



Plant Description CO2 CAPTURE, CONCENTRATION, PURIFICATION & LIQUIFICATION PLANT BOC NORTH TEES HYDROGEN SITE		
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Noise Control Concept

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1 Purpose

This document describes the allowable noise limits according to the available legal regulations and customer individual requirements, the possible noise reduction measures, the methods used for the sound propagation calculation and noise measurements for the control of equipment, plant and environmental noise for the Teesside CO2 project located in United Kingdom.

This concept doesn't include infrastructural noise reduction measures, e.g. traffic regulations in plants etc. The implementation of those requirements is typically in the responsibility of plant operators.

2 Scope

This concept shall be used as reference and guideline for the acoustic design of the plant, where noise reducing equipment is needed. It specifies:

- In-plant noise limits
- Design criteria for noise control treatment

The acoustic design of the plant applies to normal operation including start-up and shutdown at design conditions. Other operating conditions such as emergency cases and abnormal operation are exempt from the given noise limitations.

3 Definitions

Abbreviations:

ANSI	American National Standard Institute
DIN	Deutsches Institut für Normung (German Institute for Standardization)
EEMUA	Engineering Equipment and Material Users Association
EN	Europäische Norm (European Norm)
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
LS	Linde Standard

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Definitions:

Contractor	Contractor performing engineering, procurement and construction services for Company directly contracted by customer.
Vendor	Means any and all persons, firms, partnerships, companies, entities or a combination thereof including sub-vendors and suppliers, who are providing goods, and the successors and assigns of such persons, firms, partnerships, companies, entities or a combination thereof.
Noise Level	May refer to either a sound pressure level (L_p) with reference to 20 μ Pa, or a sound power level (L_w) with reference to 1 pW.

$$L_p = 10 \cdot \lg\left(\frac{P}{P_0}\right)^2, \text{ here } P_0 = 2 \cdot 10^{-5} \text{ Pa}$$

$$L_w = 10 \cdot \lg\left(\frac{W}{W_0}\right), \text{ here } W_0 = 10^{-12} \text{ W}$$

Note: All logarithms in this specification are to the base 10.

Noise Limit	Specification of a maximum allowable noise level.
Noise with tonal components	Describes a noise with one or more significant tonal components.
Impulsive Noise	Describes a noise source containing significant irregularities, such as bangs, clanks, or thumps, or if the noise is only existent momentarily and is of a character to attract attention. Under these conditions, the noise shall be considered as impulsive for the purpose of this specification.
Narrow-band Noise	Describes a noise source containing a pure tone or a narrow-band component which is noticeable to the ear as a noise of distinguishable pitch, and which represents a dominant feature of the total source noise. Under these conditions, the noise source shall be regarded as containing narrow-band noise for the purpose of this specification. Note: Where there is doubt about the subjective assessment of narrow-band noise, a narrow-band analysis using an instrument with a bandwidth not more than 10 Hz or 1%, whichever is the less, shall give clarity.
Work Area	Any position not less than 1 meter from equipment surfaces accessible for personnel or any position where a worker's ear may be exposed to noise in the normal course of his duty is defined as work area. It includes any platform, walkway, or ladder.
High Noise Area	Any position not less than 1 meter from equipment surfaces accessible for personnel, where the work area noise limit is exceeded for different reasons (e.g. no noise protection equipment installed, for example noise enclosures, for the advantage of better maintenance of the equipment) can be defined as high noise area.

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4 References and Regulations

The following chapters include the essential international and local references and regulations, which are frequently used within the noise control conception.

4.1 International References and Regulations

ISO 266	Acoustics – Preferred frequencies
ISO 1996-1	Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic Quantities and assessment procedures
ISO 1996-2	Acoustics – Description, measurement and assessment of environmental noise – Part 2: Determination of environmental noise levels
ISO 1999	Acoustics – Determination of occupational noise exposure and estimation of noise-induced hearing impairment
ISO 3744	Acoustics – Determination of sound power levels of noise sources using sound pressure – Engineering method in an essential free field over a reflecting plane
ISO 3746	Acoustics – Determination of sound power levels of noise sources – Survey method using an enveloping measurement surface over a reflecting plane
ISO 3864-1	Graphical symbols – Safety colours and safety signs – Part 1 Design principles for safety signs in workplaces and public areas
ISO 4871	Acoustics – Declaration and verification of noise emission values of machinery and equipment
ISO 8297	Acoustics – Determination of sound power levels of multi-source industrial plants for the evaluation of the sound pressure levels in the environment – Engineering method
ISO 9613-2	Acoustics – Attenuation of sound during propagation outdoors – Part 2: A general method of calculation
ISO 9614-1	Acoustics -- Determination of sound power levels of noise sources using sound intensity (Measurement at discrete points)
ISO 9614-2	Acoustics -- Determination of sound power levels of noise sources using sound intensity (Measurement by scanning)
ISO 11201	Acoustics – Noise emitted by machinery and equipment – Measurement of emission sound pressure levels at work stations and other specified positions, Engineering method in an essentially free field over an reflecting plane
IEC 61260	Electroacoustics - Octave-band and fractional-octave band filters
IEC 61672-1	Electroacoustics – sound level meters – Part1: Specifications
IEC 61672-1	Electroacoustics - sound level meters - Part2: Pattern evaluation tests
IEC 60942	Electroacoustics - Sound calibrators
IEC 61252	Electroacoustics - Specifications for personal sound exposure meters
EEMUA 140	Noise procedure specification
EEMUA 141	Guide to the use of noise procedure specification
EEMUA 161	Guide to the selection and assessment of silencers and acoustic enclosures
ANSI S1.1	Acoustical terminology
ANSI S1.11	Specification for octave-band and fractional octave-band analogue and digital filters
ANSI S1.25	Specifications for personal noise dosimeters

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4.2 European, German and Local References and Regulations

Directive 2003/10/EC	Directive of the European parliament and of the council on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise)
2005 No.1643	Health and Safety – The Control of Noise at Work Regulations 2005
DIN 45641	Acoustics – Averaging of sound levels.
DIN 45681	Acoustics – Determination of tonal components of noise and determination of a tone adjustment for the assessment of noise immissions.
DIN EN 60651	Acoustics – Sound level meters.
DIN EN 60804	Acoustics – Integrating-averaging sound level meters.

4.3 Linde References

LS 910	Linde Standard – General Noise Specification.
&AZ-S-PE 2070.450.010 (EN)	Work Instruction – Noise Protection.

5 Basic of Acoustic Design

The acoustic design of the plant applies to normal operation. Other operating conditions such as start-up, shut-down, other abnormal or transient operation conditions and emergency cases are not considered.

5.1 In-Plant Noise Limits

5.1.1 Equipment Noise Limit

The maximum allowable sound pressure level in 1m distance from any equipment outside buildings, machine house or noise hoods shall not exceed 85 dB(A) (according to Basis of Design, chapter 8.5 "Noise Emission").

When equipment is supplied with gear unit and/or driver, the equipment noise level limits shall be applied to the combined noise level for the equipment, gear unit and/or driver.

5.1.2 High Noise Area Noise Limit

The noise level for high noise areas is between 85 dB(A) and 95 dB(A).

There are a few areas where the combined sound pressure level inside the plant will be higher than 85 dB(A) at 1m distance. These areas will be signposted as "high noise area". Noise protection equipment which would be necessary to reduce the noise level of this equipment will hinder access for maintenance of the equipment (e.g. enclosures) and therefore will not be foreseen. Furthermore, the daily exposure time of personnel in the high noise area is normally short. At these areas the use of personnel ear protection for short times is required for the advantages of easier access and better maintenance to the equipment.

5.1.3 Absolute Noise Limit

The maximum allowable sound pressure level at 1 m distance at any points from any equipment surfaces, accessible to personnel is 135 dB(C) inside work areas irrespective the duration of the exposure or the use of hearing protection

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5.2 Employee Noise Exposure Limit

Following personnel noise exposure limit based on “The Control of Noise at Work Regulations 2005” for UK shall be considered.

5.2.1 Lower exposure limit

Daily or weekly 80 dB(A)

Peak sound pressure 135 dB(C)

5.2.2 Upper exposure limit

Daily or weekly 85 dB(A)

Peak sound pressure 137 dB(C)

Where the exposure of an employee to noise varies markedly from day to day, an employer may use weekly personal noise exposure in place of daily personal noise exposure for the purpose of compliance with the regulation.

5.3 Environmental Noise Limit

There are currently no requirements according maximum allowable sound pressure level at the plant boundary.

5.4 Consideration of Narrow-Band / Impulsive Noise

Any narrow-band or impulsive components will be reduced sufficiently below the broadband noise from equipment so that it is no longer audible (see Appendix E of EEMUA 140). If this is not possible, the equipment noise limit will be reduced by 5 dB for such equipment.

6 Equipment Noise Data

The vendor shall be responsible for the following:

6.1 Noise Data Basis

The Vendor shall obtain all necessary information relating to the noise levels generated by equipment. This information shall be based on one or more of the following points. The different methods are listed according to their priority, starting with the most preferred one.

- Actual measurements in suppliers shop in accordance with applicable standards.
- Noise test data obtained on a duplicate unit running under similar conditions in an existing plant.
- Noise test data obtained on a duplicate unit in accordance with referenced standards.
- Calculations based on empirical methods. In this case the expected deviation must be given.

6.2 Responsibility

The accuracy of all data and calculations must be based on the methods described in the section above. All data shall be certified by persons knowledgeable and experienced in acoustics, otherwise data has to be approved by an authorized expert.

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6.3 Selection of Measures

Determination of all areas where the relevant noise limits would be exceeded if standard equipment was used. Selection of methods or measures to meet the limitations in these areas. Corrective action may take one or more of the following forms which are listed below according to their priority, starting with the most preferred one.

- Selection of alternative equipment capable of meeting this specification.
- Modification of design to reduce the radiation at source.
- Insulation of equipment and connecting pipes.
- Enclosure of equipment or working areas.

6.4 Individual Noise Limits

The determination of suitable noise limits for individual items of equipment in order to achieve the plant noise limits. The allowable noise levels of individual items are to be specified in noise data sheets.

7 Noise Reduction Measures

The noise reduction measures in this document are related to the secondary noise reduction measures, which include the following two aspects,

- equipment noise and
- personal noise reduction measures.

The primary and secondary organizational noise reduction measures are not handled here.

The specification of noise abatement appropriate for the individual noise sources is the result of a so called "Acoustic Planning" which ensures that the noise requirements are met in an effective, economic and safe manner. Special care is to be taken on allocation of allowable sound radiation (e.g. Sound Power Levels) of the main noise sources. This task consists of an optimization procedure, in which the following criteria are considered:

- Required noise reduction to fulfil the requirements
- State of acoustics technology and realization of measures
- Purchase costs of equipment including noise reduction measures
- Planning and erection costs
- Process, safety and operational requirements
- Operating costs
- Accessibility for maintenance
- Experience from comparable plants

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7.1 Equipment Noise Reduction Measures

For achieving the necessary noise limits, part of the equipment has to be provided with noise reduction devices, mainly furnished by the equipment supplier.

As far as it is necessary for the satisfaction of the aforementioned requirements, the following noise reduction measures will be provided:

(Considerations for acoustic modelling and specified limits and resulting treatment will incorporate complete package equipment including motor and motor driven equipment.)

7.1.1 Turbo Machinery, Compressors

Compressors shall be installed with noise enclosure around screw compressor casing, if required.

The noise of compressors is mainly radiated from the connected piping. Therefore, effective noise reduction is achieved by acoustic lagging on suction and discharge lines or inline silencers.

If necessary, low-noise design for gearboxes (e.g. spiral toothed gear wheels) and insulation shall be provided.

7.1.2 Pumps and Drivers

Normally, the sound emission of the motors exceeds the radiation of the pumps. Therefore, large motors are to be fitted with low-noise cooling fans or noise hoods.

Additionally sound insulation shall be foreseen for part of the connected piping.

7.1.3 Control Valves, Piping

The noise radiation of control valves depends on the flow rate, expansion ratio, temperature and medium. The main part of the sound is generated in the valve and will be radiated by the pipes.

To reduce the noise different types of low noise valves and grill plates will be foreseen. For gas and steam service, special-design low-noise valves (preferred) or in-line silencer may be used. For liquid flows, select valves that will prevent cavitation, erosion, and vibration. If these measures are insufficient or not practical; additional acoustic insulation will be provided until the required limit is met.

For economic reasons variations of the sequence are possible.

Sound insulation and consideration of thermal insulation for noise abatement is in the responsibility of LINDE and shall not be taken into consideration by the vendor. LINDE may order valves at higher sound pressure levels, if pipes are insulated for process reasons.

The noise radiation of the pipes by flow excitation is negligible since the velocities of the media are low for economic reasons and, therefore, not critical for noise. In addition, most piping is equipped with thermal insulation which will further reduce noise. Special lagging will be furnished where piping emits sound generated by connected turbo machinery or control valves.

7.1.4 Vents

All Vents incorporated in the design to meet operational requirements shall be subjected to the same restrictions as equipment (excepting vents for emergency use)

Blow-off silencers at vents shall be foreseen where noise level above 85 dB(A) can be expected.


7.2 Personal Noise Reduction Measures

Areas, where the sound pressure level inside the plant exceeds the defined noise limits shall be signposted as "high noise area". In these areas it is not reasonably practicable to reduce the noise level at or below the work area limit and the use of personnel ear protection is required. Efforts shall be made to reduce the noise level as low as reasonably practicable.

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8 Appendix

8.1 Vendor Noise Data Sheet (Example)

 <p><small>THE LINDE GROUP</small></p> <p>Linde</p>	<p>Vendor Noise Data Sheet</p>	<p>Item No Proj No Code Doc No</p>						
Page 1 of 3								
<h1 style="margin: 0;">Vendor Noise Data Sheet</h1> <h2 style="margin: 0;">Pump</h2> <p style="font-size: 2em; color: magenta; opacity: 0.5; margin: 20px 0;">Typical only</p> <p style="text-align: center; font-weight: bold; margin: 20px 0;">THIS DATA SHEET IS TO BE FILLED IN COMPLETELY BY THE VENDOR ! It is only valid in connection with "General Noise Specification" LS 910-01.</p> <p>Attachments:</p> <p style="margin-left: 40px;">LS 910-01</p>								
Status	Issue	Date	Description	Pages	Prepared	Checked	Approved	Authorized

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SOUND SOURCE - APPLICATION

Item	Equipment Type	Manufacturer	Power kW	Size			Notes
				Length	Breadth	Height	
I							
II							
III							
IV							

INSTRUCTIONS TO SUPPLIERS

Acoustical definitions, methods, and procedures shall be in accordance with **DIN EN ISO 3740** and **LS 910-01**

<p>All noise levels, Lp or Lw, shall be guaranteed with an upper tolerance of +0 dB; octave band levels are in un-weighted decibels. Lp is Sound Pressure Level in decibels re 20 μPa at 1 meter from the source and Lw is Sound Power Level in decibels re 10E-12 Watts. The noise guaranteed by the equipment and/or components shall not exceed the more stringent of the noise limits given in the table below, for any of the conditions of operations for which the equipment may normally be expected to be used.</p> <p>If the equipment generates noise with tonal or impulsive components, the limits shall be taken to be 5 dB more stringent (for the overall, A-wtd level). If the measured Lp levels surrounding the equipment differ by 6 dB or more in any octave band, the Supplier shall complete Sheet 2. If the equipment noise levels exceed the overall limit(s), OR if the equipment noise levels exceed the octave band limits (in any band) by more than 5 dB, the Supplier shall provide data for acoustically-treated equipment and shall include details and costs of the treatment.</p>		
I: Configuration Codes	II: Data Source Codes	
(Completed by Purchaser) 0	Required noise levels in Lp or Lw or both	A Noise Test, equipment loaded
(Completed by Supplier) 1	Guaranteed noise levels without acoustical provisions	B Noise Test, equipment unloaded
(Completed by Supplier) 2	Guaranteed noise levels with acoustical provisions	C Noise Test, identical equipment
(Completed by Supplier) 3		D Noise Test, similar equipment
(Completed by Supplier) 4		E Noise Test, outdoor (free-field)
(Completed by Supplier) 5		F Noise Test, other – attach explanation
		G Calculation/estimation – attach details, calculations, and explanations
		H Other – attach explanation

ACOUSTICAL PERFORMANCE

Noise measurements and calculations shall be carried out in accordance with **DIN EN ISO 3744**

To be completed by: <input type="radio"/> Purchaser <input checked="" type="radio"/> Seller, if not specified by purchaser <input type="checkbox"/> Seller (also indicate, if data is measured or estimated)																
EQUIPMENT TRAIN AND COMPONENTS	I) Config'n Code	Level Type	OCTAVE BAND CENTER FREQUENCY (HERTZ)								OVERALL		II) Data Source	ACOUSTICAL TREATMENT, REMARKS, AND NOTES		
			63	125	250	500	1k	2k	4k	8k	LIN.	A-WTD				
I	<input type="radio"/> 0	Lp*													Req'd	
	<input type="radio"/> 0	Lw													Req'd	
II		Lp*														
		Lw														
III		Lp*														
		Lw														
IV		Lp*														
		Lw														
"Sum"		Lp*														
		Lw														

*Measured at 1 meter from any equipment surface or enclosure face (measuring position details are to be included with data submittal).

INFORMATION TO BE SUBMITTED WITH THE TENDER – Include all necessary drawings and engineering notes

- Guaranteed acoustical performance information as indicated above
- Description of measurement details as indicated above (attach additional pages as needed)
- Explanations, details, and/or calculations as prescribed above (attach additional pages, as needed)
- Description of special designs/acoustical treatments used to meet requirements (attach additional pages, as needed)
- Details of added costs for special designs/acoustical treatments (attach additional pages, as needed)
- Completed silencer and/or enclosure data sheet, as applicable
- Other:

REMARKS

With the declaration of the sound pressure level it shall be assumed that the connected piping is insulated by acoustic lagging.
With the declaration of the sound power levels it shall be assumed that the connected piping is insulated by acoustic lagging.
The max. permissible sound pressure level for the scope of supply at 1 m distance is _____ dBA per unit. Plus tolerances are not conceded.
The max. permissible sound power level for the scope of supply is _____ dBA per unit. Plus tolerances are not conceded
We _____ (Company), guarantee to meet the equipment sound level limits as specified above.
Signature / Date: _____

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ALL DATA AND INFORMATION BELOW IS TO BE PROVIDED BY THE SUPPLIER PER PROJECT REQUIREMENTS

LAYOUT DIAGRAMM OF EQUIPMENT AND NOISE MEASUREMENTS POINTS

DETAILED SOUND PRESSURE LEVEL MEASUREMENT DATA

Noise measurements and calculations shall be carried out in accordance with **DIN EN ISO 3744**

Sound Pressure Level in decibels re 20 μ Pa at indicated distance from the source; octave band levels are in un-weighted decibels

MEASUREMENT LOCATION	DIST. (m)	OCTAVE BAND CENTER FREQUENCY (HERTZ)								OVERALL		REMARKS AND NOTES
		63	125	250	500	1k	2k	4k	8k	LIN.	A-WTD	

*Measured at 1 meter from any equipment surface of enclosure face (measuring position details are to be included with data submittal).

Comments: