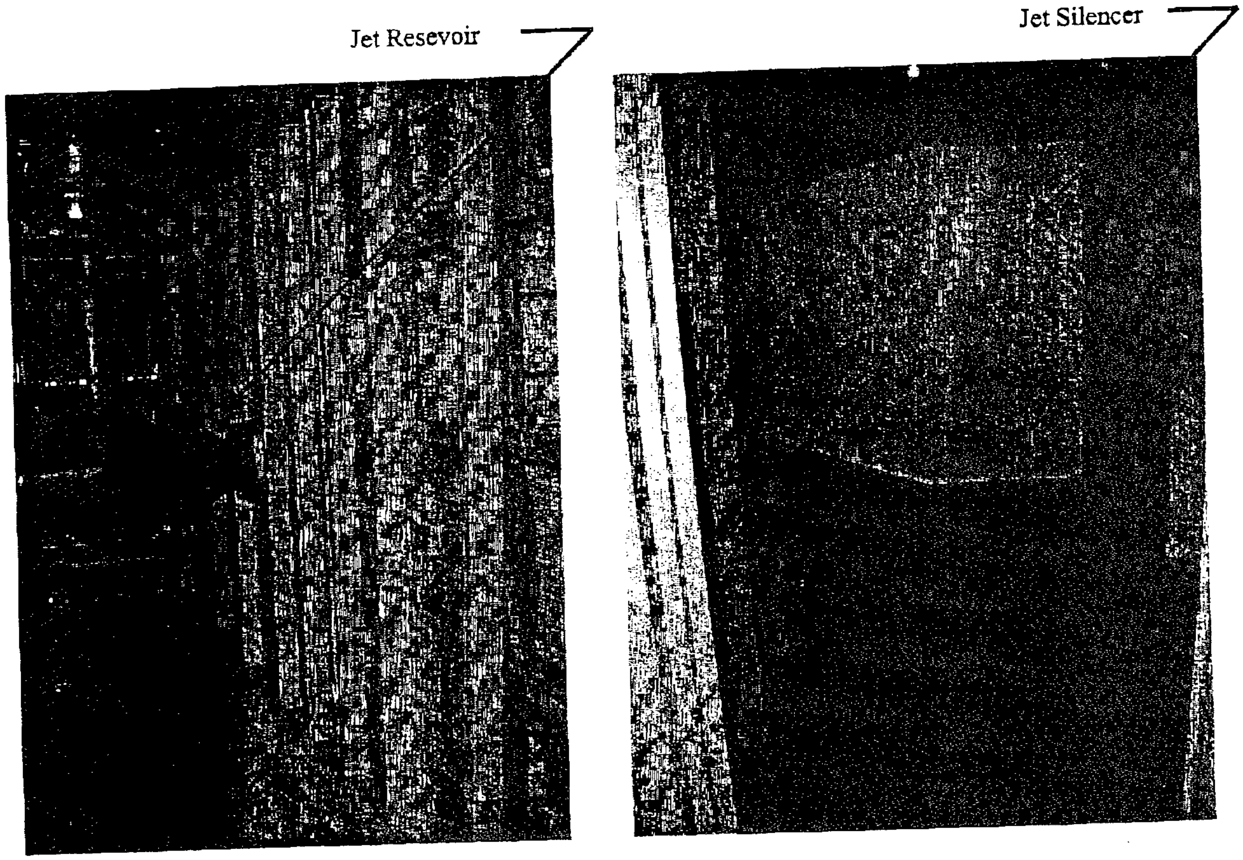


Figure 5. Interior East Wall. One-side of double door open with wedge plug removed.



(A) (B)

Figure 6. The intake plenum (A) and exhaust plenum (B).

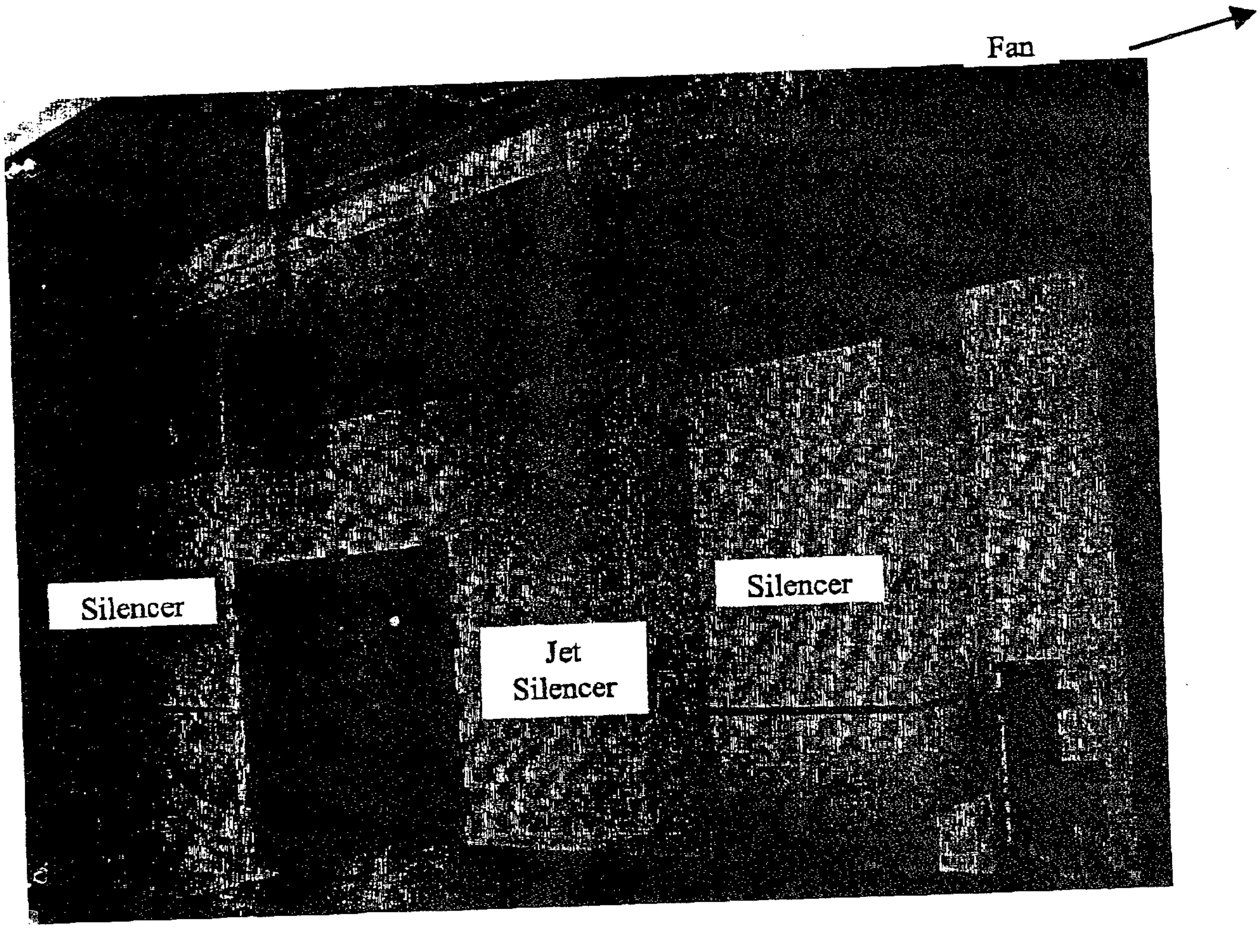


Figure 7. Outside view of chamber and its exhaust handing ductwork.