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PROPOSED ISOs ON NOISE CONTROL PROCEDURES IN OPEN PLANT, AND ACOUSTIC INSULATION FOR PIPES

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1. INTRODUCTION

ISO/TC 43/SC1/WG48 is engaged in preparing Committee Drafts of two new ISO Standards. These are described below.
This paper describes the current aims of the working group in the preparation of committee drafts of these ISOs and describe their current status.

ISO 15664 " Recommended Practice for Noise Control Procedures in Open Plant during Project Execution" covers the acoustic design procedure for open plant such as refineries, chemical works etc.

Noise problems with open plant are most effectively dealt with during the design phase, rather than after start up. This paper will outline the approach taken by the working group in making the ISO flexible enough to have a world-wide use among a range of client, contractor and consultant organisations having a varied range of technical abilities. The design activities to be carried out have to be selected and agreed between client and contractor or consultant. This process of discussion and agreement is intended to bring out into the open noise issues that may be overlooked in initial project planning.

ISO 15665 "Acoustic Insulation for pipes valves and flanges" sets out to specify three levels of insulation performance for acoustic insulation on piping. Construction methods using common materials that will provide the three levels of insertion loss are described. Thus insulation constructions using the materials and installed as specified are "deemed" to have the required acoustic performance. The intention is not to exclude other types of pipe insulation, existing or future. However, these other insulation constructions will have to be tested before they can claim that they have a performance comparable with one of the three classes.

A testing method for the insertion loss of piping insulation is included.

2. BACKGROUND

Many major oil, chemical and utility companies have their noise design procedures that they want to be used during the design of their plants. As part of those procedures they may also have their own specifications for acoustic insulation for pipe work and valves. These company procedures were often first written in the 1960's and 1970's when the issue of noise in plant and outside plants grew in importance. When these company

procedures were written there was no recognised document in place covering this aspect, so these operating companies had to write their own.

All company procedures need to be maintained and updated. This costs time and money. The downsizing of head office technical staff in the major oil companies has reduced the time and expertise available to control the noise aspects of their projects and to update their procedures. Some of these companies are now questioning if they need to have their own specifications which will need updating. They would prefer to use an ISO or other standard if it was available and applicable.

Nederlands Normalisatie-Instituut (NNI) then proposed a new work item to produce these two ISOs. This was accepted by ISO. TC43/ SC 1 formed WG48 with Erik Tromp of Shell as convenor. This Working Group has now produced Draft 03 of these documents.

3. A. WD15664.03 ACOUSTICS - RECOMMENDED PRACTICE FOR NOISE CONTROL PROCEDURES IN OPEN PLANT DURING PROJECT EXECUTION

3.1. Aim of the ISO

Most engineers or consultants in the field have been asked to solve noise problems that should have been eliminated in the design phase. After start up, it is often difficult and expensive to rectify noise problems in a complex plant.

The intention of the standard is that the recommended practice should guide the end user and contractor to a good noise design that suits the plant being built or modified. The recommended practice sets out a process for ensuring that the noise design is carried out to a reasonable standard and that there is follow through with equipment specifications. This should minimise unpleasant surprises after start-up. The steps outlined in the recommended practice should cause the aspect of noise control design to be discussed early during negotiations between client and contractor, or between client and consultant.

The recommended practice is not a design handbook on how to design quiet plant. It is a procedure to achieve a successful outcome in the design of noise aspects of the plant, and is intended to be flexible to suit projects large and small. The highlights of the ISOs are described below, based on the headings in the document.

3.2. Scope

The recommended practice addresses the technical and possibly contractual procedures that need to be addressed in the course of designing the noise aspects of an open plant.

The ISO is applicable to large and small projects and to new projects and modifications to existing plants. Plant that is totally enclosed in a building is excluded, although it is considered applicable to a plant that is basically open but may have some components that are in buildings.

This is a procedural specification. Specific noise problems are not identified or solutions offered. However the procedural steps to a good noise design are identified. The recommended practice is not intended to be used in the purchase of individual equipment items. It raises "global" issues in plant design that an individual equipment vendor is not able to address. This generally leads to confusion.

A useful part of the recommended practice concerns the identification of noise control design activities which are shown in WD15664.03 Appendix G. It forces the possible noise issues into the open where they may otherwise have been hidden.
Both parties can agree which design activities need to be carried out and who should do them. This can be arrived at based on the technical capabilities and contractual position of the parties. If neither party understands acoustics and noise control, then this process will not work. One or both sides should hire a competent consultant or other party to advise them.

Consequently, the caveat is applied that *"The users of this document should be familiar with the type of plant involved and have sufficient technical expertise and experience in industrial plant noise control design."* There is no attempt to formalise or quantify this level of competence. There is provision for the addition of specific requirements to suit a particular plant or an end user's needs in WD15664.03 Annex H. This recommended practice is not intended specifically to be a contract document, but it is recognised that Annex G and Annex H may form part of a contract between the end user and the contractor. Annex G can be signed to form part of a contract.

3.3. Definitions

Most of the definitions will be familiar, but both this ISO and WD15665.03 Acoustics - Acoustic Insulation for Pipes Valves and Flanges use the term "End-user (or owner or operator)" is used. This is defined as: "The party which initiates the project and ultimately owns or operates the project, or pays for its design and construction. The end-user will generally specify the technical objectives and/or requirements. The end-user may also be an agent or consultant, authorised to act for the end-user."

3.4. General

The procedure recognises that the need for noise control in a plant is required for the following reasons:

- to conserve the hearing of personnel;
- to reduce work, speech and concentration interference;
- to provide quiet accommodation for personnel;
- to prevent annoyance to the neighbouring community.

3.5. General Noise Limits

The procedure requires the investigation of the local regulations on hearing conservation and environmental noise limits. An absolute noise limit for emergency situations is also addressed.

3.6. Equipment Noise Limits

The procedure addresses the setting of equipment noise limits for a variety of equipment types and also for piping and vents. It also addresses the issue of setting individual equipment item noise limits below the required work area noise limit if the work area noise limit is to be achieved.

The setting of sound power limits for equipment is addressed. The issue of iterating a whole plant sound power level design to arrive at acceptable sound power limits for equipment is also addressed. A sample equipment noise data sheet to be used in an equipment purchase order is attached to the standard.

3.7. Silencing Equipment

The purchase of silencers and enclosures is discussed. The recommended practice does not advocate that a decision on the use of silencers and enclosures be left till after plant start-up However, the procedure does recommend the practice of engineering services to and from equipment such that silencers or enclosures can be fitted later with minimum inconvenience.

3.8. Project Control

This is an area where the recommended practice can be useful.
The requirement to prepare a noise control engineering report can show where problems exist before it is too late for rectification without additional cost. The need for noise testing before delivery is also an issue which is overlooked. A model format is attached in WD15664.03 Annex B which will assist in minimising the possibility of overlooking a noise issue. Project control is assisted by the used of the flow chart in Annex C which indicates the data and decision flow required for the noise control design.

3.9. Annex A

Annex A lists the data that the noise engineer will need in order to be able to carry out a noise control design. The information listed is:

Plot plan
Basis of plant design
Equipment summary, project specification
Equipment data requisitions for:
Heat exchangers (air coolers only)
Furnaces, burners
Mechanical handling equipment
Extruders, ejectors.
Pumps, compressors, incl. drives
Valves
Flare and vent stacks
External insulation, sound proofing only
Transformers, generators
Electric motors
Cooling towers

Fired steam generators
Silencing equipment (silencers, enclosures, screens)

3.10. Annex E

While this is not a design handbook , engineers are directed towards other data sources for help with their noise design.

[1]	API RP 521	Guide for Pressure Relief and Depressuring Systems
[2]	VDI 3733	Noise at pipes
[3]	Bies & Hansen	Engineering Noise Control

Issues for ISO 15664 " Recommended Practice for Noise Control Procedures in Open Plant during Project Execution

The procedure started off based on an oil company document. Is the draft broad enough to be used in a wide range of industries where the plant is in the open ???

4. B. WD15665.03 ACOUSTICS - ACOUSTIC INSULATION FOR PIPES, VALVES AND FLANGES

4.1. Introduction

The second draft ISO, **"Acoustic insulation for pipes, valves and flanges"**, addresses the specification of acoustic insulation for piping. The specification sets three levels of acoustic performance so that the type of performance can be specified by a purchaser. Insulation constructions that meet that the three levels are specified. The prescribed methods use simple, commonly available materials.

It is recognised that many other types of acoustic insulation construction can achieve the same performance, and these are not excluded. In order to classify these types of insulation, a test method is proposed. This will allow the insulation system to be rated as complying with Class A, B or C insulation, or the performance can be stated as "tested to ISO15665".

4.2. Scope

This recommended practice addresses the insulation of circular section piping and piping components conveying fluids to reduce the noise emitted by these components. Piping or ducting which is not of circular section is excluded.
The standard does not specify construction aspects which are in common with thermal insulation such as: the compatibility with the environment of materials for porous layer and cladding, fastening, sealing, surface protection and safety regulations.

4.3. Classes of acoustic insulation

This recommended practice sets out three classes of acoustic insulation based on increasing acoustic insertion loss. These classes are shown in Table 1.

	Octave band C. F. (Hz)	63	125	250	500	1K	2K	4K	8K
Class	Nom. Diam. range (DN)	Minimum insertion loss (dB)							
A			-10	-10	1	9	20	30	35
B			-8	-3	9	21	30	35	40
C1	diam < 300		-5	-1	12	26	45	45	45
C2	300 <= diam < 650		-3	4	15	25	35	40	40
C3	diam ≥ 650		3	9	18	25	33	40	40

Table 1. Required insertion loss for Insulation Classes

4.4. Guide to the reduction of noise from pipes

This section provides calculation methods to determine the type and extent of the acoustic insulation that may be required. The performance of acoustic insulation is frequency dependant, and the recommended practice provides typical spectrum shapes for some noise sources to allow the acoustic insulation performance to be estimated. These sources are for control valves, centrifugal compressors and pumps. All are common piping noise sources. Calculation methods are also shown.

4.5. Construction of typical insulation systems

The general construction of piping insulation systems is described in some detail in this section. The cladding, porous layer, damping materials acoustic seals and cladding support systems are addressed.

4.6. Acoustic Insulation construction to meet the insulation class requirements.

The recommended practice proposes three standard construction methods of acoustic insulation that will provide the acoustic insertion loss of the three insulation classes.
A range of suitable materials for the cladding and porous layers are described in Table 2.

Class A	min. thickness of porous layer	[mm]	:50	
	+min. mass per unit area of cladding	[kg/m^2]	:4,5	(e.g. 0,6 mm steel plate)
Class B	min. thickness of porous layer	[mm]	:100	
	+min. mass per unit area of cladding	[kg/m^2]	:6,0	(e.g. 0,8 mm steel plate)
Class C	min. thickness of porous layer	[mm]	:100	
	+min. mass per unit area of cladding	[kg/m^2]		
	for nominal pipe diameters < 300 mm		:7,8	(e.g. 1,0 mm steel plate)
	for nominal pipe diameters >= 300 mm		:10,0	(e.g. 1,3 mm steel plate)

Table 2 Construction of Standard Classes of Acoustic Insulation

4.7. Installation

The recommended practice states that an essential feature of acoustic insulation is that the cladding shall not be in direct contact with the pipe. WD15665.03 Annexes A to J describe in detail the application of acoustic insulation in a variety of situations to achieve the maximum acoustic performance from the materials.

4.8. Combined Thermal and Acoustic Insulation

The application of acoustic and thermal insulation for hot and cold piping services is described.

For hot service, the materials used for both are similar so the requirements of hot insulation and acoustic insulation can be combined. For cold services. the cold thermal insulation is often a hard material with little acoustic performance other than to increase the radiating area of the pipe. Acoustic insulation is more usually applied after the cold insulation is completed.

4.9. Testing of Acoustic Insulation systems

Other constructions of acoustic insulation can be rated as complying with one of the three classes based the acoustic insertion loss of the insulation. A standardised test method for acoustic insertion loss is specified. Existing and new acoustic insulation construction can then be performance rated against the WD15665.03 standard test method.

4.10. Certification of Acoustic Insulation systems

This recommended practice does not intend to limit the use of acoustic insulation constructions to those that comply with the three performance classes. Insulation types that fall below class A in terms of acoustic performance cannot claim to have class A performance. However their claimed performance can be stated "as measured to ISO 15665". Similarly acoustic insulation constructions that exceed class C performance can claim their acoustic performances "as measured to ISO 15665".

Accredited laboratories that have tested an acoustic insulation system to the methods described in clause 10 of the standard may issue a certificate indicating the acoustic performance of the system. This certificate shall show:

The name and location of the laboratory.	The date of the test.
The NAMAS accreditation number.	The name of the tester.
The name of the insulation system supplier	The trade names of any materials used.
The weights and thickness and material form (sheet, roll, pre-formed section) of any materials used.	Full details of the isolation system between the pipe and the outer cladding.
The flow resistivity of all permeable materials used.	The numeric results required for the classes.
The pipe diameter(s) used.	The numeric test results.

4.11. Issues for WD15665.03 Acoustics - Acoustic Insulation for Pipes Valves and Flanges

An issue not addressed yet is the tolerances to be applied to the results, and whether a Rw type rating, possibly centred around the 500Hz octave band, should be considered.

5.0. WD15664 Annex G Summary of action items and allocation of responsibility
The action items defined in this standard are summarised below, the allocation of the responsible party shall be agreed before the start of a project:
NOTES: (1) The action items below are not in the chronological order in which they may occur in a project. (2) Ticked responsibilities are given as an example, they may deviate from project to project.

action item No.	Task description	ref. clause	Action required/Responsible party (2)	
			end-user	contractor
A1	Investigate local regulations for in-plant noise	5.1.1	x	
A2	State in-plant noise limits in project specification	5.1.1	x	
A3	Investigate local regulations on environmental noise and discuss with authorities	5.1.2	x	
A4	Consider environmental noise (where no reg's exist)	5.1.2	x	
A5	Incorporate sound power level in project spec.	5.1.2	x	
A6	Set noise limits for occasional operating conditions, viz. start-up, shut-down, maintenance and emergencies	5.1.3	x	
A7	Set special noise limits during plant construction	5.1.3	x	
A8	Obtain end-user's permission for restricted areas, *set new limits for those areas*	5.2.3		x
A9	Prepare for erection of earmuff signs during construction	5.2.3		x
A10	Specify equipment noise limits, including. addional restrictions.	6.2.1 6.6		x x
A11	Determine pipe noise, assess insulation and silencer requirements	6.3.3		x
A12	Determine the need for vent silencers	6.3.4		x
A13	Evaluate the need for special requirements for flare	6.3.5		x
A14	Obtain noise limitation sheet with guaranteed Lp/ Lw from supplier, incl. silencers / enclosures	6.7		x
A15	Select least noisy equipment	6.7	(x)	x
A16	Agree on details of silencers/enclosures	7	(x)	x
A17	Agree on postponing the decision to apply noise control measures until after start-up	7	(x)	x
A18	Prepare noise control (background) information	8.1	(x)	x
A19	Submit noise allocation report	8.2		x
A20	Submit noise control report	8.2		x
A21	Decide which equipment shall have a 'noise' test.	8.3		x
A22	Agree on acceptance test procedure	8.4	(x)	x
A23	Perform final plant acceptance test	8.4		x
A24	Prepare in-plant noise contour maps	8.4		x
A25	Take corrective action where required	8.5		x

Action items and allocation of responsibilities agreed:

Signed: For End-user .....of.....Date.....
For Contractor .....of.....Date.....