Acoustic Test Facilities

A complete solution to all types of acoustic test facilities





making the world a quieter place

IAC Making the world a Quieter Place ACOUSTICS

Founded on an unrivalled history of engineering with some of the most pioneering discoveries in the industry, the IAC Acoustics brand is synonymous with technological innovation.

From controlling noise at a power station to tuning the sound in a TV or radio studio, IAC Acoustics has had a positive impact on society and helped to shape what can be achieved to make speech more intelligible, music more enjoyable, reduce the impact of industrial noise and protect people's sense of hearing.

The continual success of our products and services over the decades has brought the brand a reputation for quality and reliability among customers, whether they are multinational corporations or independent family businesses. This is supported by the expertise and passion of our workforce, the people behind the products, including designers, engineers and industry specialists.

To face the ever increasing noise reduction demands of the future, we will strive to further enhance our ability to reduce excessive noise. We aim to focus on developing tomorrow's solution today, innovating faster and delivering solutions that meet the requirements of the next generation. In doing so, we will stay true to our key values and founding philosophy to make the world a quieter place.

making the world a quieter place

<image>

Leading Supplier of Acoustic Test Chambers

IAC is one of the largest suppliers of acoustic test chambers and facilities in the world, with hundreds of installations worldwide. As the world's largest manufacturer of noise control products, IAC is able to utilise its expertise and bring together many different products for use in an acoustic test facility. Being able to supply a complete package reduces overall project spend and minimises the number of required suppliers. All IAC products have an individual acoustic rating and when accompanied by a laboratory certificate, give peace of mind about the overall performance of a completed facility. With such a detailed knowledge of acoustics, IAC is capable of tailoring solutions to meet the exact requirements of the client without compromising performance.



Fully anechoic chamber at the National Physical Laboratory (NPL) in London, UK Image Courtesy of NPL



Acoustic Test Facilities for Manufacturers of:

- Motor cars
- Motorcycles
- Industrial engines
- Diesel generators
- Mechanical plant equipment
- Home appliances
- Office machines
- Electronic components
- Computers
- Mobile phones
- Hi-fi equipment

IAC has also supplied facilities to academic research organisations, government agencies and independent test houses.

Turnkey Suppliers

IAC has successfully carried out a number of turnkey acoustic test facility projects around the world. As a turnkey supplier, everything from the initial concept design through to the final commissioning is carried out by IAC. As part of the turnkey process, IAC will also be involved in:

- Planning applications with local authorities
- Noise surveys and acoustic mapping
- Architectural design of buildings
- Mechanical and electrical installation design
- Appointing reputable sub-contractors

By opting for a turnkey solution, costs can be consolidated via one single supplier, reducing overall spend and minimising administrative input. This is particularly effective if many different acoustic facilities are being installed at one location or if a complete building is required.



Hemi-anechoic chamber for Dana Trucks, USA

IAC's Capabilities

Since 1949, IAC has designed and constructed thousands of acoustic test facilities including several hundred small anechoic and reverberation chambers.

These controlled environments encompass a wide range of performance specifications – from simple quality control requirements to elaborate high precision acoustic measurements.

IAC's design engineers and research physicists bring a wealth of experience to provide data for an informed discussion on how to select free-field anechoic chambers and diffuse-field reverberation rooms.



What is an Anechoic Chamber?

An anechoic chamber can be considered similar to a precision acoustical measurement instrument, providing a free-field environment without noise interference or sound reflection.

In an ideal free-field environment, the inverse square law would function perfectly. This means that the sound level from a spherically radiating sound source decreases by 6dB for each doubling of distance from the source.

For a free field to exist with perfect inverse square law characteristics, room boundaries must have a sound absorption coefficient of unity at all angles of incidence. In practice this is usually not quite perfect and deviations from the inverse square law are to be expected. Table 1 highlights the maximum allowable deviations from the inverse square law as set out by ISO 3745 which states that "an anechoic room provides the preferred environment for measurements with the smallest uncertainty."

Type of Room	1/3 Octave Band Centre Frequency, Hz	Allowable Difference, dB
Fully Anechoic (Free-Field)	←630 800 to 5,000 →6300	± 1.5 ± 1.0 ± 1.5
Hemi-Anechoic (Simulated Free-Field)	←630 800 to 5,000 →6300	± 2.5 ± 2.0 ± 3.0

 Table 1 – Maximum allowable difference between the measured and theoretical levels

Construction of Anechoic Rooms

For anechoic rooms to function well, a number of acoustic, mechanical, electrical and aerodynamic considerations apply. These will include some, or all, of the following:

- Anechoic treatment selection
- Cut-off frequency
- Internal acoustic ambient noise level
- Noise reduction
- Vibration isolation
- Silenced ventilation systems
- Acoustic doors operation and sizing
- Interior floors cables and / or gratings
- Lighting and electrical systems
- Overall structural design considerations
- RF shielding requirements





Noise & Vibration Isolation Characteristics

A well constructed room must provide good sound isolation against external noise so that resulting internal noise will not invalidate acoustic measurements. This may require the use of single or doublewall construction with appropriately designed vibration isolation to adequately reduce air – and / or structure-borne noise transmission.

For best results, anechoic facilities should be individual structures, separate from any host building walls.



Anechoic Wedges

One practical well proven method to achieve a free-field is to shape sound absorbing material into wedge configurations for mounting on to the interior surfaces.

The wedge shaped geometry ensures a gradual change in the acoustic impedance of the transmission media, ensuring that sound waves are absorbed by the material, rather than reflected at an interface.

The effectiveness of the absorption depends on the geometry and materials used.

The lowest frequency at which the absorption is effective (cut-off frequency) is inversely proportional to the depth of the wedge.

IAC's own impedance tube is used for critical adjustment of wedge dimensions before finalising each design.

Due to variations in material characteristics, statistical quality control measures are employed during wedge production to ensure specified acoustic performance.





IAC Metadyne® Wedges

Metadyne[®] anechoic and hemi-anechoic test rooms have been chosen by the world's leading companies for the many unique advantages they have over rooms built using other materials, such as glass fibre or foam.

Metadyne[®] wedges were developed by IAC as a solution to some of the problems associated with using 100% foam or glass fibre. IAC was the first manufacturer to provide acoustic performance of the highest standard with a range of wedges which are entirely encased in perforated metallic casings.

Metadyne® wedges are ideal for large facilities which require low frequencies to be absorbed for testing products such as cars or engines. The rugged wedge construction and their long life span offer advantages to laboratories working with heavy equipment and / or flammable materials.

All Metadyne[®] wedges are manufactured in IAC factories across the globe to set standards and tolerances. This means a consistent finish can be achieved on large global projects and also ensures the acoustic performance of each wedge.

Metadyne® metal-faced anechoic wedges offer:

- Guaranteed acoustic performance, with very low cut-off frequencies
- Compliance with international test standards, including ISO 3745, ISO 3744, ISO 26101
- Superior fire and impact resistance
- Greater durability and a longer lifespan than any other wedge type
- Ease of cleaning to ensure an "as new" appearance throughout their working life
- A bright, healthy and safe working environment for test personnel
- Bespoke paint options available to match corporate colours

Inverse square law curves for a hemi-anechoic room with Metadyne® wedges fall well within acceptable ISO tolerance standards. Inside clear dimensions: 6426 x 9500 x 3607mm cut off frequency 60Hz

1500

2000

3000

4000

Distance, mm

000

6000

500

750

1000



IAC 50Hz Metadyne® LF Wedge Test Report

Test Report Number: 04036-119 Module Size: 1200mm x 1200mm x 1450mm

Tested in accordance with ISO 10534-1:1996 Acoustics — Determination of sound absorption coefficient and impedance in impedance tubes — Part 1: Method using standing wave ratio.

Cut off frequency to ISO 10534 : 50Hz

Frequency, Hz	Sound Absorption Coefficient	
40	0.903	
50	1.000	
60	0.995	
70	0.995	
80	0.993	
90	0.999	
100	0.997	
120	0.997	
140	0.997	
160	0.997	
180	0.998	
200	0.999	





IAC 63Hz Metadyne® LF Wedge Test Report

Test Report Number: 020508-3 Module Size: 1200mm x 1200mm x 1200mm

Tested in accordance with ISO 10534-1:1996 Acoustics — Determination of sound absorption coefficient and impedance in impedance tubes — Part 1: Method using standing wave ratio.

Cut off frequency to ISO 10534 : 63Hz

Frequency, Hz	Sound Absorption Coefficient	
40	0.726	
50	0.903	
63	0.993	
80	0.994	
100	0.998	
125	0.997	
160	0.994	
200	0.998	
250	0.998	





Frequency (Hz)



IAC 70Hz Metadyne® LF Wedge Test Report

Test Report Number: 160408-1 Module Size: 1200mm x 1200mm x 1150mm

Tested in accordance with ISO 10534-1:1996 Acoustics — Determination of sound absorption coefficient and impedance in impedance tubes — Part 1: Method using standing wave ratio.

Cut off frequency to ISO 10534 : 70Hz

Frequency, Hz	Sound Absorption Coefficient	
40	0.721	
50	0.838	
63	0.969	
80	0.999	
100	0.999	
125	0.999	
160	0.997	
200	0.995	
250	0.998	





IAC 100Hz Metadyne® LF Wedge Test Report

Test Report Number: 290808 Module Size: 1000mm x 1000mm x 800mm

Tested in accordance with ISO 10534-1:1996 Acoustics — Determination of sound absorption coefficient and impedance in impedance tubes — Part 1: Method using standing wave ratio.

Cut off frequency to ISO 10534 : 100Hz

Frequency, Hz	Sound Absorption Coefficient	
80	0.958	
100	0.992	
125	0.994	
160	0.995	
200	0.993	



Frequency (Hz)





IAC 125Hz Metadyne® LF Wedge Test Report

Test Report Number: 160408-1 Module Size: 1000mm x 1000mm x 700mm

Tested in accordance with ISO 10534-1:1996 Acoustics — Determination of sound absorption coefficient and impedance in impedance tubes — Part 1: Method using standing wave ratio.

Cut off frequency to ISO 10534 : 125Hz

Frequency, Hz	Sound Absorption Coefficient
80	0.893
100	0.981
125	0.998
160	0.994
200	0.995
250	0.997



Wedge Testing – The Impedance Tube Method

If an anechoic chamber is to meet the free-field criteria of ISO 3745, the wall lining is required to have a normal incidence absorption coefficient D of no less than 0.99 when tested in an impedance tube (plane wave absorption). The cut-off frequency of the wedge is the lowest frequency at which this criterion is met. IAC has a strict testing regime ensuring that all anechoic wedges are designed and verified at full scale within our impedance tube.

Impedance Tube Features

- The impedance tube is designed using the guidance set out in ISO 10534-1 'Acoustics – Determination of sound absorption coefficient and impedance in impedance tubes – Part 1 Method using standing wave ratio', and ASTM C 384-98
- Walls constructed from 20mm plate with 140mm thick concrete and a 100mm air gap to ensure minimal losses and increase the accuracy of measurements
- The tube length limits the lowest measurement frequency (40Hz), and its cross-sectional dimensions limit the upper frequency limit (264Hz)
- The tube cross-section is big enough to test full size wedges

Background Theory

The equipment is very straightforward, the only required measurements are the sound pressure levels at multiple positions along the tube. For each frequency of interest, a speaker outputs a pure tone which creates a standing wave within the tube and a trolley mounted microphone automatically traverses this sound field and measures the sound pressure level at each point, recording the maximum and minimum values.

The absorption coefficient is determined from the ratio of the maximum to the minimum sound pressure level in the tube.

Wedge Testing in Reverberation Chamber

In addition to the impedance tube method, IAC anechoic wedges are also tested in independent laboratories to ISO 354, "Measurement of sound absorption in a reverberation room." By carrying out these additional tests, IAC ensures that each wedge design exhibits excellent absorption characteristics at frequencies above the upper limit of the impedance tube.

Proving the adequacy of the room absorption prior to installation is the best method for ensuring a guaranteed chamber performance.







Data Acquisition

IAC's own system captures all of the data and manages all subsequent data reductions, providing repeatable results on a straightforward and user friendly sheet. To capture the amount of data manually would not be time



effective, in fact, a single wedge test takes less than 30 minutes to complete. This fast testing method allows IAC to make changes to the profile of anechoic wedges and optimise the material configuration.



Typical view of IAC's data acquisition system for impedance tube testing

Wedge Test Results

A wedge will be considered suitable if the results show a normal incidence sound absorption coefficient greater than 0.99 at and above the required cut-off frequency.

The results opposite are those for a wedge with a cut-off frequency of 70Hz.

The software allows any individual frequency to be tested within the limits of the tube.



Wedge vs. Flat Anechoic Linings

Flat acoustic absorber panels can be used in a chamber to create a lower grade free-field, anechoic space. These panels are typically used if space is limited as they take up less room than a chamber lined with wedges. IAC's flat anechoic absorption range, Planarchoic™ can be tuned to deal with certain frequencies in the same way as our range of Metadyne[®] wedges.

Although Planarchoic[™] lined chambers have the benefit of increasing the available floor space for testing, the free-field area is reduced (as seen in the diagram below).

Planarchoic[™] free field rooms are always hemi-anechoic, usually large in size and can be placed on a hard floor in the absence of structurally transmitted vibration and noise. Planarchoic[™] rooms are suitable for sound measurements of cars, lorries, fork-lifts, transformers and other industrial equipment.

Special care must be taken in the relationship of Planarchoic[™] room volume to test object dimensions to assure a free-field environment, due to the reduced area for taking viable measurements.

Due to flat surfaces creating even a small amount of sound wave reflection, despite being acoustically treated, their performance is typically not as great as anechoic wedges.

Better acoustical measurements can be taken and relied upon using a chamber lined with wedges. All IAC chambers with wedge linings are certified to ISO 3745 for the determination of precision acoustic power levels (Grade 1). Chambers with flat absorbers applied to surfaces typically only qualify for ISO 3744 which is for non-precision acoustic power level measurements (Grade 2).



Free-field area inside a hemi-anechoic chamber comparison between surfaces lined with flat absorbers and wedges



Hemi-anechoic room showing flat absorbers on the walls with wedges in the roof to increase the amount of absorption

IAC Noise-lock[®] High Performance Acoustic Doors

IAC is a leading supplier of high performance acoustic doors with over fifty years experience in door design and manufacture. IAC offers a wide range of standard models, or can design and make doors to suit specific applications.

Over 1,000,000 IAC acoustic doorsets have been installed in industrial and commercial buildings throughout the world. They have been used in many applications in addition to acoustic test facilities and offer a high performance solution to situations where sound must be contained within or excluded from a room or building.

All IAC Noise-lock[®] doors and frames are designed to be acoustically compatible with rooms in terms of sound transmission loss. Hinges can either be cam-lift or level swing, depending on the requirements and double magnetic seals assure acoustic performance. Threshold compression seals can be provided with or without a sill.

IAC Noise-lock[®] Acoustic Doors for Anechoic Facilities

Specialist doors are required for anechoic facilities in order to maintain the same level of absorption as other walls and surfaces.

Anechoic wedges can either be attached directly to the inner face of Noise-lock[®] acoustic doors, or a separate 'basket' style arrangement can be used.











IAC Wedge Basket Doors

To maintain an absorbent wedge finish on all walls, entrances to an anechoic facility can solely utilise basket doors, or be used in conjunction with IAC's Noise-lock® range of high performance acoustic doors.

Depending on the available space and the type of wedge used, IAC can offer a cost effective solution to accommodate basket doors for any situation.











Reverberation Rooms

What is a reverberation room? A reverberation room can be considered the opposite of a an anechoic chamber because its boundaries reflect, rather than absorb sound energy. Reverberation rooms are designed for the determination of sound power output of noise sources, transmission loss of partitions, insertion loss of silencers, response characteristics of microphones and random incidence absorption coefficients of materials. They are also used for high-intensity noiselevel fatigue testing of aircraft, space vehicles and other equipment.

The purpose of a reverberation room is to create a highly diffused acoustic measurement environment, defined as a sound field in which acoustic energy flows equally in all directions.

A reverberation room must provide sound isolation against extraneous noises and an environment which can be temperature, pressure and humidity controlled.





IAC has installed many field-proven reverberation rooms in different configurations. With more than 60 years experience, IAC is the pioneer and leading company in the design, construction and commissioning of modular reverberation chambers.

Construction of Reverberation Rooms

For a reverberation room to perform correctly, careful consideration must be given to a number of factors which include:

- Test standard or method
- Interior volume
- Room dimensions in relation to test object size
- Interior working space
- Lowest frequency band of interest
- Internal acoustic ambient noise level
- Noise reduction
- Vibration isolation
- Silenced ventilation systems
- Doors and access
- Lighting and electrical systems
- Overall structural requirements

Standard Features

IAC reverberation rooms come fully equipped with the following features:

- IAC Hardliner[™] panel construction
- Double / single wall and ceiling construction
- IAC ventilation system coupled to building supply
- Interior lighting and power
- A standard size IAC Noise-lock[®] acoustic door
- Complete certification and commissioning tests

Options

- Self-contained air handling/ ventilation system
- Additional/larger door
- Access panels for equipment and test openings
- Air mounts, or other types of vibration isolation
- RF shielding
- Turning vanes and/or diffusers

IAC Ventilation Systems

A ventilation system must provide adequate air circulation at sound pressure levels below design criterion. IAC Quiet-vent® silencing systems are designed to provide approximately 15 air changes per hour in a typical anechoic facility. If specialist

heating/cooling needs are required, then IAC can custom-design a system to meet your needs.

IAC is an industry leader in the design and construction of silencing devices for air/gas flow systems. These range from minimal air changes to large elaborate intake and exhaust silencing systems to accommodate engine research within an acoustic test facility.

IAC has designed and manufactured hundreds of thousands of silencers for soundproof rooms, HVAC systems, industrial machinery, power plants, engine test cells and gas turbines.



Climatic Chambers

IAC can enhance ventilation systems to cover a wider range of temperatures within the chamber. IAC Metadyne[®] wedges are able to withstand high and low extremes without degradation, provided that the temperature cycling is controlled for condensation.

Areas of potential complication are frequent room calibration for differing temperatures, structural design for very low temperature, personnel safety, test equipment durability and operation.

Should extreme temperature testing be required including fluctuations in humidity, IAC can work with clients to achieve the best possible results.

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Isolation

With regard to chamber isolation, at design budget stage, there is usually insufficient information to confirm whether structural isolation of the floor slab is or is not required. IAC would review proposed site layouts, Geotech reports and space planning to analyse what may affect the chamber performance based on surrounding facilities. IAC has found through experience, that other than in extreme cases, with good isolation of the dynamometer and plant room equipment, an expansion joint 'break' in the floor slab would be enough to eliminate most problems for general NVH.







Spring mounts being installed for floating floor system

Ancillary Equipment

In addition to core acoustic products, IAC is also able to offer full integration of other ancillary equipment within facilities, including electrical items (lighting, alarms, sensors, CCTV etc) and mechanical plant and equipment (chassis dynamometer, instrumentation, chillers etc).

Cranes, Hoists & Vehicle lifts

IAC has supplied many different types of systems ranging between 2 post lifts, 4 post lifts, recessed floor systems, overhead cranes and runway beam cranes.

Lighting

IAC supplies the latest LED-based lighting system that is designed to provide a diffused light field. IAC also include emergency lighting as necessary. The lighting provided ensures that horizontal luminance in the working area at 1m above the floor is no less than 600lux and their lifespan rated at no less than 75,000 hours. The lights are selected to achieve the lowest possible background noise levels and ambient temperatures.

Plant & Test Equipment

Air cooled external chillers with buffer vessels and pump systems for chilled water cooling, chassis and engine dynamometers.









Hemi-anechoic room highlighting IAC's chosen lighting system alongside the client's preferred fire suppression system



Plant room for turnkey acoustic testing facility

Below is an example of a project for Volvo Cars where the facility was completely overhauled by IAC to include new wall linings, acoustic doors and a silent ventilation system.

Before









After





Refurbished anechoic pass-by chamber facility with foam and IAC $\mathsf{Metadyne}^{\otimes}$ wedges

Refurbishment

The last two decades have seen an explosion in acoustic testing by automotive manufacturers, component suppliers, engineering institutions and educational organisations together with a rapid growth in the construction of new acoustic test facilities.

Many older facilities have become tired and may contain materials that are now considered unsuitable and hazardous. IAC can provide your facility with a much needed upgrade complying with current day standards and utilising state of the art robust materials and technology. All IAC products are rigorously tested and the new materials permit "corporate styling" and high aesthetics to suit each customers' individual requirements.

Upgrade products include:

- Survey and design
- Existing chamber strip-out
- Replacement wedges
- Replacement doors
- Replacement ventilation
- Replacement lighting and electrics



IAC Curved Roof for Turnkey Hemi-Anechoic Chambers

Main contractors sometimes struggle to provide a smooth, flat and level surface to the underside of concrete roofs or walls, to allow the installation of IAC's wedge support structure. Because of the spans, the concrete thickness tends to escalate where the roof load can easily exceed 500 tonnes (all of which needs supporting). A builder's solution, normally, is to install deeper steel beams and hollow-pot type ceiling, however, this is not acceptable physically or acoustically for the wedge system.

This heavy design also increases the steel tonnage, foundations, costs and at the end there may be no acoustic guarantees from the builder. For the same size, with a guarantee, IAC can supply a flat or curved roof system that will only weigh a fraction of an equivalent concrete solution at 30 tonnes.

Please refer to the adjacent photos of IAC's solution of level or 'curved' panel ceilings. The curve also has the added benefit of improving the anechoic performance inside the chamber and the reduced wall height reduces cost and allows space for return air ductwork above the rooms.



Hemi-anechoic chamber with a curved roof during construction phase



The same site, once the chamber was completed and the wedges installed



Typical building shape from outside a turnkey facility with a curved roof



Facility Testing and Final Commissioning

IAC offer a comprehensive commissioning service for all acoustic test facilities to ensure the performance criteria is met and an exact frequency cut-off determined.

IAC has been represented on the International Standards Organisation working group to develop a standardised test method for anechoic and hemi-anechoic chambers. The new standard (ISO 26101 – Acoustics — Test methods for the qualification of free-field environments) provides a test method applicable to all free-field environments, as an alternative to the method given in the Annex of ISO 3745 which is primarily for anechoic rooms designed for sound power measurement.

When commissioning a facility, IAC will determine the effectiveness of the chamber by making sound pressure level measurements as a function of distance from a sound source situated in the centre of the chamber, and comparing these with the corresponding values predicted by the inverse square law.

In addition to commissioning the test cell, IAC also carries out ambient noise levels (including the ventilation system) and transmission loss, reverberation time and dynamometer noise measurements. As part of the commissioning procedure, IAC also fully tests and commissions the ventilation system in the facility, including air flow balancing.









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Automotive Test Facilities

- Hemi-anechoic Chambers
- VSAC
- Pass-by Chambers
- Powertrain NVH Test
 Laboratories
- Driveline Chambers
- Listening Rooms
- Modal Analysis Facilities
- Shake & Rattle Chambers
- Airbag Test Facilities
 Quiet Rooms



Automotive Acoustic Test Facility International Customer List

Customer	Description	Location	Customer	Description	Location
Aberdeen Proving Ground		USA	Ford Motor Company	00 🕒	USA
Airic		Iran	Ford Motor Company	00	Australia
American Axle		USA	Ford Motor Company	00	USA
Alpine		Germany	Ford Motor Company	00	USA
Arcelic		Turkey	Ford Motor Company	M 🕄	UK
Artc		Taiwan	Ford	1	UK
Arvin		USA	Ford Rawsonville	00	USA
Arvin Muffler		USA	Georgia Tech		USA
Arvin Muffler		USA	GIF	WV	Germany
Arvin N.A.		USA	GM Corporation	00	USA
Audi		Germany	GM Lansing	M (1)	USA
Audi		Germany	GM Truck & Bus	WV	USA
Audi Ingolstadt		Germany	GM Brazil	WV	Brazil
Bajaj Autos	MP	India	GM Flint		USA
Bar F1		UK	GM Milford	M ()	USA
BMW	B	UK	GM Saginaw	M (1)	USA
Bosch Auto		USA	Goodyear	WV	Luxembourg
Bosch Automotive	MH	USA	Harley Davidson	M P	USA
Bridgestone/Firestone		USA	Harman Consumer Group		USA
BYD (Build Your Dreams)		China	Harman International	M (1)	USA
Burke E. Porter		USA	Harman International	M (1)	USA
Ceeva		France	Harman Motive		USA
Cetecom		Germany	Harman OEM Group		USA
Chrysler Motor Corporation		USA	Harman Becker UK		UK
Chrysler Motors		USA	Honda F1	00	UK
CMI-Ricardo	M E	USA	Honda	FB	USA
Coltec Automotive		USA	Honda America	FH	USA
Continental	FV	USA	Honda America		USA
Creos	\mathbf{M}	France	Honda UK		UK
Daewoo		USA	Hyundai Motor		USA
Dana Corp.		USA	Hyundai Motor		USA
Deere & Company		USA	Idiada	() () ()	Spain
Deere & Company		USA	ITT Automotive	F B	USA
Deere & Company		USA	ITT Automotive	FB	USA
Deere & Company		USA	ITT Rochester		USA
Deere & Company		USA	IMS Morat + Söhne		Germany
Delphi Automotive		USA	Ivensys	R	USA
Delphi Int. Sys.		USA	Jaguar		UK
Delphi Products		Luxembourg	Jaguar	N N M	UK
Delphi Products		Luxembourg	Katri		Korea
Delphi Products		Germany	Kampmann		Germany
Dow Automotive		USA	Karmann		Germany
Faital		Italy	Kolano & Saha		USA
FEV Engine Tech		USA	Kuzoi Motors		Taiwan
Fiat		Italy	Kwang Motors		USA
Fisa		Italy	Lear Corporation		USA
Ford Motor		USA	Land Rover		UK
Ford Motor Company	🕐 🕐 x12	USA	Lombard Co.	00	USA

Customer	Description	Location
Lotus		UK
Lotus		UK
Magna Corporation		USA
Mando		USA
Massey Ferguson		France
Maruti Suzuki		India
McLaren F1		UK
Merloni		Italy
Methode Electronics	0	USA
Monroe Auto		USA
Monroe Auto Equipment		USA
Monroe Auto Equipment		USA
Motor Products		USA
MTS		USA
Nissan European Technology Centre		UK
Nissan European Technology Centre		UK
Nissan		Spain
Nissan		USA
Opel		Germany
Opel Russelsheim		Germany
Perstorp		USA
Porsche		Germany
Porsche		Germany
Renault		France
Ricardo		UK
Ricardo		USA
Rousch Anatrol		USA
Rousch Anatrol		USA
Rousch Anatrol		USA
Rover		UK
Rover	SR	UK
Rolls Royce Motor Cars Ltd		UK
Sanden		France
Schenck Pegasus		USA
Schenck Pegasus (Ford Motor Co.)		USA
SDRC		USA
Sebring		Austria
Siemens Corporation		USA
Siemens Corporation		UK
Siemens Ag, Bad Neustadt	0	Germany
Siemens Munich		Germany
Siemens Kamplintfort		Germany
Siemens Bocholt		Germany
Siemens Ulm		Germany
Siemens Production Technology		Germany
Siemens Beijing		China
Sika Industry		USA
Skoda	🔘 🕒 🕒 💿	Czech. Rep.

Customer	Description	Location
Sverdrup Technology Inc.	0	USA
Tennex Industries	M I V Å	UK
Toyota	M () V	USA
TRW	000	Germany
US Army	() ()	USA
Valeo	000	USA
Valeo		USA
Valeo Wiper Systems	000	USA
Valeo		France
Visteon (Ford)		UK
VW Wolfsburg		Germany
Volvo	M I V	Sweden
Volvo		Sweden
Volvo		Sweden
Volvo Penta		Sweden

	Metadyne [®] Wedges
M	Microdyne [®] Foam Wedges
F	Microdyne [®] Fiberglass Wedges
E	Planarchoic™ (flat) Panels
A	Full Anechoic Chamber
B	Hemi-anechoic Chamber
V	Vehicle Semi-anechoic Chamber (VSAC)
E	Engine Semi-anechoic Chamber (ESAC)
P	Pass-by Chamber
	Listening Room
Q	Quiet Room
SR	Shake & Rattle Facility
SQ	Sound Quality Room
R	Reverberation Chamber
ŵ	Turnkey Project

Key

Industrial & OEM Facilities

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Industrial & OEM Acoustic Test Facility International Customer List

Customer	Description	Location
AMD		USA
AP Products		USA
Apple Computers		USA
Arcelic	0	Turkey
Artc		Taiwan
AT & T	(1)	USA
Autophon (UK) Ltd.	M H	UK
AWA/Aisin		USA
Bafam (Berlin Germany)		Germany
Becton Dickinson		USA
Blachford		USA
BPB America/Celotex		USA
British Telecom		UK
Bristol Compressors		USA
Bureau of Mines		USA
Burke E. Porter		USA
C. Iber & Sons		USA
Canon Virginia		USA
Cemoter	MH	Italy
Cidco Inc.		USA
Conner Peripherals		USA
Copeland Corp.		USA
Cosi		USA
Cummins	🕅 🕕 x2 🏠	USA
Defiance		USA
Delco Electronics		USA
Dell Computer		USA
Deutsche Telekom Ag (Steinfurt)		Germany
Dunn Construction		USA
Eaton Technologies Inc.		USA
Environetics		USA
Ericsson	M H	UK
Fachhochschule (Kiel Germany)		Germany
FG Wilson Ltd.	M B A	UK
Faital		Italy
FBI		USA
FEV Engine Tech		USA
Firma Cetecom		Germany
GE Appliances	R	USA
GHSP		USA
Goodmans Loud Speakers		UK
Grundfos		Denmark
Grundig		Germany
Harman Consumer Group		USA
Harris Corp.		USA
Hewlett Packard	()) (1)	USA
HLFU (Germany)		Germany
Honeywell Inc.		USA

Customer	Description	Location
Hull City Council	M 🕕	UK
IA & A Acoustics		USA
IBM Corp.	M ()	USA
Inalfa Roof		USA
Ingersoll Rand		USA
Intel	(1)	USA
ITT Telecom	M H	USA
Jabil Circuit		USA
Kelley & Associates		USA
Ketchum & Walton		USA
Kokusai Electric		USA
Lectron Products		USA
Mabe		USA
Magna Corporation		USA
Mando Machinery	M ()	USA
Matsushita Electric	(1)	USA
Maxtor Corp.		USA
Mayo Clinic		USA
Merloni		Italy
Meyer Sound		USA
Microsoft		USA
Ministry of Defence		UK
Miracle Ear/Dahlberg		USA
MIT	00	USA
MOD	00	Israel
Motorola	(1)	USA
MTD Products		USA
Nacco		USA
Nastech		USA
NEC America		USA
Neuroscience		USA
Newman Technology		USA
Nidec Corp.		USA
NIST		USA
Nokia UK		UK
Nokia Bochum		Germany
Nokia Copenhagen		Denmark
Northern Telecom		USA
Northrop Electro		USA
Nytt Rikshospital		Norway
Oeler Industries/Polymics		USA
Ohio State University		USA
OKI Telecom	M H	USA
Owens Corning		USA
Oxford Speaker Company		USA
Panasonic		UK
Penn Ventilators		USA
Phonak Gmbh		Germany

Customer	Description	Location
Pioneer Speakers Inc.		USA
Pitney Bowes		USA
Prince Corporation		USA
Q-Tran		USA
Ransco	())	USA
Resound Corp.		USA
Robert Bosch		USA
Rockwell International		USA
Rolm Systems		USA
Rudolph Libbe		USA
Samsung	M (1)	UK
Sanitherm Engineering		USA
SCJ Associates		USA
SDRC		USA
Seagate Technologies	M H	USA
Shure Brothers		USA
SIAC	M ()	Singapore
Simpson		USA
Singer Controls		USA
Smith Corona Corp.		USA
Standard Telecommunication Lab.		UK
STC Telecommunications Ltd.		UK
Sunbeam Oster		USA
Sverdrup Technology Inc.		USA
Systems Mat'l Handling		USA
Tokai Rika		USA
Tokia Rubber		USA
US Army		USA
US Dept. of Labor		USA
USA Medical Research		USA
VDE	B	
Veridian Veda Operations		USA
Vertu		UK
W.E. O'Neil		USA
Western Digital		USA
Walbridge Aldiner		USA
Walker		USA
Whirlpool Singapore	00	USA
Xerox Corporation	000	USA
Yazaki Eds Eng		USA
Yazaki N.A.		USA
York International	(i)	UK
Yosemite Trading		USA

Key

M	Metadyne® Wedges
	Microdyne® Foam Wedges
F	Microdyne [®] Fiberglass Wedges
F	Planarchoic™ (flat) Panels
A	Full Anechoic Chamber
θ	Hemi-anechoic Chamber
	Listening Room
R	Reverberation Chamber
Ŷ	Turnkey Project

High Performance Acoustic Test Facilities

Facilities For education and acoustic research organisations



Academic & Research Acoustic Test Facility International Customer List

Customer	Description	Location
Aberystwyth University	0	UK
BSI		UK
CEM	M (A) 🖸	Spain
Department of Science		USA
Edinburgh University		UK
Goodmans Hi-Fi	🕅 🔕 🖻	UK
Harman Becker	M \Lambda 🖻	UK
HSL Buxton		UK
Imperial College London	M 🕒	UK
Institute of Sound & Vibration Research (ISVR)	R A	UK
Lorent	R	UK
McQuarie University	F A	Australia
MIT	M ()	USA
MOD Aquilla		UK
National Physical Laboratory (NPL)	M A 🖸	UK
Neuroscience Department		USA
Ohio State University		USA
Oxford University		UK
Portsmouth University		UK
Qinetic		UK
Salford University		UK
SATRA	M B	UK
Southbank University		UK
Southampton Solent University	M	UK
Strathclyde University	0	UK
University College London		UK
University College Northampton	0	UK
University of Southampton		UK
US Army		USA
US Dept. of Labor		USA
USA Medical Research		USA
Warwick University	0	UK

Кеу

- Metadyne® Wedges
- Microdyne® Foam Wedges
- F3 Microdyne® Fiberglass Wedges
- Pure-tone Certified
- A Full Anechoic Chamber
- Hemi-anechoic Chamber
- Listening Room
- Reverberation Chamber
- 1 Turnkey Project



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