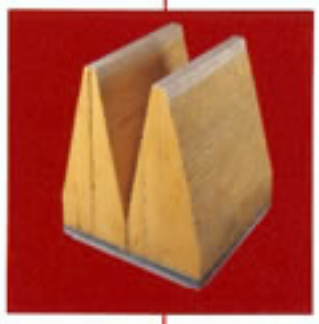
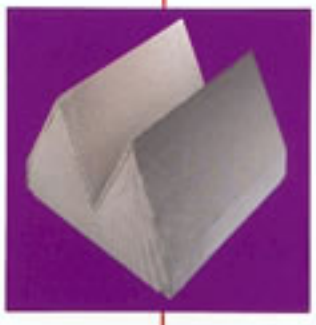
ECKEL

NOISE CONTROL TECHNOLOGIES

Acoustic Testing Facilities

Anechoic
SuperSoft™
Reverberant





SOUND
SOLUTIONS
FOR THE FUTURE

Mission Statement

During World War II, Oliver C. Eckel, working in close association with Leo Beranek and others, produced anechoic wedges for the first anechoic chamber. This chamber was built in the United States at Harvard's Cruft Laboratories. Later, in 1952, Mr. Eckel founded Eckel Industries. Since then Eckel has become synonymous with the highest standards in building acoustic research and testing facilities.

Eckel Industries, Inc. designs, fabricates and installs full and hemi- anechoic chambers to precise specifications for government laboratories, industrial concerns, and leading universities. Totally integrated systems and designs include requirements such as isolated floors, light and power connections, ventilation, temperature and humidity control, instrumentation sleeves, control supports, working floors, and single and double sound doors.

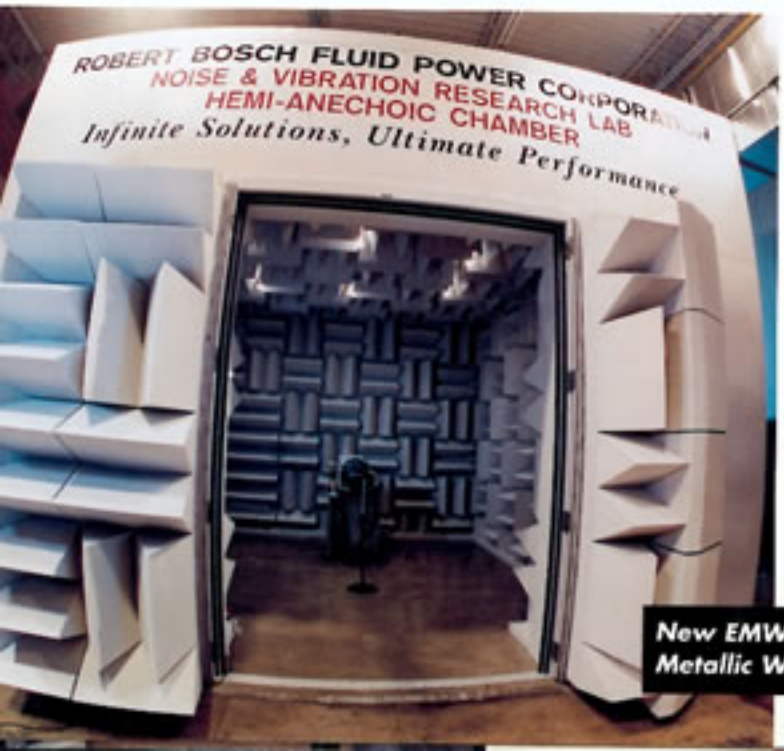
For over forty years, major national and international clients such as Bosch, Bose, General Motors, Harvard, MIT, Penn State, Pratt & Whitney, Chrysler, General Electric, Boeing, McDonnell-Douglas, the US Navy and NASA have relied on Eckel Industries to meet the full range of their acoustical testing and research requirements. We are grateful for this trust in our capabilities and proud of our outstanding record of service.

As we approach a new century, we remain firmly committed to maintaining the high standards we have set for ourselves and the industry. Eckel Industries will continue to develop and introduce innovative products that will allow our clients to carry out their testing and research projects in perfect confidence that they are working with the best anechoic chambers available anywhere.

Portable Anechoic Chamber

Special Foam Lining

Standard Fiberglass



New EMW Perforated Metallic Wedge Design

Anechoic Chambers

Anechoic chambers are echo-free enclosures with a sound energy absorption level of 99% to 100%, or a reflected sound pressure level of 10% or less. The frequency at which the energy absorption drops below 99%, or the pressure reflection exceeds 10%, is known as the low-frequency cut-off. Sound absorption is obtained by lining the walls, ceiling, and floor with wedges or other sound absorbing elements or SuperSoft™ panels, depending on performance level required and cut-off desired.

Anechoic Chamber Linings

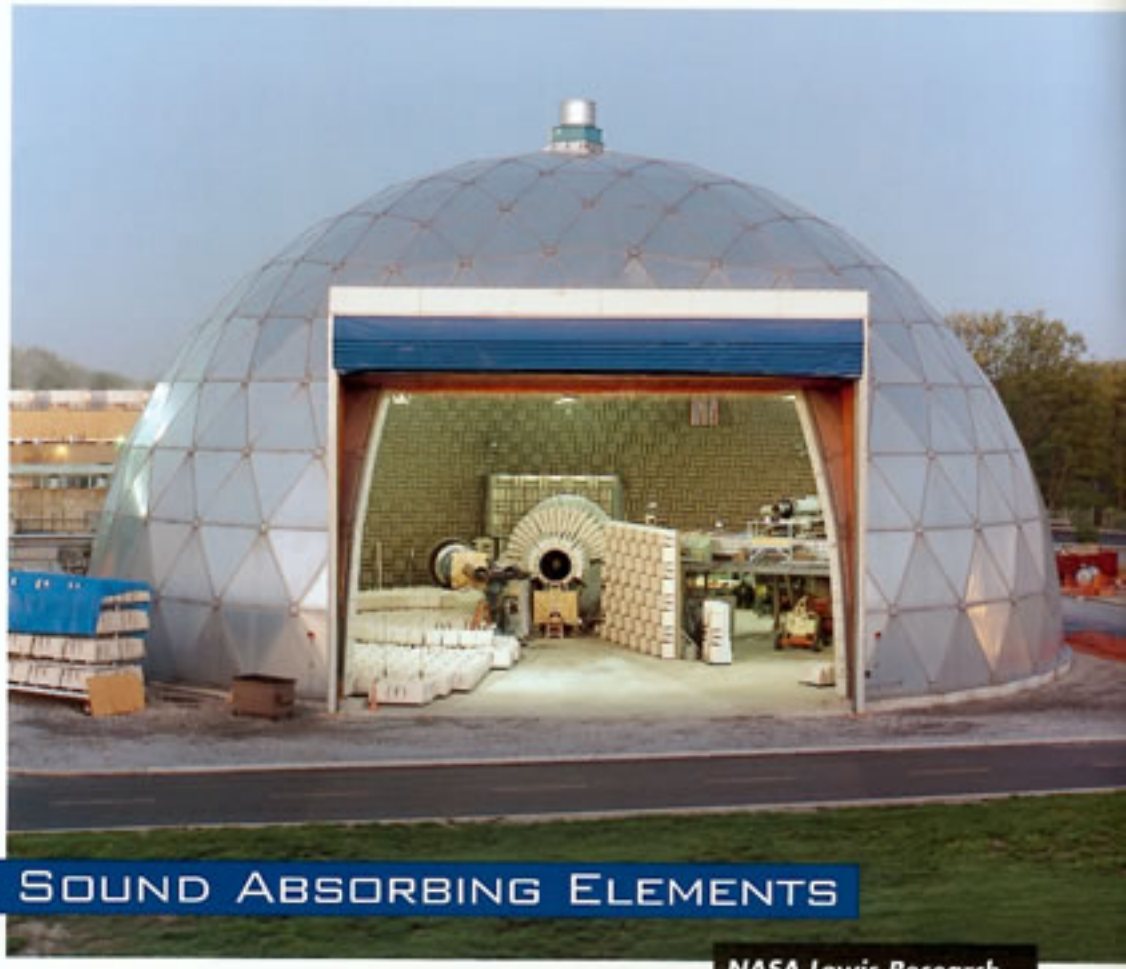
Eckel anechoic chamber linings represent the most advanced technical thinking in design and construction. Currently, we offer fiberglass, foam, and perforated metallic EMW types of sound absorbing wedges, as well as new E-Element concept and SuperSoft™ panels to accommodate the widest range of testing requirements.

NASA Lewis Research Center Hemispherical Anechoic Chamber

Wedges & Sound Absorbing Elements

The basic dimensions and physical characteristics of anechoic wedges were established at Harvard University's Cruft Laboratory in 1943 under a grant from the U. S. Office of Scientific Research and Development. The data was published in OSRD Report No. 4190 and the Journal of the Acoustical Society of America.

Wedges and Sound Absorbing Elements



NASA Lewis Research Center Hemispherical Anechoic Chamber

Achieving Optimum Performance.

Although the original parameters remain accurate, some modifications in the base and taper may be required. The geometry of the wedge unit may be adjusted to accomplish the desired cut-off.

Construction and mounting considerations may also be factors in the design dimensions of the anechoic unit. The final wedge design is verified in an impedance tube where the fixed conditions can be duplicated. The air space, base, and geometry may be adjusted for optimum performance.

John Deere Tractor Hemi-Anechoic Chamber

SuperSoft™ Panel Lining

York International SuperSoft™ Acoustic Test Facility

SuperSoft™ Panels

Eckel SuperSoft™ panels provide a unique and economical design for environments requiring a high degree of sound absorption but where the erection of a full anechoic chamber may be impractical or unfeasible. SuperSoft™ panels are 2.75" or 4.75" thick and 2'-6" or 3'-0" square with "V" rigged .22 ga. perforated metal.

Attachment is by means of a 20 ga. removable batten* to supporting framework. Acoustic fill is 2" or 4", fine fibered AF fiberglass.

*Allows individual or groups of panels to be removed.

Cavity fill airspace and fill density may be adjusted to meet specific testing requirements.

Linear SuperSoft™ Panels are also available in the same thickness and 2'-6" and 3'-0" wide in lengths up to 12'-0" where the square alternated pattern of the standard SuperSoft™ is not required.

Performance Testing

A production sample from each of the 100 units is tested for acoustical performance. A copy of the performance curves of the pre-production and production linings will be delivered to the purchaser and certified.

Anechoic Chambers

Chamber configuration

The final dimensions of an anechoic chamber will depend on the nature of the tests to be conducted. The well-designed chamber for general acoustical research will have a minimum free field dimension of not less than one wavelength of the cut-off frequency, and its largest dimension not less than one and one-half wavelengths of the cut-off frequency. Where dimensions far exceed the minimum, a ratio of 1.5 to 1.0 of the largest to the smallest dimension is still sound practice.

In addition to cut-off frequency, free field dimensions will be affected by other factors such as the dimension of the equipment to be tested.

Under these conditions, the minimum free field dimension of the chamber should be:

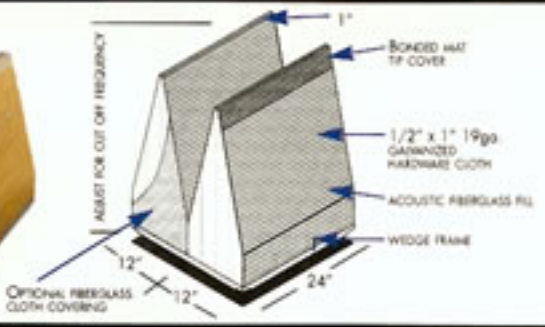
Width or Height = $\lambda + D$

where λ is one wavelength at cut-off and D is the maximum width or height dimension of the equipment.

Length = $1\frac{1}{2}\lambda + L$

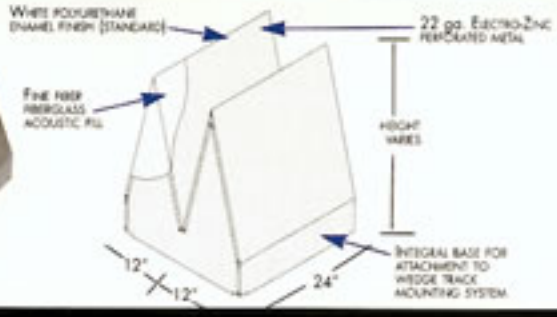
where L is the maximum length of the equipment.

EW Standard Wedge



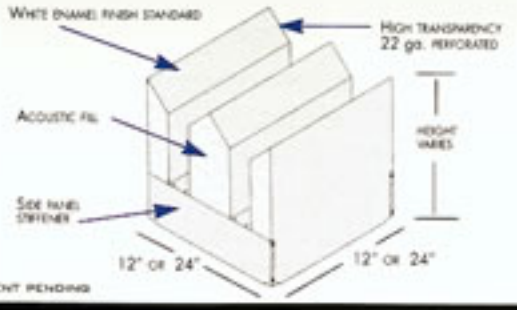
The E.W. Standard Wedge is the classic design based on the original geometry established by Beranek and Sleeper at Harvard during W.W.II. Current E.W. Wedges incorporate the latest materials and design modifications for a wedge treatment with maximum broadband performance.

EMW Perforated Metallic



The Eckoustic Metallic Wedge represents the execution of the Classic design with a perforated metal cover versus the original wire hardware cloth. Utilizing high transparency 22 ga. perforated steel or aluminum, the metal cover is virtually acoustically transparent.

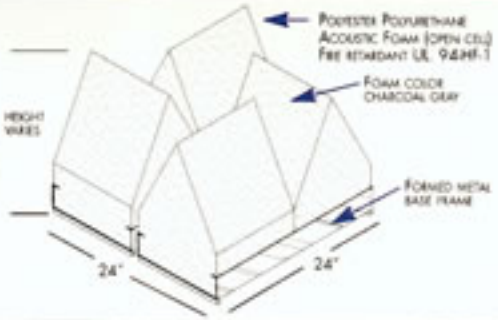
E-Element Anechoic Absorbing Unit



Patent pending

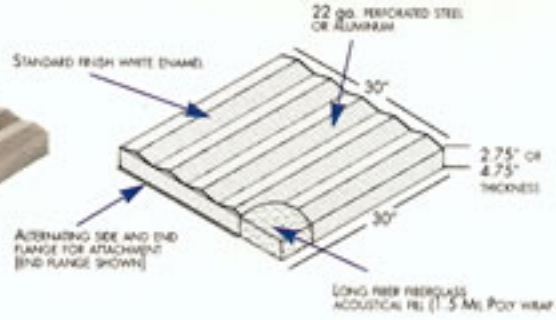
Utilizing a unique geometry the E-Element offers a new dimension in anechoic chamber construction differing from the conventional wedge design. The E-Element is constructed of multiple parallel surfaces with tapered leading edges that alternate 90% out of phase with one another. This creates a sound absorbing array which achieves cut-off with less depth of treatment than conventional "wedge" designs.

Acoustic Foam Wedge Units



Acoustic foams, (polyurethane and melamine) offer acceptable acoustical characteristics in many applications and may be more economical than traditional treatments. Polyurethane foam chambers must incorporate a sprinkler system because they are hazardous if combusted. Properly designed foam chambers work well in many applications.

SuperSoft™ Panel Lining



SuperSoft™ panel lining for acoustic test facilities was developed to fill "a niche," when a full anechoic chamber was not needed. An existing or new structure could be lined with an extremely high performance acoustic panel to yield a test environment satisfactory for general product testing and noise emission.

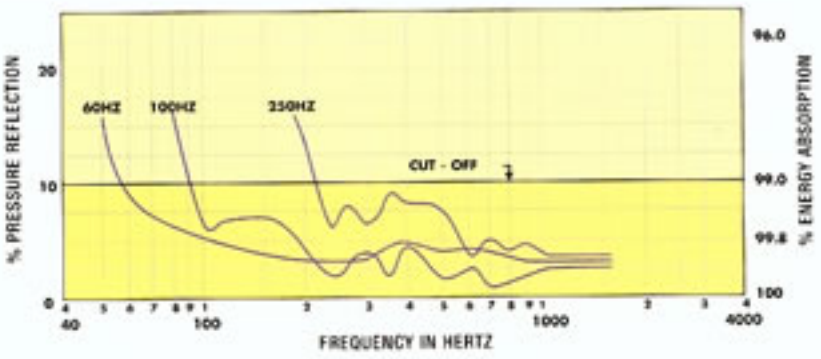
Wedge & Chamber Performance

Wedge Performance

Impedance Tube Method - ASTM-C 384-90a
A production sample of individual wedges shall be tested to verify design, materials and cut-off frequency.

Cut-off frequency

Wedges or sound absorbing elements shall have a low frequency cut-off Hertz (Hz). Above this frequency, they shall have a .99 coefficient of absorption, or the ratio of reflected sound pressure to incident sound pressure of 10% or less.

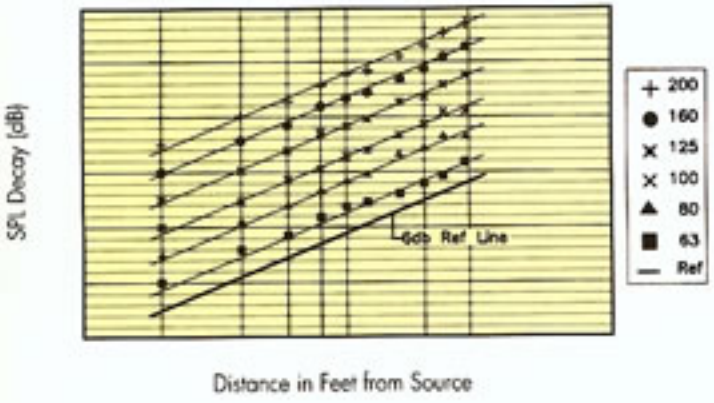


Impedance Tube Measurements - Typical Wedges

Chamber Performance

ISO 3745: Inverse Square Law, ANSI 12.35 1990 (R1996)
Measurements shall be taken in full room configurations

80Hz Hemi-Anechoic Chamber - Boeing Aircraft
Low Frequency Inverse Square Measurements - 63Hz to 200 Hz



Maximum Allowable Variations From Inverse Square Law

Type of Test Room	One-Third Octave Band Control Hz	Allowable +/- dB
Anechoic	<630	1.5
	800 to 5000	1.0
	>6300	1.5
Hemi-Anechoic	<630	2.5
	800 to 5000	2.0
	>6300	3.0

Noise Reduction Data

Single Wall Panel Room

Measured noise reduction through a 4" Eckoustic Panel Anechoic Chamber

Frequency Hz	62.5	125	250	500	1000	2000	4000	8000
Noise Reduction dB	25	38	58	59	60	62	64	55

Noise Reduction Data

Double Wall Panel Room

Measured noise reduction through a 4" Eckoustic Panel and 8" masonry wall

Frequency Hz	62.5	125	250	500	1000	2000	4000	8000
Noise Reduction dB	45	59	80	90	92	95	90	90

Attenuating Structures

In order to obtain a suitable sound environment, the anechoic lining is installed in a proper noise isolating structure. This enclosure may be one of several types of construction built on isolated floor, or floated on springs or other vibration isolation material.

Panelized Rooms

Eckel Industries, Inc. provides enclosures built from Eckoustic panels with solid faces on both sides. Eckoustic panel rooms are completely pre-fabricated in the factory and can be quickly erected in an existing facility. These modular enclosures allow for flexible arrangements of doors and utilities.

Design & Construction Features

Doors are structurallly and acoustically compatible with the wall construction. Hard spots or internal framing are provided for attachment of hardware. Penetrations for lights, power, instrumentation wiring, and ventilation are incorporated into the panel construction.

Masonry

A masonry enclosure is typically used in new construction, or when the anechoic facility is planned as an integral part of a new building. An 8" or 12" masonry block usually provides adequate noise reduction. The addition of an inner panel room will provide increased noise reduction when required. Walls should be constructed on an isolated reinforced floor separated from the building floor or in a pit to allow the working floor in the chamber to be flush with the host room floor.

Working Floors

Cable or grating (full and partial)

Since anechoic wedges are not designed to support heavy loads, a working floor must be provided over the top of the floor wedge points. Eckel Industries recommends two types for general use: spring tensioned cable floors and grating floors (expanded and subway grating).

Spring tensioned cable floors are best from an acoustical standpoint, whereas floor gratings are desirable where concentrated loads must be supported. Floor gratings are provided in sections so they can be removed during testing.

Cable Floor Detail

Ventilation Design

The ventilation system in Eckel anechoic chambers is designed to maintain a uniform temperature, provide fresh air for humans and/or animals and facilitate proper combustion in air-consuming equipment.

Ten to twelve air changes per hour of the free field volume will generally maintain uniform temperature and provide ample fresh air for humans or animals, while removing normal heat from lights, body radiation, and instrumentation.

Installation Procedure

Eckel anechoic linings are constructed according to a strictly supervised installation protocol. Chamber linings are installed on roll formed wedge tracks attached to wall and ceiling surfaces by means of a "Z" bar mounting system. As wedges are erected, the space between the wedges is filled with light density compressible fiberglass or melamine foam.

Instrumentation Hangers

Eckel installs all hangers and brackets required to support instrumentation and test specimens. This includes a network of all necessary cables or wires.

Wedge Track Mounting System

Eckel provides engineering or design data pertinent to the support of any type of equipment within an anechoic chamber upon request to the purchasers, and their consultants or engineers.

Penetration Sleeves

Electrical power, wiring, and other services are introduced into the anechoic chamber by pipe sleeves that pass through the basic structure and wedges. Eckel Industries plans pipe penetrations carefully so that they enter the chamber through the valleys of the wedges and not the joints between the wedges.

Lighting, Electrical

Electric services are always installed in compliance with local or UL-approved regulations. Electric light, conduits, and outlets usually penetrate the structure through the wedge valleys and terminate at that point with the appropriate outlet or fixture.

Vibration Isolation

Anechoic chambers shall be isolated from structural vibration by one of the following systems:

Type	*Natural Frequency*
Air Mounts	1Hz
Spring Mounts	3Hz
Neoprene Isolators	7.5 - 8Hz

Reverberation Rooms

Eckel reverberation rooms are designed for the determination of sound output of noise sources, transmission loss of partitions, insertion loss of silencers, response characteristics of microphones, and random incidence absorption coefficients of materials.

Eckel reverberation rooms satisfy reverberant test requirements and meet specific interior sound levels and other environmental requirements necessary for proper test measurements.

Reverberation Room

Windows

Interlocking Wedge Door

Other Available Features

Eckel offers RF shielding, temperature and humidity control and other special features depending on client needs. Fiberglass cloth cover option protects against fiber migration, especially where the chamber will be incorporated into a wind tunnel test configuration.

Call on the experience, expertise and proven quality that only Eckel Industries can provide for your next Anechoic Chamber.

Design and Engineering Services.

Eckel
Partial Client List

3M Co.
Acoustic Research
Beltone Electronic
Boeing
Robert Bosch and Fluid Power Corporation
Bose Corp.
Cadillac Motor Co.
Carrier Corp.
Chrysler Corp.
Deere & Co.
Delco Div., GMC
Diablo Systems
Digital Equipment Corp.
Eastman Kodak Co.
Electro-Voice Corp.
Federal Signal
Ford Motor Co.
Fort Belvoir
General Electric Co.
General Motors Corp.
Goodyear Tire & Rubber Co.
Harvard University
Hewlett-Packard
Homelite Corp.
Honeywell Bull
IBM Corp.
Iowa State University
ITT
J.B. Lansing/Harman
Jet Propulsion Laboratory
Klipsch
Lockheed Aircraft Co.
Lucent Technologies
Mack Truck Corp.
McDonnell Douglas Corp.
MIT
NASA, Langley, Lewis, Houston, Marshall
National Institute of Standards & Technology (formerly NBS)
Nippondenso
Penn State University
Pratt & Whitney
Raytheon
Redstone Arsenal
Sacramento State College
Saturn Corp.
Shure Bros., Inc.
Sikorski Aircraft
Southwest Research Institute
Storage Technology
Syracuse University
U.S. Army Tank Command
U.S. Navy
United Technologies
University of Iowa
Westinghouse Electric Co.
York
Zenith Corp.

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