

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.

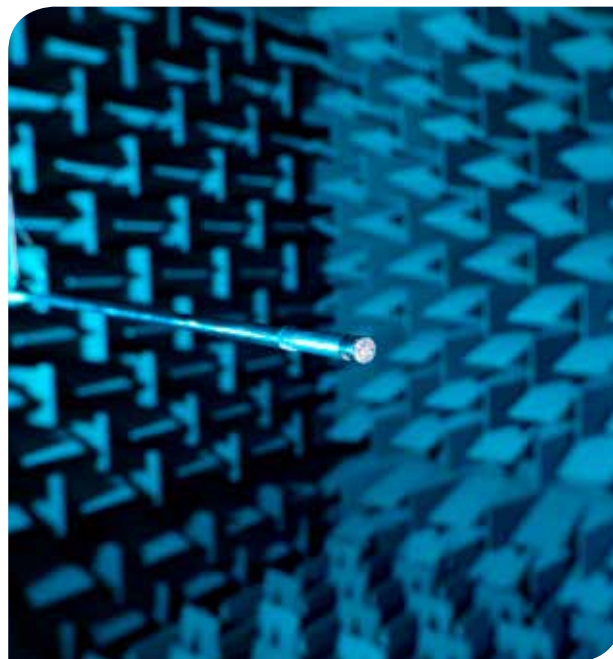
making the world a quieter place



Turnkey complete acoustic test facility for Cummins Power Generation in Fridley, Minnesota

Leading Supplier of Acoustic Test Chambers

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

Turnkey Suppliers

IAC Acoustics 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 Acoustics 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	± 1.5
	800 to 5,000	± 1.0
	>6300	± 1.5
Hemi-Anechoic (Simulated Free-Field)	<630	± 2.5
	800 to 5,000	± 2.0
	>6300	± 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 double-wall 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.





High Performance Acoustic Test Facilities

For education and
acoustic research
organisations





Hemi-anechoic chamber for the University of Salford

Acoustic Testing for Education and Cutting Edge Research & Development

In addition to being the world's largest supplier of noise control solutions to industry, IAC is also unique in its ability to provide some of the best acoustic test facilities to colleges, universities and research groups around the globe. Specialist education establishments where cutting edge research is carried out, demand the highest acoustic specifications for their facilities. IAC has been privileged to have worked with some of the best organisations worldwide.

Typical Construction

Anechoic facilities used by research institutions are typically constructed from IAC modular acoustic panels to the configuration of either Schedule 40 (single wall) or 60 (double wall) Microdyne® chambers.



Fully anechoic chamber for University College London (UCL)



“IAC Acoustics is able to supply pure-tone anechoic facilities for research institutions.”

IAC Clients

IAC Acoustics has worked with the following organisations for high-specification acoustic test facilities:

- Institute of Sound & Vibration (ISVR) at Southampton University
- National Physical Laboratory (NPL)
- Salford University
- McQuarie University
- CEM
- Imperial College London
- Oxford University
- University College London (UCL)
- SATRA Technology

Schedule 60 Microdyne® Chambers

The IAC Microdyne® Schedule 60 anechoic room is designed for the research physicist or engineer who must make precise sound measurements in a free-field acoustic environment. Schedule 60 rooms provide high sound transmission loss (TL) characteristics and have a completely anechoic wedge lined interior to meet these requirements.

For maximum sound isolation, IAC Schedule 60 rooms are designed as a room within a room featuring certified IAC Noise-lock® and Moduline™ components. The inner room is set on a vibration isolation system created for the specific weight and frequency cut-off of the room.

Schedule 40 Microdyne® Chambers

Schedule 40 chambers are designed for applications and locations where the noise reduction characteristics for a single wall and ceiling construction provide adequate noise isolation.

The single wall construction results in smaller overall outside dimensions and is particularly suited to placement in less noisy areas. In every other respect, the Schedule 40 is similar to the Schedule 60 series with the same standard features and options available.

making the world a quieter place



Standard Features

Microdyne® anechoic rooms come with the following standard features:

- Anechoic wedges (foam, fibreglass or IAC Metadyne®) with the required low-frequency cut-offs
- Double or single wall and ceiling construction
- IAC standard ventilation system coupled to the building supply
- Lighting (interior) minimally acoustically reflective
- Tubular cable ports
- Interior non-reflective cable floor system above the floor wedges with a nylon catch net below
- IAC Acousti-flote™ floor system with vibration isolators
- One IAC Noise-lock® wedge acoustic door

Options

- Floor grating for chambers which will house heavy items
- Additional or larger Noise-lock® acoustic doors
- Access panels for equipment and test openings
- Double Acousti-flote™ floor for Schedule 60 anechoic rooms
- Air mounts, springs or other types of vibration isolators
- Independent ventilation system
- RF shielding

Floors

Fully anechoic chambers pose a challenge when people need to enter the facility in order to place items under test. IAC Acoustics has developed a range of floor solutions to minimise reflective sound. Typical installations utilise a grid-based system to maximise the absorption of the floor wedges. IAC also uses a range of cable floors to support people and heavy test objects. For some very high specification facilities, IAC has developed a range of retractable floors which completely remove any reflective surfaces when in use to achieve the most accurate measurements.

Cable Floors

IAC fully anechoic chambers are typically provided with a tensioned cable floor, situated approximately 100mm above the tips of the floor wedges. Beneath this cable floor is a nylon catch net to prevent debris and small objects falling out of reach.

The cable floor consists of stainless steel cable interwoven in a criss-cross matrix of 50mm separation. Each cable is tensioned from an acoustically lagged steel ring beam by turnbuckles at one end and a coil spring at the other. This ensures that the floor is strong with even deformation and spring characteristics.



Example of Microdyne® fully anechoic chamber with gridded floor for ISVR in Southampton



Example of Microdyne® fully anechoic chamber with cable floor plus additional platform for Deutsche Telekom

Typical Uses of Precision Chambers

Typical uses of IAC's range of high precision anechoic and hemi-anechoic chambers include:

Microphone Calibration

- Primary calibration, free-field reciprocity method
- Secondary calibration by the substitution method
- Frequency response and directivity

Sound Level Meter Calibration

- Pattern evaluation
- Frequency response
- Directivity

Psycho-acoustic Testing

- Sound perception testing is typically used for research and development of products
- An example of research carried out was by Stable Micro Systems Ltd at NPL in the UK where tests were carried out on the "crispiness" of biscuits and their effects of peoples' perceptions of taste

Sensory Deprivation Testing

- Used for military and educational research

Speaker Research & Development

- Sound power output measurements
- Physical speaker design
- Distortion and frequency response

Acoustic Science

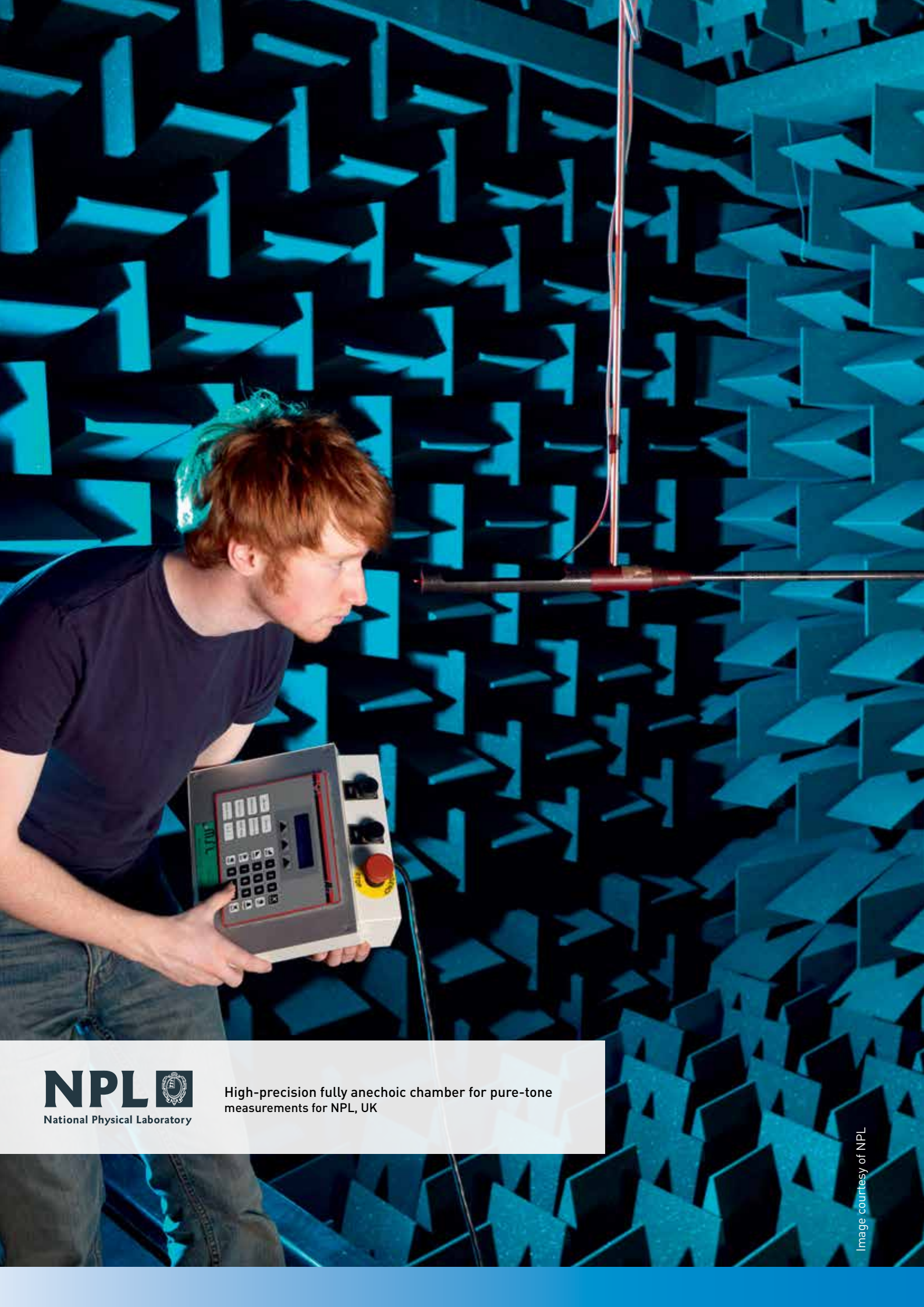
- PhD projects
- Ultrasound scanning research
- Virtual acoustics – generating auralisations of concert halls, city streets and other spaces

CE Marking/Certification

- All machines are required to have a sound power output test carried out prior to being released for sale
- Testing of toys to ensure suitability for hearing in children
- Items such as hearing protectors are required to be tested in an anechoic chamber to measure their effectiveness

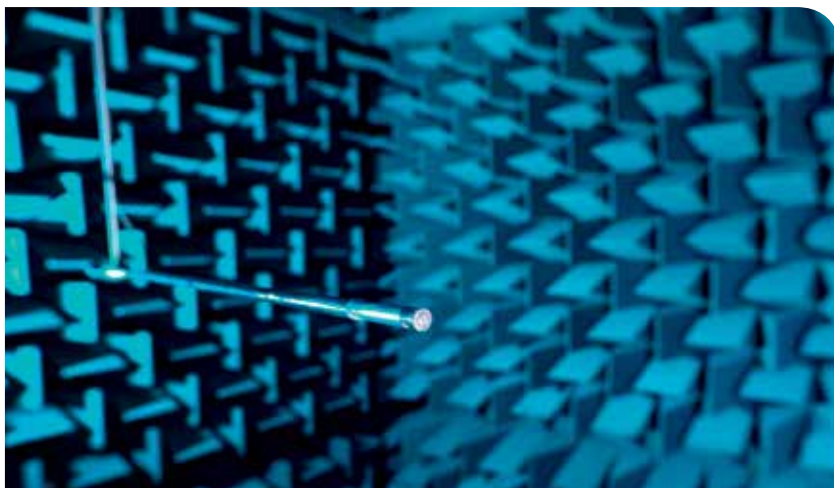
Hearing Research

- Free-field audiometry
- Cochlear implant testing



IAC Project – National Physical Laboratory (NPL)

- Fully anechoic facility
 - 125Hz cut-off frequency
 - ISO 3745 compliant for pure-tone anechoic chambers
 - Unique twisting basket door arrangement
 - Fire retardant foam wedges
 - Integrated microphone positioning system
-



The UK's national measurement institute, the National Physical Laboratory (NPL), is a world-leading centre of excellence in developing and applying the most accurate measurement standards, science and technology. Its acoustics team provides the primary standards for sound pressure in air in the UK. In order to support their research and calibration requirements, IAC refurbished and commissioned the acoustic anechoic chamber.

This new anechoic chamber provides exceptional free sound field conditions at frequencies from 125Hz to 20kHz and is primarily used for free-field calibration of microphones. The facility exceeds the requirements defined in ISO 3745 for pure-tone anechoic chambers (<0.5dB deviation from free-field behaviour with root-mean-square deviations as low as 0.04dB). The chamber is formed with a concrete shell, lined on all surfaces with an absorbent treatment of over 1600 fire-retardant foam wedges. The result is a near perfect free sound field with ambient noise levels in the chamber of lower than NR1 to ensure low measurement uncertainties.

Devices under test may be mounted on a computerised traversing mechanism which runs along the centre line of the chamber. This provides source-receiver separations along the nominal axis of the chamber's sound source and ensures accurate and repeatable positioning of the test device.

A suspended retractable floor allows access to the room. During measurements, this is withdrawn to expose the floor wedges, thereby creating the perfect free-field. The floor is removed by means of a rolling mechanism, storing the grid beneath the floor wedges.

“Since its commissioning, the NPL free-field chamber has been used extensively, delivering world-class measurement results in a number of research projects, for example in characterising novel transducers, as well as reliable calibration data for our clients.

In a recent international project to evaluate methods for determining the free-field performance of sound level meters, results determined in the NPL chamber were found to be comparable with data from other laboratories where post-processing had been applied and were significantly better than others where such techniques were not used.”

Richard Barham
Principal Research Scientist NPL

IAC Project – The University of Salford

- Fully anechoic chamber with 100Hz cut-off
 - 2 hemi-anechoic chambers each with 250Hz cut-off
 - 4 acoustic studios complete with adjoining control rooms
 - Anechoic/hemi-anechoic chambers are all ISO 3745 compliant
-



The University of Salford approached IAC to provide a number of different acoustic facilities for their Acoustics, Audio and Video Engineering Department. Included in the test environments provided were a single fully anechoic chamber with a 100Hz cut-off frequency, a pair of hemi-anechoic chambers, each with a cut-off frequency of 250Hz and a block of 4 acoustic studios, all with adjoining control rooms.

Used by students, researchers and commercial clients, the acoustic test facilities completed by IAC were part of a £2.5m investment programme by the University of Salford.

The anechoic chamber was constructed as a room within a room to prevent sound from getting into the chamber and the inner walls and floor were mounted on anti-vibration pads and springs to prevent structure-borne

noise. The chamber itself incorporates a unique set of double acoustic sliding doors and uses a tensioned cable floor to minimise reflective sound.

This chamber is predominantly used for testing the sound attenuation of hearing protectors, but is also used by PhD students who require very precise sounds to be reproduced.

The pair of hemi-anechoic chambers are of a single wall construction and identical in terms of size and performance. One is used for commercial purposes and the other is solely utilised for teaching. The teaching laboratory is typically used for noise measurement and measuring the response of loudspeakers.

In addition to the anechoic facilities, IAC also constructed a suite of 4 acoustic studios, three digital and one analogue. The four control rooms were built around four live rooms that are interlinked to allow recording from multiple live rooms for maximum isolation between instruments. One live room was dedicated for drums and as such had a higher level of acoustic isolation.

The studios were built to high acoustic specifications, to provide an accurate monitoring environment. Each room has been placed on acoustic dampers to isolate them from outside noise and each other. Between the control rooms and performance areas, quadruple glazed windows were installed to allow good visual contact between musicians and the studio engineer.





University of
Salford
MANCHESTER

Fully anechoic chamber, part of a range of facilities
provided for the University of Salford, Manchester



Hemi-anechoic chamber for SATRA Technology,
Nottinghamshire, UK

IAC Project – SATRA Technology

- Hemi-anechoic chamber
- 125Hz cut-off frequency
- ISO 3745 compliant
- Fire retardant foam wedges
- Integrated speaker mounts
- Double-wall construction
- Performs as specified, despite a background noise of around 70dB(A) in the surrounding area



IAC Acoustics was approached by SATRA Technology, one of the world's leading research and technology centres of its kind to build and commission a hemi-anechoic chamber with a very high acoustic specification.

Formed in 1919 SATRA helps manufacturers and suppliers to evolve by providing technical knowledge, research and testing. Currently commissioned for testing various PPE items such as high visibility clothing, footwear and protective eyewear, SATRA wanted to be able to offer testing of hearing protection to their portfolio. In order to certify, test and develop products such as ear defenders for various manufacturers, an anechoic chamber was required.



Positioned within an existing building with other kinds of research being carried out on a day-to-day basis, the proposed chamber needed to meet a demanding acoustic

specification despite a high background noise level of around 70dB(A) within the host structure. With this in mind, the new facility was configured as a room within a room and constructed using IAC's Moduline™ acoustic panel system. The inner chamber is structurally isolated from the outer skin using a series of anti-vibration mounts and an air gap between the two walls helps to further increase the acoustic performance.

The internal walls and ceiling of the chamber were covered with foam anechoic wedges of an appropriate size and length to achieve the 100Hz cut-off frequency target set by SATRA in the specification. Access to the chamber is via a set of IAC Noise-lock® linked acoustic doors between the two skins and a wedge basket door at the room entrance to ensure maximum internal sound absorption.

Due to the nature of the core function of the facility which is for hearing protection products, IAC worked closely with SATRA at the design phase to incorporate an array of mounts for holding speakers. The speakers, act as the noise source for which products on test will be graded.

Commenting on behalf of SATRA, Andy Todd, Acoustic Engineer said: "The new hemi-anechoic chamber will help to widen the range of services SATRA is able to provide, not only for hearing protectors, but hopefully other products in the future. Overall the project ran very smoothly and the new chamber performs very well."

IAC Project – Lorient

- Transmission suite
 - BS EN ISO 10140 compliant
 - Moveable walls to accommodate different size doors and offer flexibility
 - High performance acoustic doors used
 - Background noise level of less than 20dBA
-



Lorient Polyproducts Ltd, based in Devon, design and manufacture market-leading, high-performance door sealing systems, helping to contain sound within a room and also shield unwanted noise from entering. With 35 years experience, Lorient is respected throughout the industry for their technical knowledge.

IAC Acoustics was approached by Lorient, to build and commission a facility to enable them to develop and test their products in compliance with parts of BS EN ISO 10140. Compared to standard IAC products, the project at Lorient was completely bespoke and entailed an entirely new installation. The Global Acoustic Test Facilities team at IAC designed, supplied and installed a transmission suite, for measuring airborne sound and was suitable for testing to the acoustic parts of BS EN ISO 10140:2010. The suite needed to be designed 'dismountable' so that it could be disassembled, relocated and assembled in another location at a future date. The suite also needed to include a variable sized opening to readily install double doors, single doors or windows, with a blanking panel system that reliably ensured a repeatable baseline transmission loss through the wall.

IAC designed Lorient a unique plug panel system to allow the versatility to switch between door and window configurations. IAC Acoustics STC-53 and STC-64 acoustic doors provided the noise isolation from the busy nearby factory floor to inside the testing rooms, resulting in a working background noise level of less than 20dBA. The reverberation times within the suite were tuned using IAC Absorbatone panels, ensuring that the reverberation times met the recommendations in the Standard.

A full commissioning service was included which included qualification of appropriate sound source and microphone positions, measurement of the Rmax condition, reverberation time measurements, checks on electrical noise floor and cross-talk and background noise. Commenting on behalf of Lorient Polyproducts Ltd, Dunstan Ferris, Technical Consultant said, "We are very happy with the level of professionalism delivered by IAC Acoustics and the finished product is not only highly impressive, it also meets the specifications required".

making the world a quieter place





LORIENT



IAC Project – Solent Acoustics, Southampton Solent University

- 100Hz cut-off rating
 - Very high performance for a single wall construction
 - Chamber used for practical laboratory testing
 - Microdyne foam anechoic wedges used
-



IAC was approached by Solent Acoustics, part of Southampton Solent University, to build and commission a single-walled hemi-anechoic chamber, to enable teaching and research for its students. The University also has a long-term view of renting the space to local companies for testing and certifying products and components.

Solent Acoustics provides a range of consultancy and training services for the industrial and educational sectors, specialising in training, education and CPD relating to noise and acoustics. In addition, they provide a range of services for sound isolation testing (Part E), through to Environmental and Occupational Noise measurements to conduct research for product development.

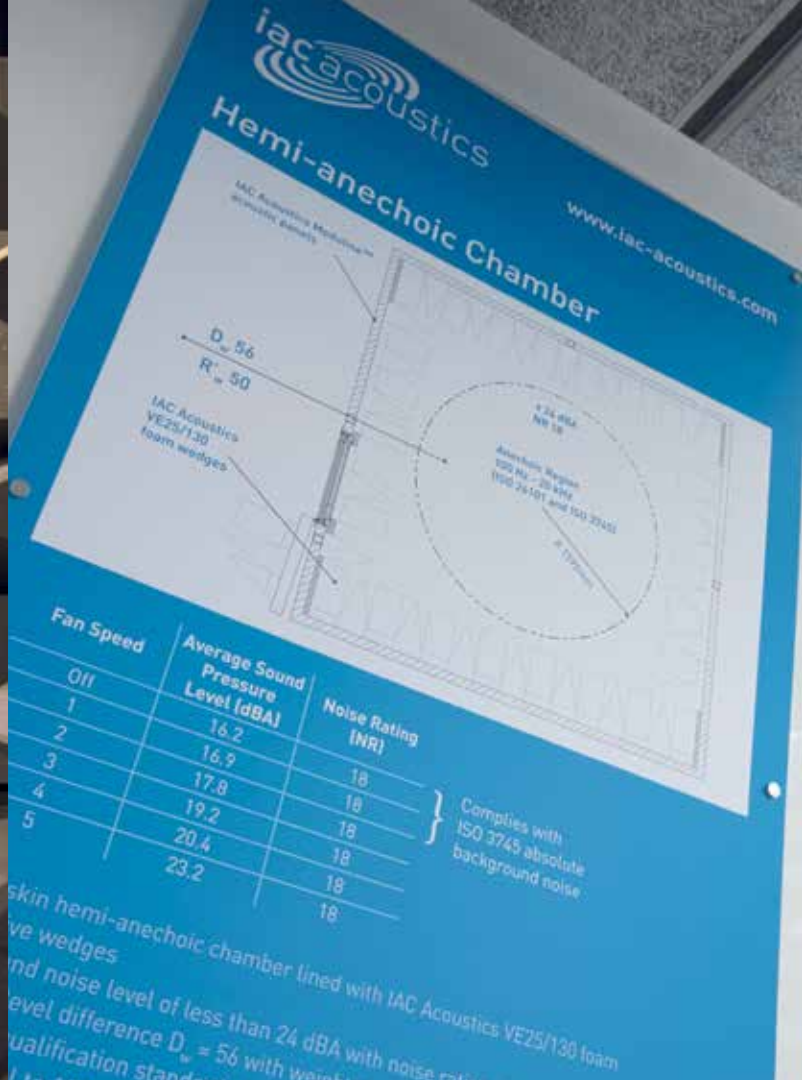
Solent Acoustics wanted a modular system that could be used for teaching, along with other capital investments in equipment, enabling them to run various Institute of Acoustics (IAO) courses such as the Diploma in Acoustics. The chamber would also be used for PHD students to conduct research specialising in acoustics.

The internal walls and ceiling of the chamber were covered with foam anechoic wedges of an appropriate

size and length to achieve the 170Hz cut off frequency target set by Solent Acoustics. After completing the project, the chamber was tested and actually achieved 100Hz. Solent Acoustics were understandably very pleased with the outcome and performance of the chamber, with low internal noise levels of 16dB (A) and NR18 achieved through a single wall chamber.

Commenting on behalf of Solent Acoustics, Christopher Barlow, Associate Professor of Acoustics said,

“I am more than happy with the level of performance of the hemi-anechoic chamber installed by IAC Acoustics. Having specified a cut off frequency of 170Hz we were very impressed when the chamber achieved 100Hz, enabling us to take a wider range of measurements at lower frequency. Overall the project ran smoothly and it was a pleasure to work with IAC.”



Southampton
SOLENT
University

Academic & Research Acoustic Test Facility International Customer List

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

Key

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



**Head Office - Winchester, UK****T:** +44 (0) 1962 873 000**E:** info@iac-uk.com**Israel****T:** +972 894 284 83**F:** +972 894 284 86**E:** hna.info@iac-noisecontrol.com**Australia****T:** +61 (0) 2 8781 0400**F:** +61 (0) 2 9725 2939**E:** info@iac-australia.com.au**Italy****T:** +39 0445 575 669**F:** +39 0445 575 002**E:** italy.info@iac-noisecontrol.com**China (Dongguan Office)****T:** +86 (0) 769 89899966 802**F:** +86 (0) 769 89899966 810**E:** china.sales@iac-china.com**Kuwait****T:** +965 2294 2000**E:** kuwait.info@iac-noisecontrol.com**China (SH Office)****T:** +86 (0) 21 68825328**E:** test@iac-china.com**United Arab Emirates****T:** +971 (0) 4451 7877**E:** uae.info@iac-noisecontrol.com**Denmark****T:** +45 36 77 88 00**E:** mail@iac-nordic.dk**Germany****T:** +49 (0) 2163 9991 0**F:** +49 (0) 2163 9991 23**E:** deutschland@iac-gmbh.de**Ireland****T:** +353 1 282 8043**F:** +353 1 282 8427**E:** ireland.info@iac-noisecontrol.com