MANUAL

NOISE CONTROL

DEP 31.10.00.31-Gen.

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DESIGN AND ENGINEERING PRACTICE

PREFACE

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Shell International Oil Products B.V. (SIOP)
and
Shell International Exploration and Production B.V. (SIEP)
and
Shell International Chemicals B.V. (SIC)

The Hague, The Netherlands,

and other Service Companies.

They are based on the experience acquired during their involvement with the design, construction, operation and maintenance of processing units and facilities, and they are supplemented with the experience of Group Operating companies. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

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All administrative queries should be directed to the DEP Administrator in SIOP.

NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

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1. INTRODUCTION

1.1 SCOPE

This DEP defines the procedures for noise control of plant and equipment. It specifies how to derive maximum allowable noise levels for equipment installed in oil refineries, chemical plants, gas plants and, where applicable, in exploration and production facilities and supply/marketing installations. A schematic flow-chart, reviewing the noise control process, is presented in Appendix 1.

This DEP applies both to design and construction of new plants and to modification of existing plants.

This DEP shall be used in conjunction with the referenced standards, which form an integral part of this DEP. Where conflict arises, the requirements of this DEP shall take preference.

This DEP is not considered suitable for reference in requisitions of individual equipment. The actual noise limits for the equipment under consideration shall be specified in the equipment requisitions under guidance of the appropriate noise control engineer.

This DEP is a revision of the DEP of the same number dated July 1992; a summary of the main changes since the previous edition is given in (1.5).

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors nominated by them (i.e. the distribution code is "C", as defined in DEP 00.00.05.05-Gen.).

This DEP is intended for use in oil refineries, chemical plants, gas plants and, where applicable, in exploration and production facilities and supply/marketing installations.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases, the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Noise level	Either a sound pressure level, with reference to 20 μPa, or a sound power level, with reference to 1 pW.

Noise limit	A maximum allowable noise level.
Noise, fluctuating	Noise whose level varies continuously and to an appreciable extent during the period of observation.
Noise, impulsive	Noise consisting of one or more bursts of sound energy of duration less than about 1 s.
Noise, intermittent	Noise whose level abruptly drops to the level of the background noise several times during the period of observation. The time during which the level remains at a constant value different from that of the ambient is of the order of 1 s or more.
Noise, tonal	Noise dominated by one or several clearly distinguishable tones

NOTE: All logarithms in this DEP are to a base of 10.

1.4 ACTION ITEMS

This DEP requires a number of tasks to be performed during a project. These tasks are assigned an Action Item (*A1, A2, A3* etc.) in the left margin. The responsibility for the execution of these Action Items is assigned to either the Principal or the Contractor as stated in (7), where a summary list of the Action Items is included.

1.5 SUMMARY OF MAIN CHANGES

This is a revision of the DEP of the same number dated July 1992. Other than editorial changes, the main changes are as follows:

Section	
1.1	Removal of general reference to EEMUA 140
3.1.2	Inclusion of ISO 9613-2 as a model for noise propagation calculations
4.3.5	Requirements for flares aligned with DEP 80.45.10.10-Gen.
6.2 and Appendix 3	Inclusion of model format for a 'Noise Allocation Report'
7.4 and Appendix 5	Inclusion of model format for a 'Noise Verification Report'

1.6 CROSS REFERENCES

Where cross references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced in this DEP are listed in (8).

2. GENERAL

The control of noise in a plant is required for the following reasons:

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

Noise limits can be given for each of the above aspects of noise control, relative to certain areas inside or outside the plant. For the purpose of this DEP they shall be referred to as 'General Noise Limits'. They are specified in (3).

Noise limits for each item of equipment shall be derived from the general noise limits, as applicable for the equipment in its specific position in the plant. They are commonly referred to as 'Equipment Noise Limits'. Procedures for deriving equipment noise limits are specified in (4).

Each potential noise source shall be subject to the requirements of this DEP.

The specified limits shall be met for the design operating conditions of the plant and for other operating conditions which occur occasionally, such as start-up, shutdown, regeneration and maintenance. The only requirement for emergency situations, i.e. any conditions other than just described, which can be foreseen or predicted (e.g. relief) is that the absolute limit of (3.2.1) shall not be exceeded.

During construction, noise levels should not exceed the limits applicable for operation of the completed plant.

3. GENERAL NOISE LIMITS

3.1 LOCAL REGULATIONS

3.1.1 In-plant noise

(A1) It shall be investigated whether any local regulations exist with respect to noise in the plant, for example for hearing conservation, speech and work interference, accommodation etc.

(A2) For locations where local regulations, statutory requirements or national standards are more stringent than this DEP, the applicable more stringent limits shall be stated in the project specification, or any other document defining the scope of the project.

3.1.2 Environmental noise

Limits for environmental noise are not given in this DEP since they will depend on the local situation.

(A3) It shall be investigated whether local regulations exist with respect to environmental noise, which may include noise limits, methods of measurement and/or calculation etc. The interpretation of such regulations shall be discussed with local authorities with the object of arriving at agreed environmental noise limits.

Environmental noise limits may be different for different times of day or night and for work-days or week-ends. The most stringent of the above requirements shall be the basis of design, taking due account of the period of operation of the plant.

It shall be ensured that any allowances for occasional higher noise levels that may be acceptable to local authorities are included in the environmental noise limits, e.g. such as for emergencies.

(A4) Where local regulations for environmental noise do not exist, this aspect of plant design shall still be considered at the project definition stage to anticipate adverse community reactions at some later date. BS 4142 may be used for guidance.

(A5) Authorities usually specify environmental noise limits in terms of maximum allowable sound pressure levels at specified locations in the vicinity of the plant or at the plant boundary line. Such limits shall be converted into limits in terms of a maximum allowable sound power level for the plant or composing parts of the plant under consideration. The resultant limits shall be included in the project specification or any other document defining the scope of the project.

Conversion of environmental sound pressure levels into plant sound power levels and vice versa shall be carried out in accordance with ISO 9613-2 or other calculation models specified or agreed by local Authorities and/or the Principal.

3.2 HEARING CONSERVATION (WORK AREA NOISE)

The 'Work Area' is defined as any position not less than 1m from equipment surfaces accessible to personnel, or any position where a worker's ear may be exposed to noise in the normal course of his duty. It includes any platform, walkway or ladder.

3.2.1 Absolute limit

The sound pressure level anywhere in the work area shall not exceed 115 dB(A) in any situation, including emergencies such as blowing of safety/relief valves.

3.2.2 Work area limit

The sound pressure level in the work area shall not exceed 85 dB(A).

3.2.3 Restricted area limit

Restricted areas are those work areas in the plant where it is not reasonably practicable to reduce the noise level below the work area limit. The absolute limit of 115 dB(A) remains valid in such areas.

If it is unavoidable that the work area limit will be exceeded around particular equipment, action shall be taken to limit the area involved as far as possible; this may include the erection of an acoustic enclosure. It is accepted that areas inside 'walk-in' type acoustic enclosures are restricted areas.

(A6) Written permission shall be obtained from the Principal to designate an area as a restricted area. Principal's permission may include a maximum allowable sound pressure level for the area under consideration. Such a restricted area limit may be between 85 and 115 dB(A). However, attempts shall be made to reduce the level below 90 dB(A).

(A7) Permanent warning signs to indicate the mandatory use of ear protectors shall be erected at the boundaries of restricted areas. The signs should be of the type given in ISO 3864.

3.3 SPEECH AND WORK INTERFERENCE

The following noise limits shall apply in order to reduce speech and work interference from equipment to acceptable proportions.

Area description	Maximum allowable sound pressure level dB(A)
• Areas in workshops and machinery buildings where communication is required. • Workshops for light maintenance	70
• Workshops offices. • Control rooms, not continuously manned • Computer rooms	60
• Control rooms, continuously manned. • Open plan offices. • Social rooms, changing rooms, wash places and toilets	50
• Offices and conference rooms.	45

NOTE : Noise that is not related to equipment but is produced by users of the various areas need not be considered.

3.4 ACCOMMODATION

The sound pressure level shall not exceed 40 dB(A) inside personnel accommodation such as bedrooms, private cabins etc.

NOTE : Noise that is not related to equipment but is produced by users of the various areas need not be considered.

3.5 ADDITIONAL RESTRICTIONS FOR TONAL OR IMPULSIVE NOISE

Further restrictions shall apply if the noise contains tonal or impulsive components. This shall be taken into account when specifying equipment noise limits, see (4.2.4).

For environmental noise, any tonal or impulsive component shall be sufficiently below the broad-band noise from the plant so that it is no longer audible (see Appendix E of EEMUA 140). If this is not possible, the Principal's advice shall be obtained.

4. EQUIPMENT NOISE LIMITS

4.1 GENERAL

Equipment noise limits shall be derived using the area noise limits and the total available plant sound power level obtained from (3), or any other limits that may be stated in the project specification.

4.2 MAXIMUM SOUND PRESSURE LEVELS FOR GENERAL EQUIPMENT

For equipment where no other limit than the work area limit of (3.2.2) is applicable, the equipment sound pressure limits as given in (4.2.1) to (4.2.4) shall apply.

Where more or less (restricted area) stringent area noise limits apply, the equipment noise limits given below shall be adapted accordingly.

Equipment sound pressure limits shall not be exceeded anywhere at a distance of 1 m from the equipment surface.

The equipment noise limits shall be given in an overall dB(A) value or, where considered more appropriate, the corresponding octave band spectrum may be specified instead.

4.2.1 Equipment emitting continuous noise

The maximum value for the equipment noise limit (sound pressure level) shall be 85 dB(A).

(A8) If equipment consists of components, e.g. a driver and a driven part, the above limits applied to each component separately will **not** ensure that the assembled equipment meets the work area limit. For such equipment more stringent limits shall be specified on the data/requisition sheets for the separate components. The permissible noise limit per component shall be based on acoustic calculations. As a guidance the following can be used:

- a reduction of 3 dB(A) shall be made for each item of a 2-component train
- a reduction of 5 dB(A) for each item of a 3-component train.

A further reduction of the equipment noise limit shall be made when several equipment items or trains are to be mounted close together, i.e. when the distance between equipment surfaces is less than the largest equipment dimension, or when equipment is located in a reverberant area. The equipment noise limit shall be based on acoustic calculations.

4.2.2 Equipment emitting intermittent or fluctuating noise

Where the equipment emits an intermittent or fluctuating noise (e.g. depressuring, boiler blow-down, sump pump), the equivalent continuous sound level, Leq, over the most noisy consecutive 8-hour period shall not exceed the equipment limits specified in (4.2.1). The maximum level shall not be more than 10 dB(A) higher than the limit for continuous noise.

For intermittent noise, the equivalents of 85 dB(A) over 8 hours are:

Equipment actually operating hours	Maximum sound pressure level when equipment in operation dB(A)
8	85
4	88
2	91
1	94

provided that no significant noise (i.e. above 75 dB(A)) is emitted for the remaining time in the 8-hour period.

Where the equipment emits noise fluctuating in a more complicated manner, the equivalent continuous sound level shall be calculated.

4.2.3 Equipment located outside the work area

The maximum allowable sound pressure level at 1 m from the equipment for equipment located outside the work area may be higher than the limits given in (4.2.1) and (4.2.2). At positions which are inaccessible for personnel, such as may be the case for vent stacks and certain control valves, the allowable increase shall be:

$20 * \log(x)$	dB(A)	for point sources (e.g. vent openings)
$10 * \log(x)$	dB(A)	for line sources (e.g. piping)

where x is the shortest distance from the equipment under consideration to the nearest work area, expressed in metres. For valves, the distance should be taken from directly connected piping to the nearest work area.

4.2.4 Additional restrictions for tonal or impulsive noise

Further restrictions shall apply when the noise of an equipment item contains tonal and/or impulsive components. The equipment noise limit shall be reduced by 5 dB(A) for such equipment.

4.3 MAXIMUM SOUND PRESSURE LEVELS FOR SPECIFIC EQUIPMENT

4.3.1 Valves for control and depressuring

For each control valve and its associated pipe work the requirements of (4.2.1) to (4.2.4) apply. This also holds for low-rate depressuring valves. Control valve noise shall be determined for three operating conditions, viz. minimum, normal and maximum throughput. Noise limits shall not be exceeded for any of the three conditions.

4.3.2 Safety/relief and emergency depressuring valves

The noise from safety/relief valves and high-rate depressuring valves (and their piping) which blow under emergency conditions only, shall not exceed the absolute limit (3.2.1) in any work area. The party which sizes safety/relief and emergency depressuring valves shall also be responsible for the calculation of their noise levels, according to a method to be approved by the Principal. The calculations however shall be confirmed by the Supplier.

If it is not possible to remain within the absolute limit for safety/relief or emergency depressuring valves they should be:

either positioned well away from the work area, so that personnel shall not have access to their immediate vicinity. In this case the maximum allowable sound pressure level, Lp, 1m away from the valve and/or piping shall be calculated using the following equations:

$Lp = 115 + 20 * \log(x)$ dB(A) for point sources (e.g. relief valves),

and

$Lp = 115 + 10 * \log(x)$ dB(A) for line sources (e.g. pipe line)

where x is the shortest distance in metres between the source and the nearest work area;

and/or - provided with a screen that shall deflect noise away from the nearest work area;

NOTES:
1. The above procedures will allow safety/relief valves and their piping to emit noise above the limits of 115 dB(A) at 1 m distance. The corresponding high levels of vibrational energy in the piping, which could cause acoustic fatigue, shall be taken into account in the design of the piping system.
2. The limit of 115 dB(A) may need to be reduced to meet the requirements of environmental noise. Repositioning and shielding shall then not be allowed.
3. Connected pipe work can also radiate excessive noise. Care shall be taken that these noise sources are taken into account.

and/or - fitted with silencers or acoustic insulation; proposals shall be submitted to the Principal for approval.

4.3.3 Piping

(A9) Noise emitting from piping is of major importance in plant noise control and shall be subject to the same restrictions as general equipment (4.2). Such noise usually has its origin in equipment such as a valve or compressor. The noise shall be controlled by selecting low noise equipment (by design) or, when this is not reasonably practicable, by incorporating in-line silencers or acoustic insulation. Guidance into the assessment and reduction of noise emitting from piping by the use of acoustic insulation is given in DEP 31.46.00.31-Gen. The use of in-line silencers in the suction line of compressors requires approval from the Principal.

4.3.4 Vents

(A10) All vents incorporated in the design to meet operational requirements shall be subject to the same restrictions as Equipment - General, see (4.2). Vents intended for emergency use only shall be subject to the same requirements as safety/relief valves, see (4.3.2); where necessary, 'vent' or 'blow-down' silencers shall be incorporated in the design.

NOTES:
1. An acceptable method of calculating vent noise is given in API RP 521.

2. A characteristic difference between vent silencers and blow-down silencers is in the pressure drop. This is as low as possible in the former, whereas in the latter it is a significant proportion of the system pressure. For venting purposes both types should be considered and the most economical type chosen.

4.3.5 Flares

(A11) Elevated flares under emergency conditions:

* The noise level at the base of the stack shall not exceed the absolute limit of (3.2.1). If the stack is provided with a derrick structure, including a platform for coupling/uncoupling segments of the retractable stack, the noise limit applies to this platform.

* If the plant to which the flare is allocated is subject to environmental noise requirements, the noise levels produced during emergency conditions shall be evaluated against local regulations.

(A11) Elevated flares under normal operating conditions (including start-up and shut-down):

* Noise levels at the perimeter of the sterile area (a radius of at least 60 m from the flare base) shall not exceed the work area limit (3.2.2) when operating at flow rates up to 15% of maximum flaring capacity or at the maximum relief rate that may occur during normal operation (including start-up and shut-down), whichever is higher.

* If there are environmental noise limits, then the sound power level generated during normal operation shall be taken into account when assigning sound power levels to noise sources, see (4.4).

(A11) Ground flares shall not exceed the work area limit (3.2.2) outside the windscreen or louver wall.

4.4 MAXIMUM SOUND POWER LEVEL FOR EQUIPMENT

When an environmental noise limit is specified in terms of sound power level, the sound power limit for individual equipment shall be determined such that the sum of the levels of all equipment does not exceed the total limit.

The allocation to individual equipment items in an early stage of a project can best be performed using vendor data, data bases, and experience taking into account type, size and speed of equipment.

Unless otherwise specified, equipment emitting intermittent or fluctuating noise shall not cause the environmental limit to be exceeded at any time (i.e. the equivalent noise level concept (4.2.2) does not apply).

4.5 COHERENCE OF NOISE LIMITS

The equipment noise limits of (4.2 and 4.3) are sufficient only to ensure that in the completed plant the work area limit will not be exceeded. Where other noise limits also apply, it shall be investigated whether they will be met.

For the purpose of this investigation, the sound power levels of individual equipment should be estimated. Sound power levels are either derived according to section (4.4) or are calculated from equipment sound pressure levels, assuming that the requirements of (4.2 and 4.3) will just be met. Where actual sound power levels or sound pressure levels are known they should be used instead. The sound power levels of individual equipment and their location thus form the basis of a calculation of noise levels in the plant. Calculations shall be carried out in accordance with ISO 9613-2 or in accordance with recognised calculation models obliged or agreed by Authorities and Principal. Screening effects of large buildings and tanks shall be taken into account where relevant.

Noise levels inside buildings or shelters shall be calculated, taking into account both the noise from equipment in the building and the noise from outside. Calculation of the attenuation of noise from outside to within a building shall be based on standard acoustic principles.

Where an environmental noise limit is specified in terms of sound power it will be sufficient, for this purpose, to add up the sound power levels of individual equipment in order to arrive at a total sound power level per plant or composing part, see (4.4).

If the results of the investigation indicate that one or more of the limits will be exceeded, the equipment concerned should be reconsidered and be replaced by equipment emitting less noise or, if this is not reasonably practicable, be treated with noise control measures such as insulation or acoustic enclosure.

The extent of noise control measures to be taken shall be considered against the severity of the requirements.

4.6 DATA/REQUISITION SHEETS

(A8) Equipment noise limitation sheets shall be prepared for all relevant items of equipment or an equipment train, if such a train will be provided by a single supplier, specifying the limits as given in (4.2), (4.3) and (4.4). If the components of a train will be provided by different suppliers, separate equipment noise limitation sheets shall be prepared.

The model sheet data/requisition DEP 31.10.00.94-Gen. shall be used to specify either a maximum sound pressure level at any location 1 m from the equipment surface or a maximum sound power level, or both.

NOTE: The maxima for sound pressure level and sound power level need not be related or equivalent since they may originate from different general limits, i.e. the sound pressure limit may originate from the 'work area' noise limit and the sound power limit from the `environmental' limit.

It shall be ensured that the supplier is made aware of the obligation to state noise guarantees for the equipment to be provided, for any of the conditions of operation for which the equipment may be expected to be used.

The equipment noise limitation sheet shall be returned with the tender, with its guarantee section completed by the supplier to give the following information:

a. Unsilenced sound pressure and sound power dB(A) levels in octave bands and overall value of the equipment.
b. Sound pressure and sound power dB(A) levels in octave bands and overall value of the equipment together with details of any silencing measures that may be necessary to meet the specified noise limits.
c. If the specified limits cannot be met, the minimum attainable sound pressure and sound power dB(A) levels in octave bands and overall value shall be given.

Additionally the following information shall be given, where applicable.

d. Completed data/requisition sheets of any silencers and/or acoustic enclosures, if the tender comprises such silencing equipment. Data/requisition sheets

DEP 31.10.00.95-Gen. and DEP 31.10.00.96-Gen. shall be used.

All noise levels quoted shall have an upper tolerance of +0 dB.

NOTE: If guarantees have been provided in some other way, specification of noise limits on individual data/requisition sheets is not required. For example, where a supplier provides all the pumps or motors in a project, a list of guaranteed noise levels and spectra per item will be acceptable.

4.7 EQUIPMENT SELECTION

(A12) It shall be ensured that suppliers have provided in their tenders all the information required in accordance with (4.6).

(A13) Bid comparison shall be made including the cost of all the options required to meet the specified noise limits. Where a choice can be made of equipment of low noise emission by design and equipment with 'path-treatment', the estimated extra cost in operation and maintenance that may result from path treatment should be capitalised and taken into account in the ultimate selection. Generally, preference shall be given to equipment of low noise emission by design.

For equipment emitting fluctuating or intermittent noise, temporary excursions above the equipment noise limit may be permissible, see (4.2.2) and (4.4). If such excursions can be avoided by selecting a less noisy and otherwise acceptable alternative then this shall be preferred. Where a higher extra expenditure would seem justified, the Principal shall be consulted.

5. SILENCING EQUIPMENT

(A14) Silencing equipment such as silencers and acoustic enclosures may be included in the tenders for noisy process equipment, see (4.6). When the Supplier has been selected, details of such silencing equipment shall be agreed upon between the Supplier and the Contractor. The Contractor may choose to order silencing equipment separately from the process equipment.

Noise emission of certain silencing equipment (e.g. silencers on vent stacks, acoustic insulation on pipes) is not always the responsibility of any particular equipment supplier, and is the responsibility of the Contractor. It shall be ensured that such silencing equipment is incorporated in the design and that the relevant data/requisition sheets are prepared.

It shall be ensured that sound-absorbing materials or constructions are incorporated in the design of potentially reverberant spaces. The minimum absorption coefficient, averaged over walls and ceiling, shall be 0.2 for frequencies above 200 Hz.

For some equipment, calculations or measurements may indicate that the noise limits will be exceeded, but with a margin of uncertainty extending down to levels below the limit (i.e. there is a possibility that the limits may be met). For such equipment the design and application of noise control measures shall not be postponed until actual noise levels have been obtained after start-up, unless specifically agreed with the Principal. If application of the noise control measures may be delayed until after start-up, services such as electrical and instrumentation and any necessary other requirements shall be provided in advance of start-up.

Silencers shall comply with EEMUA 161. The design of silencers shall ensure that any internal parts that may inadvertently break loose do not partly or completely block the silencer outlet or damage downstream equipment (e.g. compressors).

Silencers to suppress commissioning noise only may be of a movable type.

Silencers to reduce noise in transient operations such as start-up, shutdown etc., shall be permanent.

Acoustic enclosures may be either of the 'close fitting' or 'walk-in' (large) type. Large enclosures shall be designed in such a way that operating/maintenance personnel can conduct their work without being hampered in their movements.

Large enclosures shall also be subdivided in such a way that personnel servicing the equipment during partial shutdown are not exposed to excessive noise generated by other equipment that may also be in the enclosure. This can be achieved for example by a separating wall between two independent trains of equipment.

6. PROJECT CONTROL

6.1 INFORMATION FOR THE NOISE CONTROL ENGINEER

(A15) For the provision of the required information within the Principal's office, a list of documents that should be made available is given in Appendix 2.

6.2 ENGINEERING PHASE REPORTS

(A16) Where environmental noise limits or a plant sound power limit are specified, a ‘Noise Allocation Report’ shall be prepared to show how sound power levels are allocated to various equipment items. The report, with figures based on manufacturer's information, experience or data bases, serves to set equipment noise limits and to anticipate noise abatement measures. The report shall be submitted to the Principal for approval before data/requisition sheets are released for tendering. The model format given in Appendix 3 shall be used for this report

When a preliminary noise allocation report has been prepared by the Principal as part of the project definition document, a re-issue shall be submitted incorporating the Contractor's assessment.

(A17) In any event the Contractor shall prepare a ‘Noise Control Report’ for approval by the Principal after the major part of the equipment selection has taken place. The report shall give sufficient data and calculations to demonstrate to the satisfaction of the Principal that the acoustic design of the plant will meet the requirements.

The model format given in Appendix 4 shall be used for this report.

In both reports (action items *A16* and *A17* above) due attention shall be given to the prediction of piping noise.

6.3 'NOISE' TEST RUNS

(A18) The Contractor shall decide which equipment shall have a 'noise' test run at the Supplier's works and inform the Principal accordingly.

NOTE: Where acceptance of individual equipment items is conditional on satisfactory conclusion of noise test runs at the Supplier's works, the test run shall reflect the in-situ arrangement and a suitable test procedure shall be agreed between the Contractor and the Principal.

6.4 ACCEPTANCE TEST

(A19) Responsibility of the Contractor for meeting the specified noise limits will not end until measurement and evaluation by an independent acoustic consultant have shown that limits are not exceeded. The results of this test shall be presented in a ‘Noise Verification Report’. Contracting out the test and the preparation of the report to this independent consultant shall form part of the Contractor's scope of work.

The test includes, as a minimum, the preparation of an in-plant noise contour plot, showing contours of 75 dB(A) and higher, with incremental steps of 5 dB(A).

Where a sound power limit applies to the project, a suitable test procedure shall be agreed between Contractor and Principal. The final report could be prepared in accordance with the format shown in Appendix 5.

6.5 REMEDIAL ACTION

(A20) Corrective action shall be taken if actual sound levels or levels calculated from measurements made in the acceptance test exceed the specified limit. The corrective measures shall have the Principal's approval.

7. SUMMARY OF ACTION ITEMS AND ALLOCATION OF RESPONSIBILITY

The Action Items defined in this DEP are summarised below:

NOTE: The Action Items below are not in the chronological order in which they may occur in a project.

Action Item No.	Task description	Ref. Section	Responsible party	
			Principal	Contractor
A1	Investigate local regulations for in-plant noise	3.1.1	x [1)]	
A2	State local in-plant limits in project specification	3.1.1	x [1)]	
A3	Investigate local regulations on environmental noise and discuss the interpretation with authorities	3.1.2	x [1)]	
A4	Consider environmental noise aspect (where no regulations exist)	3.1.2	x	
A5	Incorporate sound power level in project specification	3.1.2	x [1)]	
A6	Obtain Principal's permission for restricted areas, set limits for those areas	3.2.3		x
A7	Erect earmuff signs	3.2.3		x
A8	Specify equipment noise limits, including additional restrictions	4.2.1 4.6		x x
A9	Determine pipe noise, assess insulation and silencer requirements	4.3.3		x
A10	Determine need for vent silencers	4.3.4		x
A11	Evaluate need for special requirements for flare	4.3.5		x
A12	Obtain noise limitation sheet with guaranteed power/pressure level from supplier, incl. silencers / enclosures	4.7		x
A13	Select least noisy equipment	4.7	(x)	x
A14	Agree on details of silencers / enclosures	5	(x)	x
A15	Prepare noise control (background) information	6.1		x
A16	Submit ‘Noise Allocation Report’	6.2		x
A17	Submit ’Noise Control Report’	6.2		x
A18	Decide which equipment shall have a 'noise' test run	6.3		x
A19	Perform final plant acceptance test, prepare ‘Noise Verification Report’	6.4		x
A20	Take corrective action where required	6.5		x

1) If requested by the Principal this information shall be verified by the Contractor.

8. REFERENCES

In this DEP, reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

DEPs:

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Requisitioning binder	DEP 30.10.01.10-Gen.
Acoustic insulation for pipes, valves and flanges	DEP 31.46.00.31-Gen.

DATA/REQUISITION SHEETS:

NOTE: Data/requisition sheets are contained in the Requisitioning binder, DEP 30.10.01.10-Gen.

Data/requisition sheet for equipment noise limitation	DEP 31.10.00.94-Gen.
Data/requisition sheet for vent/blow-down/air-flow/in-line silencers	DEP 31.10.00.95-Gen.
Data/requisition sheet for rotating equipment acoustic enclosures	DEP 31.10.00.96-Gen.

AMERICAN STANDARDS

Guide for Pressure Relief and Depressuring Systems	API RP 521

Issued by:
American Petroleum Institute
Publications and Distribution Section
1220 L Street Northwest
Washington DC. 20005
USA

BRITISH STANDARDS

Method of rating industrial noise affecting mixed residential and industrial areas	BS 4142

Issued by:
British Standards Institution
389 Chiswick High Road
London W4 4AL
UK

Noise Procedure Specification	EEMUA 140
Guide to the selection and assessment of silencers	EEMUA 161

Issued by:
EEMUA,
45 Beech Street,
London EC2Y 8AD,
UK

INTERNATIONAL STANDARDS

Safety colours and safety signs	ISO 3864
Acoustics - Determination of sound power levels of multi-source industrial plants for evaluation of sound pressure levels in the environment - Engineering method	ISO 8297

Acoustics - Attenuation of sound during propagation outdoors - Part 2 General method of calculation — ISO 9613-2

Issued by:
International Organisation for Standardisation
1, Rue de Varembé
CH-1211 Geneva 20
Switzerland

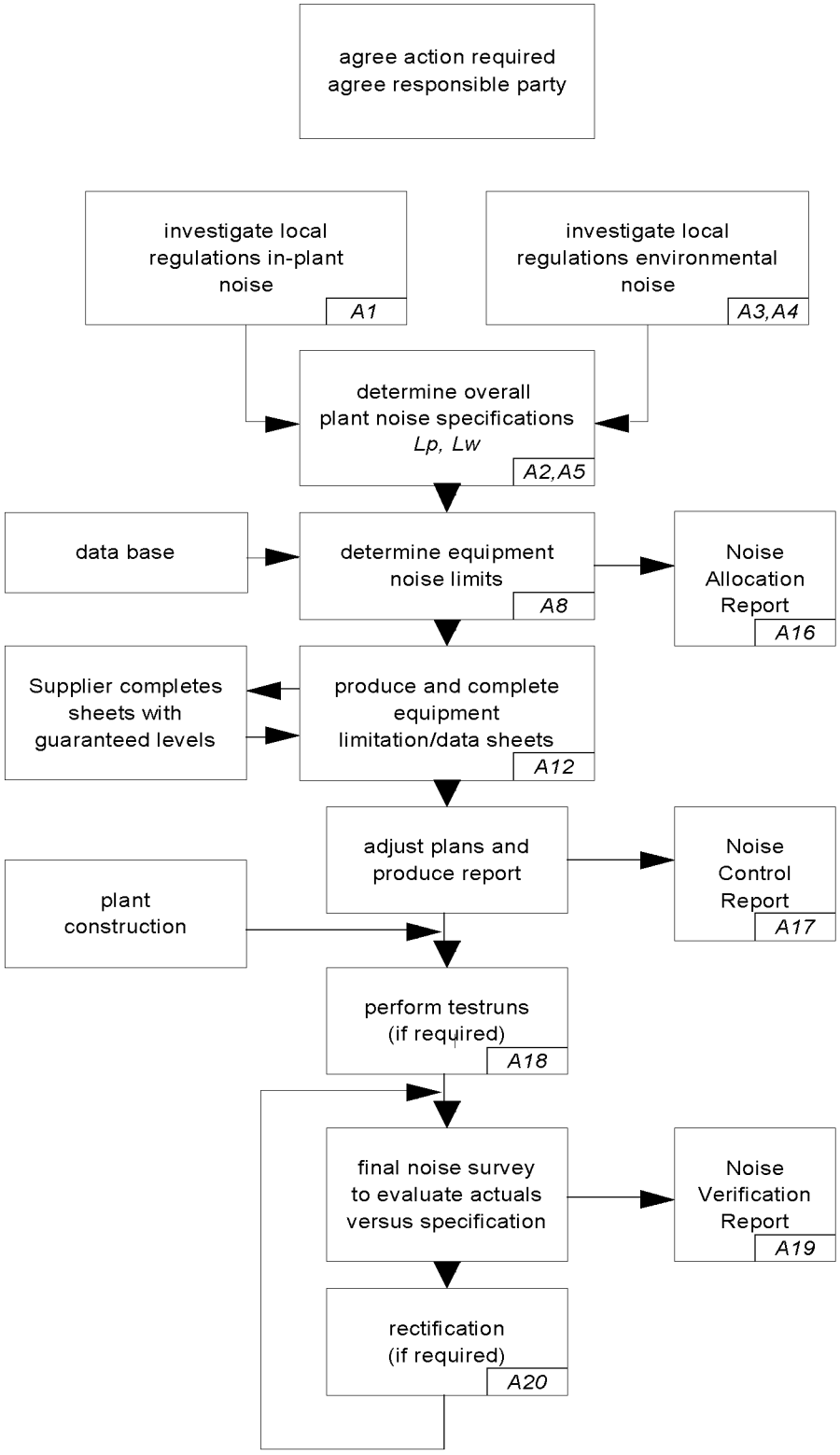
Copies can also be obtained from national standards organizations.

9. BIBLIOGRAPHY

NOTE: The following document is for information only and does not form an integral part of this DEP:

Noise Guide - Shell Safety Committee

APPENDIX 1 NOISE CONTROL FLOW CHART



Note: '*A'* numbers refer to action items, see (7)

APPENDIX 2 DOCUMENTS TO BE SUBMITTED TO PRINCIPAL'S NOISE CONTROL ENGINEER

The following documents shall be made available:

- basis of design
- project specification
- plot plan
- plan of local area
- noise allocation report (if applicable)
- noise report
- noise verification study

For major projects in the design and engineering phase and the procurement phase, the following documents should be submitted to the noise control engineer if close guidance by the Principal is required. The appropriate issue or issues shall be decided by the engineer concerned.

- Equipment summary, project specification
- Equipment data requisitions for all relevant noise sources, amongst others:
  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)
- Data on the acoustic properties of buildings (in special cases only)
- Piping arrangement data

APPENDIX 3 MODEL FORMAT FOR THE 'NOISE ALLOCATION REPORT'

The report specified in (6.2) and nominated as action item *A16* shall be prepared in accordance with the following format:

1. Specified limits - quote the original requirements and make any comments necessary.
2. A list of equipment items (including valves, piping, buildings etc.) with the following information:
   - tag number
   - short description (e.g. centrifugal pump, recip compressor)
   - typical description of duty (e.g. 3000 rpm, 150 kW)
   - allocated maximal sound pressure level in dB(A)
   - allocated maximal sound power level in dB(A)
   - total allocated sound power level per plant unit in dB(A)
   - total allocated sound power level for project in dB(A)
3. Description of anticipated 'restricted areas'
4. Indication of areas of maximum uncertainty of noise data

APPENDIX 4 MODEL FORMAT FOR THE 'NOISE CONTROL REPORT'

The report specified in (6.2) and nominated as action item *A17* shall be prepared in accordance with the following format:

1. Summary showing to what extent:
   - the acoustic design of the plant has been completed;
   - guaranteed noise data has been obtained from suppliers;
   - the specified noise limits are expected to be met.
2. Specified limits - quote the original requirements and make any comments necessary.
3. Supplier noise data
   - tables of octave band sound power, sound pressure and overall levels of all potentially noisy equipment per plant unit. The origin of the data shall be indicated (guarantee from supplier, estimate from supplier, test data from Contractor, estimate from Contractor etc.).
   - the results of 'noise' test runs.
   - a list of control valves with a noise level above 80 dB(A) with an indication where low-noise control valves will be applied.
4. Noise control measures
   - a list of silencers and acoustic enclosures
   - the detail and extent of any acoustic insulation
5. Calculations
   - in-plant noise contour maps, showing contours of 75, 80 and 85 dB(A) and higher where applicable
   - evaluation of the sound power level of the plant or sections of it, even in the case that no plant sound power limit is required
   - immission noise levels at discrete points
   - separate evaluation of plant pipe noise
   - calculations of expected noise levels inside buildings and shelters
6. Restricted areas
7. Outstanding items

APPENDIX 5 MODEL FORMAT FOR THE 'NOISE VERIFICATION REPORT'

The report specified in (6.4) and nominated as action item *A19* could be prepared in accordance with the following format:

		Tick-list
1.	The objective of the noise verification report.	☐
2.	The survey or calculation methods to be used (i.e. ISO 8297 for calculating whole plant sound power level).	☐
3.	The name of the Principal, the name and location of the plant.	☐
4.	The date and time of the noise survey.	☐
5.	The names and/or affiliations of the personnel participating in the noise survey.	☐
6.	The noise limits set for the project.	☐
7.	A map or drawing of the area to be surveyed. If community noise verification is required, include a map or drawing of the surrounding area of concern. The map or drawing should show all the measurement locations used in the survey. If applicable, the positions of noise sources outside of the plant, and the measurement locations which could be affected as a result should be documented. Where a noise contour map is required, then sufficient measurement points shall be used to allow a noise contour map to be drawn. Describe any significant noise screens or reflectors on the plant.	☐
8.	A description of the plant and a description of the type of noise being generated.	☐
9.	The plant operating conditions at the time of survey, including production configuration, % throughput, whether in normal operation, abnormal operation, start-up or shut down mode.	☐
10.	The weather conditions at the time of the measurements (if relevant), in particular wind speed and direction, relative humidity and air temperature.	☐
11.	The type, model, serial number and calibration and method of calibration of all instrumentation used. Note: The calibration of the instruments should be checked at the beginning and end of the noise survey.	☐
12.	Operator work patterns where noise exposure per shift is required to be verified.	☐
13.	Sound pressure measurements and octave band levels recorded at agreed immission points.	☐
14.	Report on any locations at which measurements could not be taken or omitted for other reasons.	☐
15.	A qualitative but brief assessment of neighbouring noise sources (other plants, road noise etc.) likely to affect the measured sound pressure readings.	☐
16.	Report the corrections for background noise, if any, and microphone positions at which the background noise could not be measured.	☐
17.	The calculated plant A-weighted sound power levels per octave band and overall sound power level.	☐
18.	Report any deviations from the survey requirements due to the site environment.	☐
19.	Prepare environmental noise contour maps.	☐
20.	Preparation of an in-plant noise contour plot, showing A-weighted contours of for instance 75 dB and higher, with incremental steps of 5 dB.	☐

	Verification	
21.	Compare the noise survey results with the requirements.	☐
22.	Identify whether any of the project requirements are exceeded(if at all).	☐
23.	Identify causes for the noise requirements being exceeded in any location, if possible.	☐
	Attachments	
24.	Octave band measurements. The height of the microphone position should be reported. Note: The determination of sound power level according to ISO 8297 requires elevated measurement positions. However practical limits may restrict microphone height.	☐
25.	Corrections made for background noise.	☐
26.	Sound power levels.	☐
27.	All input data for computer calculations	☐