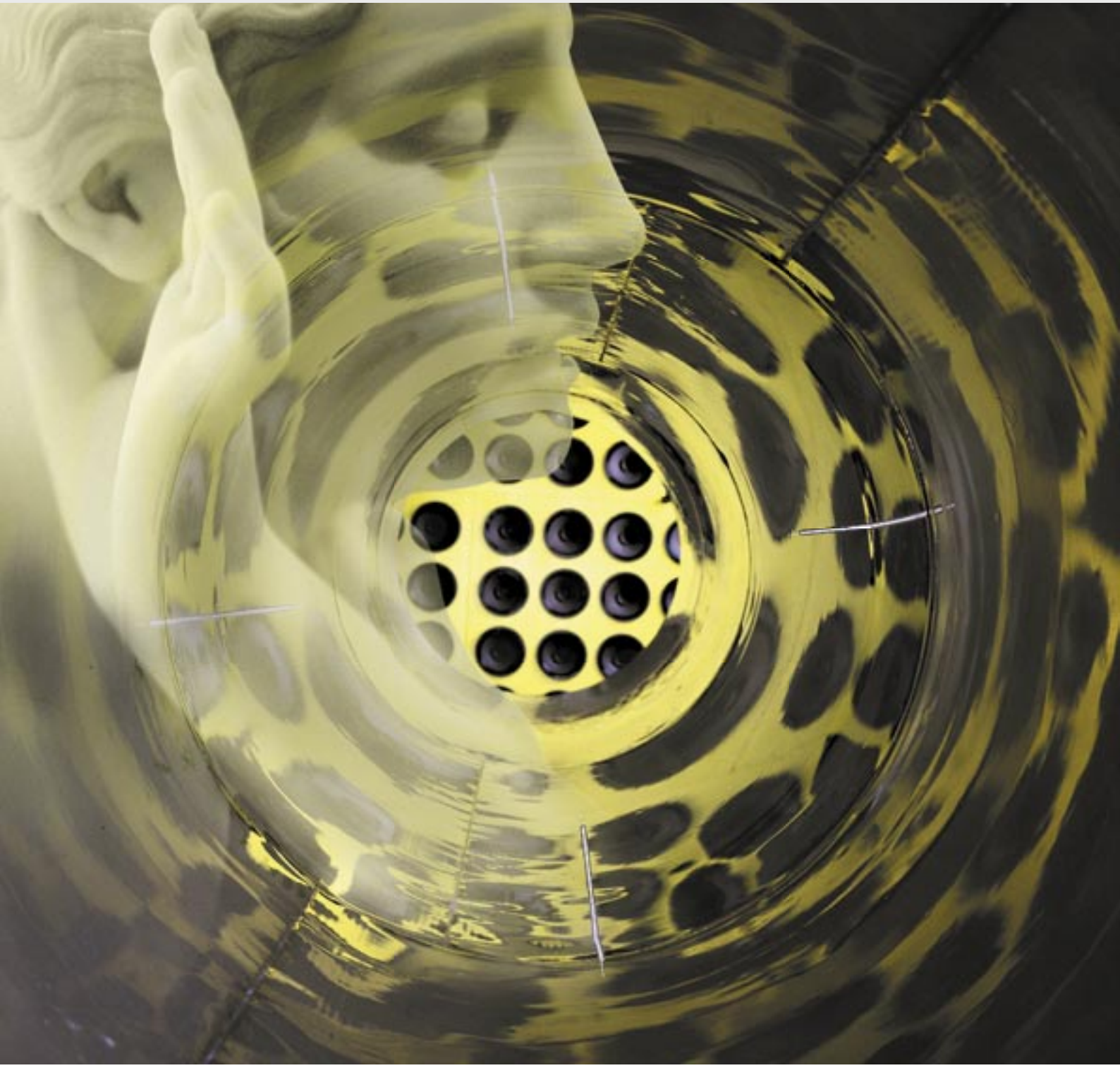


Sound Laboratory

For measuring silencers according to ISO 7235

Lindab®

A highly advanced sound laboratory

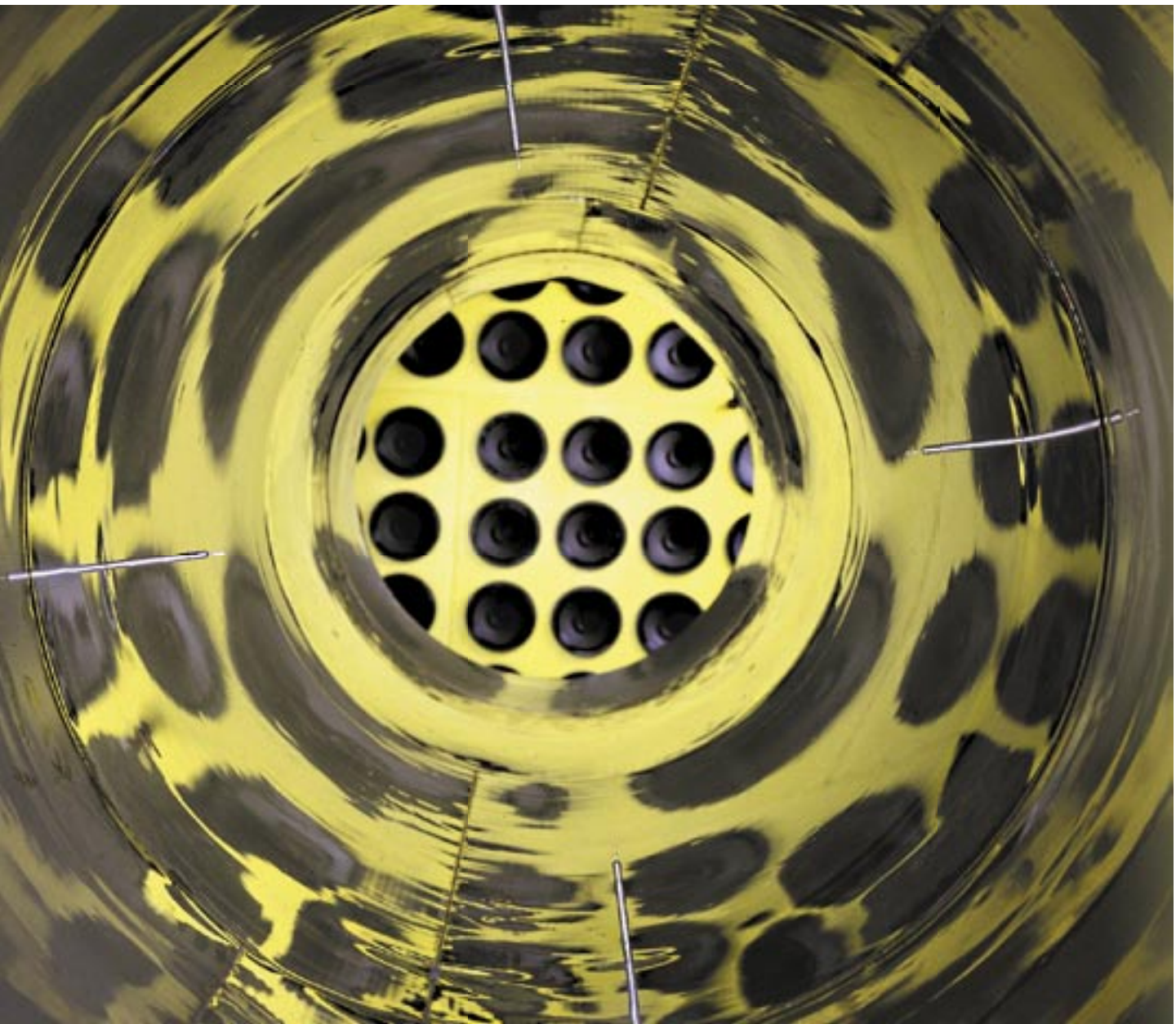
The sound laboratory at Lindab A/S, Comfort in Farum, Denmark can be used to measure insertation loss, flow noise and pressure drop in duct silencers. Testing and further development can be carried out here in identical test conditions. The laboratory can also be used to measure sound data and pressure drop in other ventilation components.

Lindab's sound laboratory was constructed in 1998 in collaboration with Carl Bro Acoustica, and was first used in the spring of 1999. The design phase also involved technical advice provided by Fraunhofer-Institut für Bauphysik in Stuttgart, and the laboratory was constructed in accordance with DS/EN ISO 7235: "Acoustics - Measuring the attenuation capacity of duct silencers - Insertation loss, flow noise and total pressure drop", 1995.

When installing silencers in ventilation systems, there are three specifications which are important when it comes to selecting the right kind of silencer.

- What is the attenuation effect of the silencer in various frequency bands?
- What is the sound power generated by the silencer when air passes through it?
- What is the pressure drop across the silencer?

Lindab's sound laboratory makes it possible to measure the exact values of these specifications.



Testing and documentation at Lindab's sound laboratory ensure correct dimensions and better all-round economy

These days the demands made on reliable documentation for both standard and special components in ventilation systems are increasing all the time.

For instance, information about attenuation values in the frequency band 63 Hz and above is needed, as well as values for the sound power generated and the pressure drop at specific air speeds. All with a view to achieving the correct dimensions and thus ensuring better all-round economy.

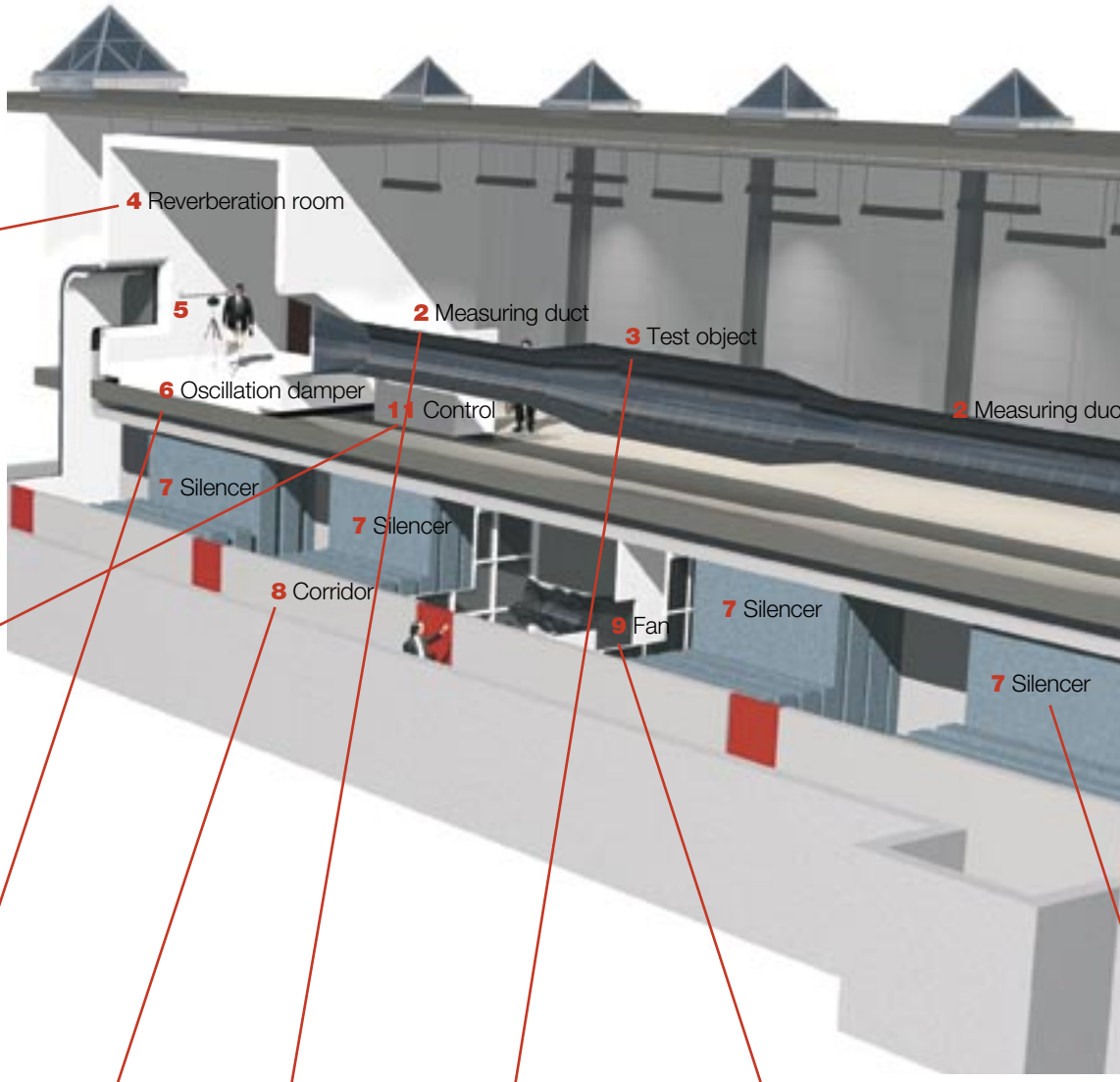
The testing and documentation of ventilation components at Lindab's sound laboratory ensures that these demands can be met.

In the reverberation room (4) the sound pressure is measured using a Brüel & Kjær microphone (5), mounted on a rotating boom. The reverberation room meets the requirements of ISO 3741.

From the control console (11) the entire measuring programme and all functions can be controlled using specially developed software.

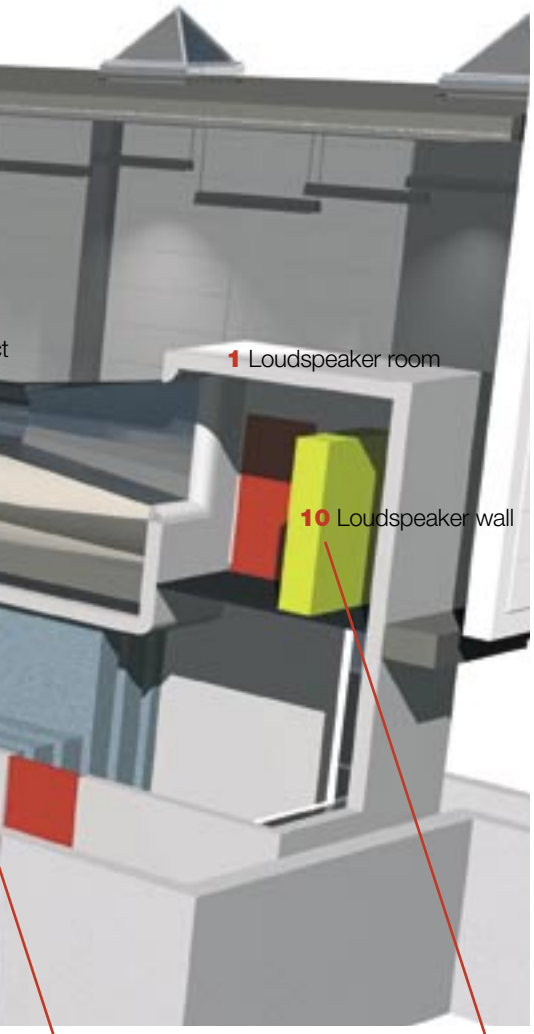
The reverberation room (4), which has a volume of 203 m^3 and a weight of 147 tonnes, is mounted on 32 pneumatic oscillation dampers (6), which prevent the varying structureborne noise in the surroundings from affecting the readings.

Along the 3×3 metre ventilation duct on the lower level there is a corridor providing access to the 4 silencers and the fan.



The loudspeaker room (1) and reverberation room (4) are connected by a 21-metre long measuring duct (2), in which test objects (3) are placed. The dimensions of the measuring duct can be adapted to suit the test objects concerned (both circular and rectangular).

The fan (9) in the middle of the ventilation duct on the lower level has adjustable blades, and the RPM can be adjusted to control the air volume precisely from 0 m^3/h up to 28,000 m^3/h.



The laboratory consists of a closed duct system on two levels. On the top level there is a loudspeaker room (1) and reverberation room (4), connected by a measuring duct (2) in which test objects (3) are placed. The measuring duct connecting the two rooms has a length of 21 metres and a maximum aperture of 1,000×1,000 mm.

In the loudspeaker room there is a loudspeaker wall (10) with 32 loudspeaker units powered by two power amplifiers, each with an output of 400 W. This loudspeaker wall generates wide-spectrum "pink noise" so that the sound pressure in the loudspeaker room is 110 dB(A). This sound pressure moves through the duct in the form of flat sound waves into the reverberation room, where the sound pressure is measured using a Brüel & Kjær microphone on a rotating boom (5).

The reverberation room, which has a volume of 203 m^3 and a weight of 147 tonnes, is mounted on 32 pneumatic oscillation dampers (6) to prevent the varying structure-borne noise in the surroundings from affecting the measurements. The room meets the requirements of the ISO 3741 standard for measuring sound power from 100 Hz to 10,000 Hz. Insertation loss can be measured from 50 Hz.

The loudspeaker room and reverberation room are also connected via a ventilation duct on the lower level. This duct has a cross-section of 3×3 metres, and is mounted on 100 mm Rockwool batts to prevent structure-borne noise from being transferred to the system. There is access to the duct from a parallel corridor (8). The fan (9) in the middle of the ventilation duct is a 20 kW axial fan with adjustable blades. The RPM can be adjusted using a VLT from 0-3,000 RPM. Using a PI regulator the air volume can be controlled precisely from 0 m^3/h to 28,000 m^3/h.

The fan with oscillation dampers is mounted on robust foundations which is isolated from the duct to prevent structure-borne noise in the fan from being transferred to the duct system. There are 2 silencers (7) with a length of 3 and 4 metres respectively mounted on both sides of the fan to eliminate air-borne fan noise. These silencers consist of vertical baffles made of melamine foam plastic with a width of 400 mm. The distance between the baffles is 85 and 200 mm respectively. This difference in length and gap width eliminates fan noise at all frequencies. To ensure an even air speed between the silencers, there are baffle plates on both sides of the fan. The dampers near the fan make it possible to reverse the air direction in the duct system so that the air flow through the test object is the opposite of the sound waves. This may be useful in connection with ventilation components which are used for extraction.

The air speed through the test object is measured using up to 4 thermo-anemometers placed in the test duct before the test object. These thermo-anemometers are calibrated for each test set-up using an accredited measuring cross.

The pressure drop across the test object is measured by mounting an outlet on both sides of the test object, connected to an electronic differential pressure meter.

In the 3×3 metre fan duct on the lower level 2 silencers (7) have been installed on both sides of the fan (9) at a distance of 3 and 4 metres respectively. The special design and position of these silencers eliminates fan noise of all frequencies.

The loudspeaker room (1) contains a loudspeaker wall (10) with 32 loudspeaker units, generating wide-spectrum "pink noise" so that the sound pressure in the loudspeaker room is 110 dB(A).

Technical specifications

Measuring section	Duct length	21 metres
	Aperture width	1,000 mm
	Aperture height	1,000 mm
Test object	Length	300 - 6,000 mm
	Maximum cross-section	1.5 m^2
	Circular silencer	80 - 1,000 mm
	Rectangular silencer	< 1,500 mm height < 1,000 mm wide
Reverbera-tion room	Length	7.2 m
	Width	6.0 m
	Height	4.7 m
	Volume	203 m^3
	Weight	147 tonnes
	Sound power	100 Hz - 10,000 Hz
	Insertation loss	> 50 Hz
Loudspeaker room	Length	3.0 m
	Width	2.5 m
	Height	2.5 m
	Volume	19.0 m^3
Loudspeaker	No. of units	32
	Output	2 × 400 W
	Sound pressure	110 dB(A)
Fan	Type	20 kW Woods axial fan
	RPM	0 - 3,000 RPM
	Air volume	0 - 28,000 m^3/h