GENERAL STANDARD

FOR

NOISE CONTROL AND VIBRATION

FIRST EDITION

FEBRUARY 2015

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS is based on internationally acceptable standards and includes selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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GENERAL DEFINITIONS:

Throughout this Standard the following definitions shall apply.

COMPANY:

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER:

Means the “Company” where this standard is a part of direct purchaser order by the “Company”, and the “Contractor” where this Standard is a part of contract documents.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR:

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR:

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

CONTENTS : PAGE No.

0. INTRODUCTION

Noise can disturb human's work, rest, sleep and communication, it can damage hearing. Vibration can cause long-term painful damage to hands and fingers, painful and disabling disorders of the blood vessels, nerves and joints and the risks of back and muscle pain.

Indeed the most important issue is industrial noise problem and a need for noise and vibration control and hearing conservation programs.

This Standard provides guidelines comprising:

a) Brief explanation of the principle and essential standards for noise emitted by machineries and equipment.

b) Brief explanation of the principle underlying standards for noise in workplace areas, and noise control procedures in plants/complexes, offices, conference rooms, etc.

c) Brief explanation of the principle for vibration control.

If there is some non-conformity through legislative requirement which has been approved by Iranian governmental organization such as Department of Environment and Health Ministry, the performance criteria shall be consider base on the above legislative mentioned. Then the following references shall be considered:

"Human's Environmental Laws, Regulations, Criteria and Standards", section 3.8 & 3.9, page 183, by Department of Environment of Iran, first edition, 1391.

This Standard is prepared in two Parts:

Part 1 Noise Control

Part 2 Vibration Control

In this standard, some of the subjects are adapted from the following specifications and handbooks:

- TLVs® and BEIs®
  Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents AND Biological Exposure Indices. Defining the Science of Occupational and Environmental Health® 2010
- GS-EP-ENV-500A "TOTAL GENERAL SPECIFICATION ENVIRONMENT (Noise abatement in production units)"
- OSHA 3074
- Industrial Noise Control fundamentals and application, by Lewis H. Bel
- ROYAL DUTCH/SHELL STANDARDS

DEP 31.46.00.31-Gen.	"Acoustic Insulation for Pipes, Valves and Flanges"
DEP 31.10.00.94-Gen.	"Data/Requisition Sheet for Equipment Noise Limitation"
DEP 31.10.00.95-Gen.	"Data/Requisition Sheet for Vent/Blow-Down/Air-Flow/In-Line Silencers"
DEP 31.10.00.96-Gen.	"Data/Requisition Sheet for Rotating Equipment Acoustic Enclosures"

1. SCOPE

This Standard defines the standard limits and procedures for noise and vibration control of plant and equipment. It specifies how to derive maximum allowable noise and vibration levels for equipment installed in oil refineries, chemical plants, gas plants and, where applicable, in exploration and production facilities and supply/marketing installations.

It applies equally to design and construction of new plants and to modification of existing plants.

This Standard is not considered suitable for reference in requisitions of individual equipment. The actual noise and vibration limits for the equipment under consideration shall be specified in the equipment requisitions under guidance of the management and appropriate occupational health and safety authorities.

Part 1 of this Standard also deals with the particular requirements for installing the acoustic insulation and is intended for the noise control engineer to consider the acoustic design of the plant.

Part 2 of this Standard defines the vibration control of particular equipment.

Under no circumstances in this standard, noise limit values shall not be exceeded of standard value in Iran -Occupational & Environmental Health Center, Ministry of Health & Medical Education and Iran- Department Of the Environment (DOE).

Note 1:

This standard specification is reviewed and updated by the relevant technical committee on Jan. 2005. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No 252 on Jan. 2005. These modifications are included in the present issue of IPS.

Note 2:

This is a revised version of this standard, which is issued as revision (1)-2015. Revision (0)-1997 of the said standard specification is withdrawn.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

API (AMERICAN PETROLEUM INSTITUTE)

API RP 521	"Guide for Pressure Relief and Depressuring Systems"

BSI (BRITISH STANDARD INSTITUTION)

BS 4142	“Method of Rating and Assessing, Industrial and Commercial Sound”
BS 5378	"Sign & Symbols"
BS EN ISO 266	“Acoustics-Preferred Frequencies”
BS EN ISO 7010	“Graphical Symbols — Safety Colours and Safety Signs — Registered Safety Signs”
BS EN ISO 11202	“Acoustics-Noise Emitted by Machinery and Equipment-Determination of Emission Sound Pressure Levels at a Work

Station and at Other Specified Positions Applying Approximate Environmental Corrections"

EEMUA (THE ENGINEERING EQUIPMENT AND MATERIALS USERS ASSOCIATION)

EEMUA Publication

No. 140 "Noise Procedure Specification"

Note:

Formerly OCMA Specification NWG-1, 2nd revision of March 1980.

EEMUA Publication

No. 161 "Guide to the Selection and Assessment of Silencers"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-M-SF-325 "Material and Equipment Standard for Personnel Safety and Fire Fighters Protective Equipment"

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

ISO 7010 "Graphical Symbols — Safety Colours and Safety Signs — Registered Safety Signs"

ISO 266 "Acoustics Preferred Frequencies for Measurements"

ISO 1683 "Acoustics-Preferred Reference Quantities for Acoustic Levels"

ISO 15664 "Acoustics –Noise Control Design Procedures for Open Plant"

ISO 9612 "Acoustics- Determination of Occupational Noise Exposure - Engineering Method"

3. DEFINITIONS AND TERMINOLOGY

3.1 Band

A band is a range of frequencies determined by the highest and the lowest frequencies in the range. Frequencies are measured in Hertz (cycles/second).

3.2 Decibel

One decibel is one tenth of one bel, the decibel (dB) is a Logarithmic_unit used to express the ratio between two values of a physical quantity, often /Power_ (physics) or /Intensity_ (physics). One of these quantities is often a reference value, and in this case the decibel can be used to express the absolute level of the physical quantity, as in the case Sound_pressure.

3.3 Impulsive noise

When a noise contains significant irregularities, such as bangs, clanks, or thumps, or if the noise is only existent momentarily and is of a character to attract attention, then it shall be considered as impulsive for the purpose of this specification.

3.4 Intermittent Noise

Noise whose level abruptly drops to the level of the background noise several times during the period of observation.

(ISO 12001: 1996 ; Definition 3.19.2)

3.5 Intensity

Intensity of sound is measured in watts per square meter .it is heard as loudness, which can be perceived differently depending on the individual and his or her distance from the source, and characteristics of the surrounding space. OSHA(MANUAL CONTROL NOISE)

3.6 Machine

Any sound source of which the acoustical characteristics are to be measured.

3.7 Narrow band noise

When the noise from a source contains a pure tone or 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, then the source noise 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 it shall be resolved by narrow-band analysis, using an instrument with a band width not more than 10 Hz or 1%, whichever is the less (See Appendix E of EEMUA 140).

Noise

Noise is any undesired sound; and by extension, noise is any unwanted disturbance within a useful frequency band.

3.8 Octave bands

A type of frequency band, are a convenient way to measure and describe the various frequencies that are part of a sound .A frequency band is said to be an octave in width when its upper Band-edge frequency, f2, is twice the lower band-edge frequency, f1: f2 = 2 f1.

3.9 Path Treatment

One step in the noise-control hierarchy is to determine ways to treat the sound transmission path. Typical path treatments include adding sound-absorption materials to the room or equipment surfaces, installing sound transmission loss materials between the source and receiver(s).

3.10 Reference surface

Is the smallest possible imaginary parallel-piped enclosing the source and terminating on the ground (excluding reentrant sections and minor protruberances which are not significant emitters of noise).

3.11 Sound and decibels

Sound is a disturbance which propagates through a medium having the properties of inertia (mass) and elasticity. The medium by which audible sound is transmitted is air. For definition of Decibels refer to the heading of definition and terminology.

3.12 Sound level

Is the A-weighted overall sound-pressure level.

3.13 Sound power

Sound power usually measured in watt, is the amount of energy per unit of time that radiates from a source.

3.14 Sound power level (Lw)

Sound power level is defined as 10 log (w/w_0) in Decibels (Db) where W is the sound power in watts and W_0 is the reference sound power is equal of 10^{-12} watt.

The relation of sound power level is as following:

$Lw=10 \log w/w_0$

The sound power level can not be directly measured with an instrument .it is obtained on the basis of the sound pressure level using the following formula :

$Lw=Lp+10 \text{ Log}_{10} S+ A$

Where LP sound pressure level for all spectrum in dB.

S in the surface area of the imaginary envelope on which Lp is measured in m^2.

A is noise attenuation due t air absorption ,ground absorption etc. it expressed in dB and for small distance is usually negligible.

3.15 Sound pressure level (LP)

Sound pressure level (LP) is defined as 20 log(p/p_0) in Db where p is the measured sound pressure in N/m^2 and P_0 is the reference sound pressure of 2×10^{-5} N/m^2

The relation LP is expressed as :

$LP= 20 \log (p/p_0)$

The relation between Lp and Lw for a given octave band is written as follows, according to equation:

LP=Lw-10 Log S- A

3.16 Sound transmission loss, TL

A measure of sound insulation value of a partition; the amount, in decibels, by which the intensity of sound is reduced in transmission through the partition.

$TL=10 \log w/w_0$

W=the incident power on a wall that is absorbed (w),

W_0=the power that is radianted out the other side of the wall.

3.17 Steady noise

Noise that gives fluctuations over a range of not more than 5 dB on a sound level meter set to frequency weighting "A" and time weighting "S".

3.18 Vibration

The periodic motion of a rigid or elastic body from a position of equilibrium.

3.19 Vibratory-velocity level

Is defined as 20 log (v/v_o) where v_o is the reference velocity of 5×10^{-8} m/s.

Note:

This is not the preferred reference velocity required by ISO 1683 but it is the most suitable value for relating vibratoryvelocity levels with sound-power levels.

3.20 Work area

Is any position not less than 1 m from equipment surfaces which is accessible to personnel, or any position where an operator's ear may be exposed to noise in the normal course of duty. It includes any platform, walkway or ladder.

4. UNITS

This standard is based on international system of units (SI), as per IPS-E-GN-100 except where otherwise specified.

PART 1

NOISE CONTROL

5. DETERMINATION OF OCCUPATIONAL NOISE EXPOSURE- ENGINEERING METHOD

5.1 Instrumentation

5.1.1 Sound level meters and personal sound exposure meters

Measurements can be made by using either integrating-averaging sound level meters or personal sound exposure meters.

Sound level meters, including the microphone and associated cables, shall meet the requirements for IEC 61672-1:2002, class 1 or class 2 instrumentation. Class 1 instrumentation is preferred and should be used when measuring at very low temperatures or when the noise is dominated by high frequencies (see also Note 3).

Personal sound exposure meters, including the microphone and cable, shall meet the requirements specified in IEC 61252. Personal sound exposure meters fulfilling the requirements of IEC 61672-1:2002, class 1, are recommended and should be used when measuring at very low temperatures or when the noise is dominated by high frequencies (see also Notes 2 and 4).

Note 1:

Most sound level meters that meet the requirements of IEC 60651:2001 [10] 1) and IEC 60804:2000 [11] 1) also meet the acoustic requirements of IEC 61672-1:2002.

Note 2:

"Personal sound exposure meter" is often referred to as "noise dose meter" or "noise dosimeter" (North America). (see Appendix III for instrument used to conduct a noise survey)

Note 3:

For IEC 61672-1:2002, class 1 instruments, the specified tolerance limits are applied for the temperature range from −10 °C to 50 °C. For instrumentation in accordance with IEC 61672-1:2002, class 2, and for personal sound exposure meters in accordance with IEC 61252, the influence of variations in the air temperature on the measured signal level is specified over the range from 0 °C to 40 °C. In order to maintain accuracy when performing measurements outside this temperature range, it can be necessary to use an instrument for which the manufacturer specifies compliance for a wider temperature range. Alternatively, a sound level meter in accordance with IEC 61672-1:2002, class 1, may be selected. In cold conditions, the measuring instrument may be kept warm, e.g. under clothing, such that only the microphone is exposed to low temperatures.

Note 4:

The choice of the instrumentation influences the uncertainty of the measurements.

Note 5:

For personal sound exposure meters, IEC 61252 allows wide tolerances in the frequency characteristics above 4 000 Hz, which can lead to incorrect measurement of high frequency sound such as that from air nozzles. In order to reduce the uncertainty when measuring noise dominated by high frequencies, it may be necessary to use a measuring instrument for which the manufacturer specifies high frequency characteristics within a narrower tolerance range.

Alternatively, a sound level meter specified in accordance with IEC 61672-1:2002, class 1, may be selected.

Personal sound exposure meters can have a cut-off level at around 70 dB. It should be checked whether this influences the measurement result.

5.1.2 Calibrator

The calibrator shall meet the requirements specified in IEC 60942:2003, class 1.

5.1.3 Periodic verification

The calibration of the sound calibrator and the compliance of the instrumentation system with the requirements of IEC 61672-1, IEC 61252 and other relevant standards shall be verified at intervals in a laboratory making calibrations traceable to appropriate standards.

Unless national regulations dictate otherwise, it is recommended that the sound calibrator and the compliance of the instrumentation system with the requirements of IEC 61672-1 be verified at intervals not exceeding 2 years.

The date for the last periodic verification and the name of the laboratory that performed it shall be recorded and given in the measurement report.

6. SELECTION OF MEASUREMENT STRATEGIES

6.1 General

The selection of an appropriate measurement strategy is influenced by several factors such as the purpose of the measurements, complexity of the work situation, number of workers involved, effective duration of the working day, time available for measurement and analysis, and amount of detailed information required.

6.2 Measurement Strategies

Three measurement strategies for the determination of workplace noise exposure are offered by this International Standard. These are:

a) task-based measurement: the work performed during the day is analysed and split up into a number of representative tasks, and for each task separate measurements of sound pressure level are taken (see Clause 9);

b) job-based measurement: a number of random samples of sound pressure level are taken during the performance of particular jobs (see Clause 10);

c) full-day measurement: sound pressure level is measured continuously over complete working days (see Clause 11).

Detailed guidance on the choice of the measurement strategy is given in Annex B.

7. MEASUREMENTS

7.1 Selection of Instrumentation

Measurements shall be performed using the following types of instrumentation (see also 5.1):

a) personal sound exposure meter worn by the worker whose noise exposure is being determined;

b) integrating-averaging sound level meter placed in discrete positions, or held in the hand whilst following a mobile worker.

Personal sound exposure meters may be used for measurements in all types of work situations. It is the preferred method when making long duration measurements for a mobile worker engaged in complex or unpredictable tasks or carrying out a large number of discrete tasks.

For measurements of single or multiple tasks at fixed workstations, hand-held or fixed sound level meters may be used.

7.2 Field Calibration

Field calibration includes an acoustic calibration check of the entire measuring system, including the

microphone, and is a distinct survey procedure separate from laboratory calibration. A field calibration shall consist of applying a sound calibrator meeting the requirements of IEC 60942:2003, class 1, to each microphone and recording the measured level at one or more frequencies within the frequency range of interest. Field calibration shall be carried out in a quiet location.

Before each series of measurements and at the start of each daily series of measurements, a field calibration with appropriate adjustment shall be performed. At the end of each series of measurements and at the end of each daily series of measurements, a field calibration without adjustment shall be performed. If the reading at any frequency at the end of a series of measurements differs from the reading of that frequency at the beginning of the series by more than 0,5 dB, the results of the series of measurements shall be discarded.

7.3 Instrument Worn by the Worker

The microphone shall be mounted on the top of the shoulder at a distance of at least 0,1 m from the entrance of the external ear canal at the side of the most exposed ear and should be approximately 0,04 m above the shoulder. The microphone and the cable shall be fastened in such a way that mechanical influence or covering by clothing do not lead to false results.

Care shall be taken not to disturb the work performance and especially not to introduce safety risks. Similarly ,care shall be taken to avoid false contributions. See also 13.2.

Note 1:

When using measuring instruments worn by the worker or in other cases when the microphone is placed very close to a worker's body, the measurement result is affected by screening effects and reflections by the body. This is especially valid for high-frequency noise and small noise sources at a short distance from the ear. In such cases, the measurements should be performed with microphones placed at both sides of the head in order to establish the exposure of the most exposed ear.

Note 2:

The advantage of using personal sound exposure meters is that the workers being monitored do not have to be followed closely and several workers can be tested simultaneously.

The worker being monitored shall be informed of the purpose of the measurement. Workers shall be advised not to remove the measuring instrument during the entire measurement period and to perform their work normally.

The personal sound exposure meter shall be reset and started according to the manufacturer's instructions.

This shall be done after the calibration has been performed, the measuring instrument has been attached and the microphone has been installed in place to ensure that no extraneous noises are introduced while fitting the personal sound exposure meter. The starting time of the measurement shall be noted. When the measurements are finished, the instrumentation shall be stopped according to the manufacturer's instructions before the removal of instrumentation and microphone. The time when the measurement was stopped shall be noted.

Any high peak sound levels recorded by the instrument which were not validated by observation shall be investigated and commented on in the report.

7.4 Measurement Time Interval

7.4.1 General

The measurement time interval shall be chosen in such a way that the emission sound pressure level and, as required, the time characteristics of sound emission at specified positions can be determined for the specified operating conditions. For a given source under test, the measurement

time interval, T, may be composed of a number of sub measurement time intervals, Ti, each of which corresponds to a specified operational period of the source. In this case, a single emission sound pressure level is usually desired. It is obtained by averaging the individual A-weighted emission sound pressure levels according to the following equation

$$L_{PA} = 10Lg\left[\frac{1}{t}\sum_{i=1}^{n} t_i\, 10^{0.1L_{PA,T_i}}\right] \qquad dB$$

Where:

T is the total measurement time interval

$$T = \sum_{i=1}^{N} t_i$$

Ti are the sub-measurement time intervals;

N is the total number of sub-measurement time intervals or operational periods;

*Lp*A,*T*(*i*) is the A-weighted emission sound pressure level over a sub-measurement time interval *Ti*.

For machinery and equipment with a specified operational cycle, it is usually necessary to extend the measurement time interval to an integral number of consecutive operational cycles.

The measurement time interval shall correspond only to the operational periods for which the emission sound pressure level and, as required, the time characteristics of sound emission are desired. Values of the measurement time interval, possible sub-measurement time intervals and number of operational cycles contained in the measurement time interval are usually to be found in the noise test code specific to the family of machinery or equipment to which the machine under test belongs, if any exists. In any case, these values shall be identical to those defined for determining the sound power level of the machine under test.

7.4.2 Steady noise

If the noise emission at a specified position is steady for the specified operating conditions (see ISO 2204 and ISO 12001), the measurement time interval shall be at least 15 s.

7.4.3 Non-steady noise

If the noise emission at a specified position is not steady for the specified operating conditions, the measurement time interval and operational periods of the machine under test shall be carefully defined and reported in the test results. They are normally specified in the relevant noise test code, if any exists.

8. CREATE A NOISE DIAGRAM (NOISE MAPPING)

The noise diagram or schematic is a useful strategy for recording noise levels in context. The diagram can help determine which workers have noise exposure, and it is useful for communicating with workers and the employer. Use a plant schematic or sketch the general floor plan. Mark and identify noisy processes. Use the sound level meter to determine the noise level adjacent to the noisy equipment or process and at various distances from the noise source. Specifically, measure noise at the ear position of workers in the vicinity.

Next move away from the noise source, making sequential measurements to determine the “hazard radius”—the distances from the noise source at which the noise level drops to the PEL and below the AL (Figure 25). Mark the distances in the sketch. Also, the dimensions of the work area and the materials that were used to construct the room should be identified.

8.1 Taking Measurements for a Noise Diagram

Your completed sketch will show a series of contours around the noise source(s) (Figure 26). Expect the contours for adjacent noise sources to overlap. Workers operating entirely outside the contour are not exposed to noise in excess of the AL. Workers whose tasks take them closer to the equipment might experience exposures between the AL and the PEL, or even in excess of the PEL. Take photographs to document the type of equipment or process.

8.2 Drawing a Noise Diagram

Where noise levels exceed the PEL, an octave band analyzer can help you determine the frequency profile of the sound. This information can aid in pinpointing the cause of the sound (e.g., slipping belt, vibrating supports) and will be useful for planning control measures.

The sound level meter is also useful for confirming the extent to which the employer's-noise reduction measures have reduced workers' noise exposure. In this case, octave band analysis can help confirm that the materials used are appropriate for controlling the particular noise.

When monitoring is complete at the end of the day, follow standard procedures for recording results from the instruments. If necessary, consult the instrument user's manual or contact CTC for assistance. Dosimeter output usually includes the TWA (normalized to 8 hours), the LAVG or LEQ representing the average dose for the period monitored, the percent dose, and the maximum or peak reading. Do not neglect to perform the post-use calibration check on each instrument.

8.3 Follow-Up Monitoring

If noise levels documented by sound level meter or dosimetry on the first day indicate that additional sampling is required, you will need to return to conduct follow-up monitoring. The additional monitoring could be necessary to confirm that workers are adequately protected or that an overexposure exists, or you might need to monitor another operation not being performed on the first day. Since the follow-up monitoring will focus on noise dosimetry, prepare to arrive in time to start monitoring with calibrated equipment just as the shift begins. The goal is to sample for a full 8 hours (or 8 hours plus the lunch break period if the break is not included in the dosimetry.

9. INFORMATION TO BE REPORTED

The report of noise exposure measurements carried out in accordance with this International Standard shall provide the following information:

a) general information:

1) name of the client (company, department, etc.) of the investigation,

2) identification of the worker(s) or group(s) of workers (such as name or worker number) whose exposure has been determined,

3) name of the person(s) and company or institution who carried out measurements and calculations,

4) purpose of the determination,

5) reference to this International Standard and the strategy that has been applied;

b) work analysis:

1) description of the work activities investigated,

2) size and composition of homogeneous noise exposure groups, where relevant,

3) description of the day(s) investigated, including the tasks comprising the nominal day when the task based measurements have been made,

4) measurement strategy/strategies employed, together with a reference to the statistical approach used;

c) instrumentation:

1) identification and class of instrumentation used (manufacturer, model, serial number),

2) configuration of the system, e.g. windscreen, extension cable, etc.,

3) calibration traceability (date and result of the most recent verification of the components of the measuring system),

4) documentation of calibration checks performed before and after each measurement;

d) measurements:

1) identification of worker(s) whose noise exposure was measured,

2) date and time of measurements,

3) instrumentation used for each measurement (if various instruments are used),

4) description of work undertaken by the worker during the course of the measurements, including duration of work activity and, if relevant, duration of cyclic events contained within the work activity,

5) report of any deviations from the normal work conditions or normal work behaviour during the course of the measurements,

6) production indicators related to the work being undertaken, where relevant,

7) description of the sources of noise contributing to the noise exposure,

8) description of any irrelevant sounds included in or deleted from the measured results,

9) description of any events observed which may have influenced the measurements (e.g. airflows, impacts on the microphone, impulsive noise),

10) relevant information on meteorological conditions (e.g. wind, rain, temperature),

11) position and orientation of microphone(s),

12) number of measurements at each position,

13) duration of each measurement,

14) duration of each task in the nominal day, and the associated uncertainty, when using the task-based approach,

15) results of each measurement, to include at least the $L_{p,A,eqT}$ and, optionally, the highest $L_{p,Cpeak}$ values;

10. Noise Control

Real effects of occupational noise exposures include the following:

- Temporary and permanent losses in hearing sensitivity.
- Physical and psychological disorders.
- Interference with speech communications or the reception of other wanted sounds.
- Disruption of job performance.

10.1 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 neighboring community.

Noise controls are the first line of defense against excessive noise exposure. The use of these controls should aim to reduce the hazardous exposure to the point where the risk to hearing is eliminated or minimized. With the reduction of even a few decibels, the hazard to hearing is

reduced, communication is improved, and noise-related annoyance is reduced.

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 specification they shall be referred to as "Threshold limit values". They are specified in Section 13.

TLVs refer to sound pressure levels and durations of exposure that represent conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse effects on their ability to hear and understand normal speech. It should be recognized that the application of the TLVs for noise will not protect all workers from the adverse effects of noise exposure.

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

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 given in Clause 13.2.1 shall not be exceeded.

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

10.2 Community Noise

Community noise problems are solved through the elimination or preventation of annoyance to neighbors and/or reduction of noise levels to within the Standard limits.

11. NOISE CONTROL AND HEALTH PROTECTION

Noise control can be implemented by the use of noise standards. These standards can be met by noise control at, source, control of sound transmission, physical separation of noise source and people and other elements as follows:

11.1 Engineering Noise Control Methods

11.1.1 Noise control at source

The most efficient action against excessive noise is the reduction of the noise at source. In industry, noise control technology is available for solving many typical noise problems arising from the use of machinery.

Usually the most effective approach is to redesign or replace noisy equipment. If this is not possible, significant reductions in noise levels can be achieved by structural and mechanical modifications, or the use of mufflers, vibration isolators, and noise protection enclosures.

11.1.2 Control of sound transmission

A further reduction in noise can be obtained by increasing the distance between people and the noise source. This can be achieved in the community by planning the location of transport facilities and, in industry, by the careful selection of work sites. Sound transmission can also be controlled by the use of partitions or barriers, e.g., around particularly noisy or disturbing machinery. Reverberant noise levels can be reduced by sound-absorbing materials.

11.2 Administrative Noise Control

Administrative controls, defined as “management involvement, training of workers, and changes in the work schedule or operations that reduce noise exposure,” may also effectively reduce noise exposure for workers.

11.2.1 Education of workers

It is vitally important that persons who are exposed to potentially hazardous noise levels should be educated in: (a) the possible consequences of excessive noise exposure; (b) the means of

protection; and (c) proper use of these means (e.g., ear-muffs).

11.2.2 Hearing conservation program (HCP)

Long term exposures to high noise levels can result in permanent hearing loss.

OSHA's hearing conservation program is designed to protect workers with significant occupational noise exposures from hearing impairment even if they are subject to such noise exposures over their entire working life times. Basic elements of a hearing conservation program (e.g., monitoring, training, noise exposure reduction measures, audiometric evaluation).

11.2.3 Reduction in Length of Exposure

A reduction in the length of exposure can be used in industry to supplement the previous measures, if necessary. This may be accomplished by job rotation or by restricting the operation of the noise source.

11.3 Hearing protection Devices

Are considered the last option for controlling noise exposures. HPDs are generally used during the time it takes to implement engineering or administrative controls, or when such controls are not feasible. The best hearing protector, when fitted correctly, is one that is accepted by the worker and worn properly.

11.4 Ear Protection

If it is absolutely impossible to reduce noise to a harmless level then some form of ear protection, i.e., ear-plugs, earmuffs, and/or helmets, should be used. They should also be used during infrequent exposures that may not be part of a worker's normal routine (see IPS-M-SF-325).

12. GUIDELINES FOR NOISE CONTROL ENGINEER

For major projects in the design and engineering phase and the procurement phase, the following documents should be submitted to the noise control engineer as they become available.

a) Project specification.

b) Ste lay-out drawing, showing equipment, buildings and traffic ways.

c) Plan of local area.

d) Basis of plant design.

e) Process flow diagram.

f) Equipment list.

g) Process description, indicating all modes of operation of the plant.

h) Equipment data requisitions for all relevant noise sources, amongst others:

- Air-cooler fans;
- 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);

-Mobile noise sources, such as lorries, cranes or loading equipment.

i) Data on the acoustic properties of buildings (in special cases only).

j) Piping arrangement data.

k) Piping and instrumentation diagram.

13. GENERAL NOISE LIMITS

13.1 Local Regulations

13.1.1 In-plant noise

It shall be investigated whether any national regulations exist with respect to noise in the plant, for example for hearing conservation, speech and work interference, accommodation, etc. Under no circumstances in this standard, noise limit values shall not be exceeded of standard value in Iran - Occupational & Environmental Health Center, Ministry of Health & Medical Education and Iran-Department Of the Environment (DOE).

For locations where national standards are more stringent than this Standard, the applicable more stringent limits shall be stated in the project specification, or any other document defining the scope of the project.

13.1.2 Environmental noise

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

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 weekends. 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.

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.

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 EEMUA 140 (using either minimal or significant screening curves) or in accordance with a national standard agreed by the Company.

(Refer to Iran - Occupational & Environmental Health Center, Ministry of Health & Medical Education).

13.2 Hearing Conservation

Hearing Conservation Program are design to prevent noise induced hearing loss . whenever employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 decibels measured on the A scale (slow response) or, equivalently, a dose of fifty percent." This 8-hour time-weighted average is known as an exposure action value.

13.2.1 Program requirements

The OSHA Manual contains a series of program requirements.

- **Engineering Controls:** Requires that "feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels personal protective equipment shall be provided and used to reduce sound levels"
- **Monitoring:** Requires that monitoring be conducted when "any employee's exposure may equal or exceed an 8-hour time-weighted average of 85 decibels.
- **Testing:** Requires an "audiometric testing program" for "all employees whose exposures equal or exceed an 8-hour time-weighted average of 85 decibels".
- **Hearing Protectors:** States that "employers shall make hearing protectors available to all employees exposed to an 8-hour time-weighted average of 85 decibels or greater at no cost to the employees"
- **Training:** "training program" for "all employees who are exposed to noise at or above an 8-hour time-weighted average of 85 decibels" and mandates certain aspects of the training that must be included. This includes the effects of noise on hearing; purpose, advantages, disadvantages, and attenuation of different types of hearing protectors; purpose audiometric testing.
- **Record Keeping:** States that employers "shall maintain an accurate record of all employee exposure measurements"

13.3 Work Area Noise

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

As a general guideline, the work area is too noisy if a worker cannot make himself understood without raising his or her voice while talking to a co-worker 3 feet away.

13.3.1 Absolute noise limit

The sound pressure level anywhere in the work area shall not exceed 115 dB(A) in less than 15 min in any situation, including emergencies such as blowing of safety/relief valves. (OSHA MANUAL CONTROL NOISE)

13.3.2 Work area noise limit

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

13.3.3 Restricted area/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 acoustic enclosures around such equipment are restricted areas.

Written permission shall be obtained from the Company's authorities to designate an area as a restricted area. The 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).

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 Appendix A.

13.4 Speech and Work Interference

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

TABLE 1- ALLOWABLE NOISE LEVELS INSIDE AN ONSHORE OR OFFSHORE PRODUCTION OR PROCESS PLANT

(GS-EP-ENV-500A "TOTAL GENERAL SPECIFICATION ENVIRONMENT (Noise abatement in production units)")

Location	Permissible noise level (dBA)	
	Offshore	Onshore
Inside buildings:		
• Executive offices, large conference rooms	45	35
• Infirmary	40	40
• Meeting room, cinema, TV rooms	45	45
• Cabins	45	-
• Telecommunication room	45	-
• Restaurant	55	55
• Miscellaneous offices, laboratories	55	50
• Control rooms, typing offices	55	55
• Sanitary facilities, changing rooms	60	60
• Kitchens	60	-
• Shops, warehouses	70	65
• Personnel shelters	70	70
• Shops housing machinery, engine room	75	75
Inside industrial units (less than 15 m from a working station or from regular maintenance area)	85	85

Note: (-) Not specified corresponding facilities are not part of the industrial units, national regulations shall be applied, if any.

13.5 Accommodation

The sound pressure level shall not exceed 45 dB(A) inside personnel accommodation such as bedrooms, private cabins, etc.

13.6 Additional Restrictions for Narrow-Band or Impulsive Noise

Further restrictions shall apply if the noise contains narrow-band or impulsive components as defined in EEMUA 140 and this shall be taken into account when specifying equipment noise limits, see Clause 14.2.4.

For environmental noise, any narrow-band 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 Company's advice shall be obtained.

14. EQUIPMENT NOISE LIMITS

14.1 General

Equipment noise limits shall be derived using the area noise limits and the total available plant sound power level obtained from Clause 11 or any other limits that may be stated in the project specification.

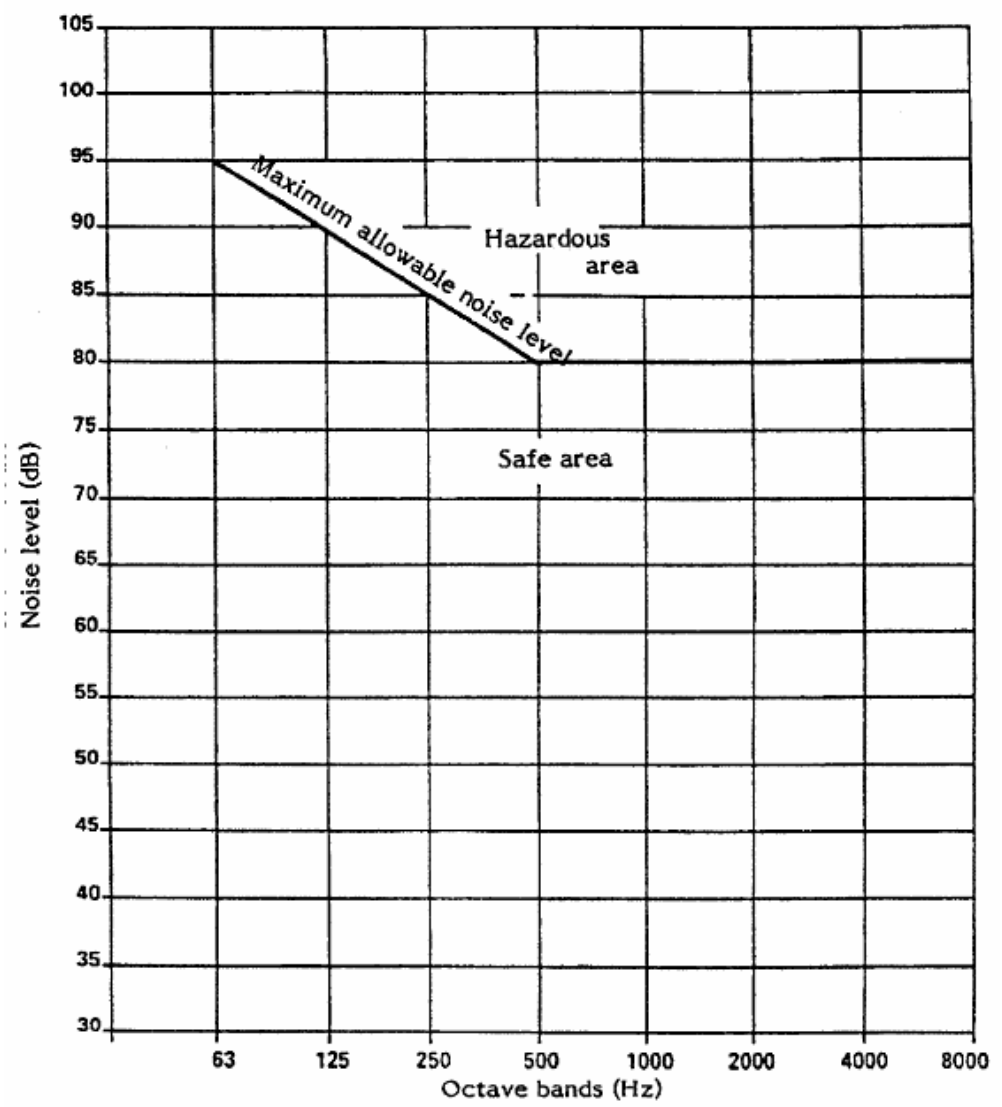
14.2 Maximum Sound Pressure Levels for General Equipment

For equipment where no other limit than the work area limit of 13.3.2 is applicable, equipment sound pressure limits as given in 14.2.1 to 14.2.4 shall apply.

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

Equipment sound pressure limits shall not be exceeded anywhere at a distance of 1m 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.(Fig.1)



ALLOWABLE NOISE LEVEL WITHIN A WORKING AREA

(GS-EP-ENV-500A "TOTAL GENERAL SPECIFICATION ENVIRONMENT

(Noise abatement in production units)")

Fig. 1

14.2.1 Equipment emitting continuous noise

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

If equipment consists of components, e.g. a driver and a driven part, the above limit applied to each component separately will not ensure that the assembled equipment can give the work area limit. For such equipment more stringent limits shall be specified on data/requisition sheets for the separate components. The permissible noise limit 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 are located in a reverberant area. The equipment noise limit shall be based on calculations.

14.2.2 Equipment emitting intermittent or fluctuating noise

Where the equipment emits an intermittent or fluctuating noise (e.g. depressuring, boiler blowdown, sump pump), the equivalent continuous sound level, L_{eq}, over the most noisy consecutive 8-hour period shall not exceed the equipment limits specified in 14.2.1. 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 as follows, provided that no significant noise (i.e. above 75 dB(A)) is emitted for the remaining time in the 8-hour period.

TABLE 2 - T.L.V. (THRESHOLD LIMIT VALUE)

EXPOSURE LIMIT WITH EQUIPMENT ACTUALLY OPERATING	MAXIMUM SOUND PRESSURE LEVEL WITH EQUIPMENT OPERATING
8 hours	85 dB(A)
4 hours	88 dB(A)
2 hours	91 dB(A)
1 hour	94 dB(A)

Where the equipment emits noise fluctuating in a more complicated manner, the equivalent continuous sound level shall be calculated according to the method given in EEMUA 140, Paragraph 3.1.6.

14.2.3 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 14.2.1 and 14.2.2. 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(×) dB(A) for point sources (e.g. vent openings)

10 * log(×) dB(A) for line sources (e.g. piping)

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

14.2.4 Additional restrictions for narrow-band or impulsive noise

The American Conference of Governmental Industrial Hygienists (ACGIH) has recommended that no exposure in excess of a C-weighted peak sound pressure level of 140 dB should be permitted No exposure to continuous, intermittent, or impact noise in excess of a peak C-weighted level of 140 dB.

According to standard IEC 60804 all exposure time to maximum noise limit shall meet the following table, that means maximum limits of noise has time restriction that personal shall be consider.

TABLE 3 - ALLOWABLE EXPOSURE DURATIONS[A] (PER IEC 60804)

Duration per Day	Sound Level, dB(A)[B]
Hours	
24	80
16	82
8	85
4	88
2	91
1	94
Minutes	
30	97
15	100
7.50*	103
3.75*	106
1.88*	109
0.94*	112
Seconds*	
28.12	115
14.06	118
7.03	121
3.52	124
1.76	127
0.88	130
0.44	133
0.22	136
0.11	139

A No exposure to continuous, intermittent, or impact noise in excess of a peak C-weighted level of 140 dB.

B Sound level in decibels are measured on a sound level meter, conforming as a minimum to the requirements of the American National Standard Specification for Sound Level Meters, S1.4 (1983) Type S2A, and set to use the A-weighted network with a slow meter response.

***** Limited by the noise source, not by administrative control. It is also recommended that a dosimeter or integrated sound level meter be used for sounds above 120 dB.

14.3 Maximum Sound Pressure Levels for Specific Equipment

14.3.1 Valves for control and depressuring

For each control valve and its associated pipe work the requirements of 14.2.1 to 14.2.4 apply. This also holds for lowrate 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.

14.3.2 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 in any work area.

The party which sizes safety/relief and emergency depressurizing valves shall also be responsible for the calculation of their noise levels, according to a method to be approved by the Company. 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 considered as follows:

a) 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, 1 m away from the valve and/or piping shall be calculated using the following equations:

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

and

Lp = 115 + 10 * log(×) dB(A) for line sources (e.g. pipeline)

where (×) is the shortest distance in meters between the source and the nearest work area;

b) 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.

c) fitted with silencers or acoustic insulation; proposals shall be submitted to the Company's authorities for approval.

14.3.3 Piping

Noise emitting from piping is of major importance in plant noise control and shall be subject to the same restrictions as Equipment General, see 14.2. 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 Shell Standard Code No. DEP 31.46.00.31-Gen. The use of in-line silencers in the suction line of compressors requires approval from the Company's relevant authorities.

14.3.4 Vents

All vents incorporated in the design to meet operational requirements shall be subject to the same restrictions as Equipment-General, see 14.2. Vents intended for emergency use only shall be subject to the same requirements as safety/relief valves, see 14.3.2; 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.

14.3.5 Flares

Elevated flares shall not exceed the work area limit (13.3.2) at the perimeter of the sterile area (of at least 60 m from the flare base) when operating at flow rates up to 15% of maximum flaring capacity.

Ground flares shall not exceed the work area limit outside the windscreen or louver wall.

If the plant to which the flare is allocated is subject to environmental noise requirements, the application of low noise flares shall be evaluated even if the flare is to be used for emergency conditions only.

Note:

Flares used operationally shall be taken into account when assigning sound power levels, see 14.4.

14.4 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, see 14.2.2, does not apply).

14.5 Coherence of Noise Limits

The equipment noise limits of 14.2 and 14.3 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 Clause 14.4 or are calculated from equipment sound pressure levels, assuming that the requirements of 14.2 and 14.3 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 EEMUA 140 or in accordance with a national standard agreed by the Company. 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 14.4.

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.

14.6 Data/Requisition Sheets

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 14.2, 14.3 and 14.4. If the components of a train will be provided by different suppliers, separate equipment noise limitation sheets shall be prepared.

The model sheet of Shell data/requisition (DEP 31.10.00.94-General) See Appendix D, entitled "Equipment Noise Limitation" 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 maximum 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 should be based on Shell Standard Code Nos.: DEP 31.10.00.95- Gen., and DEP 31.10.00.96-Gen.

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.

14.7 Equipment Selection

It shall be ensured that suppliers have provided in their tenders all the information required in accordance with 14.6.

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 capitalized 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 14.2.2 and 14.4. 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 Company shall be consulted.

15. SILENCING EQUIPMENT

Silencers shall comply with EEMUA 161 and the appropriate codes and standards for mechanical design. 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).

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.

Silencers and/or acoustic enclosures may be included in the tenders for noisy process equipment, see 11.6. When the Supplier has been selected, details of such silencing equipment shall be agreed upon between the Supplier and the Company. The Company may choose to order silencing equipment separately from the process equipment.

Noise emission from certain silencing equipment (e.g. silencers on vent stacks, acoustic insulation on pipes) is not always the responsibility of any particular equipment supplied. 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 application of noise control measures shall not be postponed until actual noise levels have been obtained after start-up, unless specifically agreed with the Company.

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.

16. PROJECT NOISE DOCUMENTS

16.1 Information for the Noise Control Authorities

For the provision of the required information within the Company's office, a list of documents that should be made available is given in Appendix B.

16.2 Detailed Engineering Phase Reports

Where environmental noise limits or a plant sound power limit are specified, a 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 Company for approval before data/requisition sheets are released for tendering.

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

In any event a report shall be prepared for approval by the Company 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 Company that the acoustic design of the plant will meet the requirements.

The model format given in Appendix C can be used for the report.

In both reports (16.2 above) due attention shall be given to the prediction of piping noise.

Note:

16.2 refers to action item Nos. A.15 and A.16 in the Table 4 Clause 17.

16.3 Noise Test Runs

Noise test run shall be implemented for specified equipment at the supplier's workshop and confirm by company 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 Company.

16.4 Acceptance Test

Responsibility of the contractor for to meet the specified noise limits will not end until measurement and evaluation by an independent acoustic consultant have shown that limits are not exceeded.

contracting out to this independent consultant shall form part of the contractor's scope of work.

The test includes 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 company.

16.5 Remedial Action

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 Company's approval.

17. SUMMARY OF ACTION ITEMS AND ALLOCATION OF RESPONSIBILITY

The Action Items defined in this Standard are summarized below:

Note:

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

TABLE 4- SUMMARY OF ACTION ITEMS AND ALLOCATION OF RESPONSIBILITY

ACTION ITEM No.	TASK DESCRIPTION	REF. SECTION	RESPONSIBLE PARTY	
			COMPANY	CONTRACTOR
A1	Investigate local regulations for in-plant noise	13.1	× [1)]	
A2	State local in-plant limits in project specification if more stringent	13.1.1	× [1)]	
A3	Investigate local regulations on environmental noise and discuss with authorities	13.1.2	× [1)]	
A4	Consider environmental noise aspect (where no regulations exist)	13.1.2	×	
A5	Incorporate sound power level in project specification	13.1.2	× [1)]	
A6	Obtain Company's permission for restricted areas	13.1.6		×
A7	Erect earmuff signs	14.1.6		×
A8	Specify equipment noise limits, including additional restrictions	14 14.2.4		×
A9	Determine pipe noise, assess insulation and silencer requirements	14.3.3		×
A10	Determine need for vent silencers	14.3.4		×
A11	Evaluate need for low-noise flare	14.3.5		×
A12	Obtain noise limitation sheet with guaranteed power/pressure level from supplier, including silencers/enclosures	14.7		×
A13	Select least noisy equipment	14.7	×	×
A14	Agree on details of silencers/enclosures	15	×	×
A15	Submit report on allocation of sound power level	16.2		×
A16	Submit noise control report	16.2		×
A17	Decide which equipment shall have a "noise" test run	16.3		×
A18	Contract independent acoustic consultant for survey	16.4		×
A19	Take corrective action where required	16.5		×

[1)] On request this information may be commented.

18. ACOUSTIC DESIGN

This section deals with acoustic aspect and is intended for noise control engineer, responsible for the acoustic designs of the plant.

18.1 Acoustical Insulation for Pipes, Valves and Flanges

The noise radiated by the wall of the pipe is usually generated by equipment connected to the pipe, such as compressor, pumps, valves, or ejectors. These noise sources may cause long section of pipe to radiate noise because noise will travel in the pipe with little reduction. The noise radiation may be reduced by acoustic insulation.

Three classes of acoustic insulation are considered, denoted as A, B and C. Calculations shall be

carried out in accordance with DEP-31-46-00-31 GEN (Shell-Design and Engineering Practice).

18.2 General Requirements for Vent Silencers

These requirements shall apply to vent silencers for steam, hydrocarbon vapors and other gases. It does not apply to vents used for particulate or polymerizing materials where special designs may be required to prevent clogging.

The silencer shall be constructed of materials compatible with the fluid being vented and all steel surfaces shall have adequate weather protection. The manufacturer shall provide details of all materials used and of the weather protection applied.

18.3 Acoustical Barrier and Enclosures

The most fundamental approach to noise reduction is to a wall between the sound source and receiver. The wall can take the form of:

1) An enclosure of the noise source (machinery),

2) the enclosure of the receiver (employee),

3) a barrier between the two.

18.3.1 Machine enclosures

The isolation of noise producing machinery by means of acoustical enclosures provides the greatest noise reduction. Noise reductions of 20-30 dBA are common with machine enclosures, and with special isolation treatment, noise reductions above 50 dBA can be achieved. Following factors are the main aspects of engineering enclosure design which should be considered:

1) Design guidelines for acoustical effectiveness,

2) consideration of machine operational requirements,

3) insuring production compatibility,

4) maintaining employee safety and welfare.

18.3.2 Employee enclosure design

In designing employee enclosure, the following important factors should be considered:

1) Location,

2) size,

3) visibility,

4) proximity.

18.3.3 Enclosure types

Three design approaches should be considered for machine enclosures, depending upon machine operational requirements and the extent of noise reduction required. These are:

1) Localized enclosure,

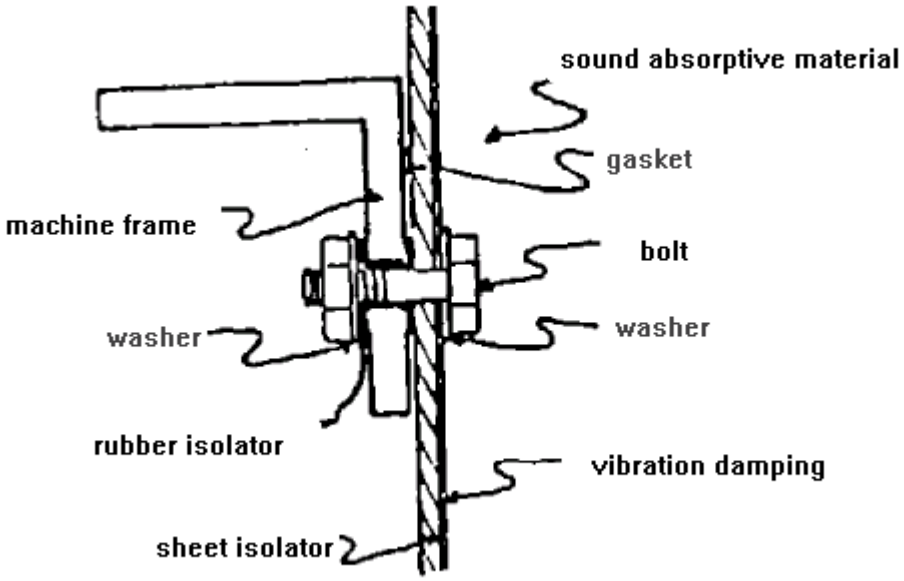
2) partial enclosure,

3) complete enclosure.

18.3.3.1 Localized enclosures

In many machines, high noise levels are associated with only localized machine elements. Where isolated noise sources are identified on a machine, it is more feasible to enclose only a small area, rather than the entire machine.

As a general guideline, acoustical enclosure panels should never be attached directly to machine elements which have high vibration levels. Where panels are machine mounted, vibration isolation techniques should be employed as shown in Fig. 1. To insure minimum sound radiation due to panel vibration, damping treatment shall also be applied to machine-mounted enclosures.



TECHNIQUE FOR VIBRATION ISOLATION

OF ENCLOSURE PANEL FROM MACHINE FRAME

Fig. 2

18.3.3.2 Partial enclosures

A machine enclosure which has at least one open side or a very large opening should be considered as a partial enclosure.

A partial machine enclosure will provide virtually no noise reduction for an employee working directly at the machine unless it:

a) Interrupts the line-of-sight path between the machine and the operator's hearing zone, or

b) Absorbs sound which is reflected from the machine to the operator by an adjacent wall or ceiling.

18.3.4 Opening in an enclosure

For effectiveness of an acoustical enclosure, openings should be prevented or minimized. Where openings are necessary (such as for ventilation), then such as for ventilation, silencers or "sound traps" can be installed.

18.3.5 Vibration isolation

Vibration is transmitted through the floor to enclosures. The large surface area enclosure panels will become a noise source. This problem can be avoided by the mounting of the machine on vibration isolators. Damping is another means of noise reduction .It dissipates energy associated with vibration, often using a coating applied to the surfaces of the noise source.

18.3.6 Non-acoustical requirements

In addition to the design of an acoustical enclosure to meet noise reduction objectives, the following additional design requirements should be considered:

1) The enclosure shall be properly ventilated to prevent heat build-up.

2) Operational accessibility shall be provided to meet production requirements.

3) Localized and complete accessibility shall be provided for maintenance.

4) If audible signals are utilized to assess machine performance alternate detection systems shall be installed.

5) Supply systems must be provided to the enclosed machinery to meet energy and process requirements.

6) In-feed and out-feed openings shall be designed which provide noise attenuation consistent with the total enclosure system but which will not obstruct material flow.

7) An internal lighting system shall be installed if the enclosure shadows exterior lighting excessively.

8) Protection shall be provided against employee and vehicular (lift trucks, etc.) damage.

9) Protection shall be provided against operational abuse: moisture, water spray, oil, grease, dirt, erosion by fluid flow, crossive air, etc.

10) Flame-spread and fire-endurance limits shall be specified for all materials. Firebreak requirements shall be employed on all ducts, pipe runs, and shafts. Smoke or temperature alarms may also be considered for enclosures.

19. VIBRATION CONTROL

Acoustical radiation from a vibrating surface is one of the two methods by which noise will radiate. In this Part the radiation of sound from vibration, and the control of vibrational energy through isolation and damping will be discussed.

19.1 Vibration Radiation

Sound is produced by the movement of a vibrating structure which, in turn, sets in to motion the air molecules which are coupled to it.

For any mechanical system vibration and noise must be considered as:

a) vibration energy; and;

b) system response.

System response is dependent upon the following two facts:

1) Vibration response:

a) mass;

b) stiffness;

c) damping.

2) Acoustic radiation efficiency:

a) surface area;

b) critical coincidence frequency.

19.2 Vibration Isolation

To control vibrationally induced noise is to isolate the driving force or the machinery from the adjacent structure. Machinery which has a driving force frequency in the 10-60 Hz range and is rigidly mounted to a building foundation will create a very annoying environment for plant and office employees. Vibration isolators will generally reduce this annoyance.

Vibration isolators can be the spring type, rubber mount, or any other type as illustrated in Fig. 3. The natural frequency of the isolator should be 3 to 10 times lower than the driving force frequency of the machinery.

Referring to Fig. 3, an isolator whose natural frequency is equal to the driving force frequency will act as an amplifier of noise. The natural frequency of an isolator system is calculated as:

$$fn = 3.13^{q}\,\bar{\frac{1}{d}}$$

Where:

fn = Natural frequency of isolator, Hz

d = Isolator's static deflection (units), or,

$$fn = 188^{q}\,\bar{\frac{1}{d}}$$

Where:

fn is in cycles per minute

Transmissibility is defined as:

$$Tr = \frac{1}{\left(fd = f\right)^2 n \quad 1} \quad !$$

Where:

Tr = Transmissibility

fd = Driving force frequency

A second requirement of an isolator specification is the damping factor of the isolator, as indicated in Fig 3. Above the "resonance" region of the curve the most efficient vibration isolator is provided by isolators with a low damping factor

A third specification is the isolator stiffness. The isolator stiffness is defined as:

$$K = \frac{w}{d}$$

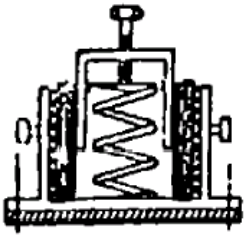
Where:

K = Isolator stiffness, kg/m

w = Weight of machinery, kg

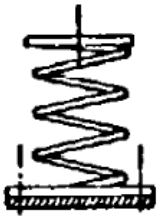
d = Static Deflection, m

In order to calculate the deflection of the isolator, use manufacturer's data. If typical curve for a spring isolator is shown in Fig. 4. The Fig. 3 indicates the various vibration isolation efficiencies. The vibration isolator manufacturer usually assumes a massive, rigid structure, but in reality machinery can be mounted on a lightweight floor. The efficiency of the isolator on a lightweight floor will be much less than it is mounted on a massive, rigid surface. Thus, higher isolation efficiencies must be used for mountings on lightweight floors.

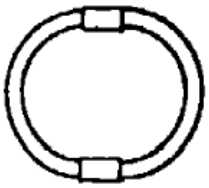


MULTIPLE PART SPRING

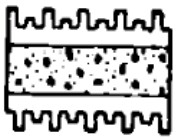
CEILING MOUNT



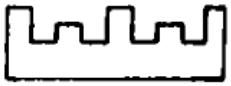
SIMPLE SPRING



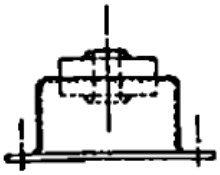
CABLE ISOLATOR



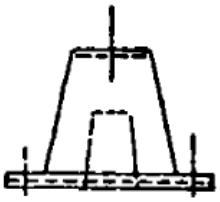
RUBBER PAD



COMPOSITE PAD



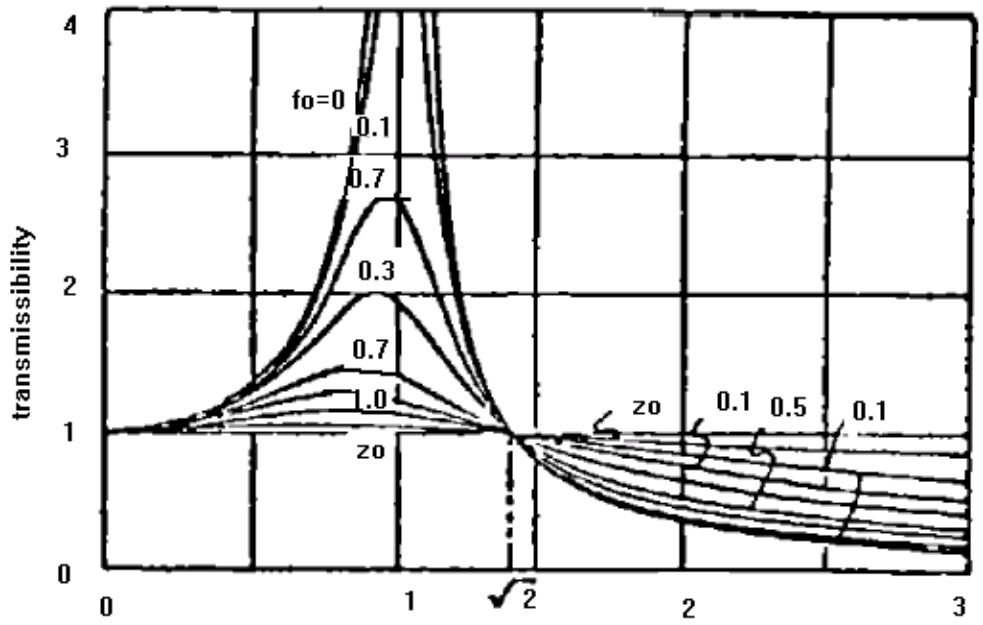
SUSPENDED MOUNT



RUBBER MOUNT

CLASSIFICATION OF VIBRATION ACTUATORS

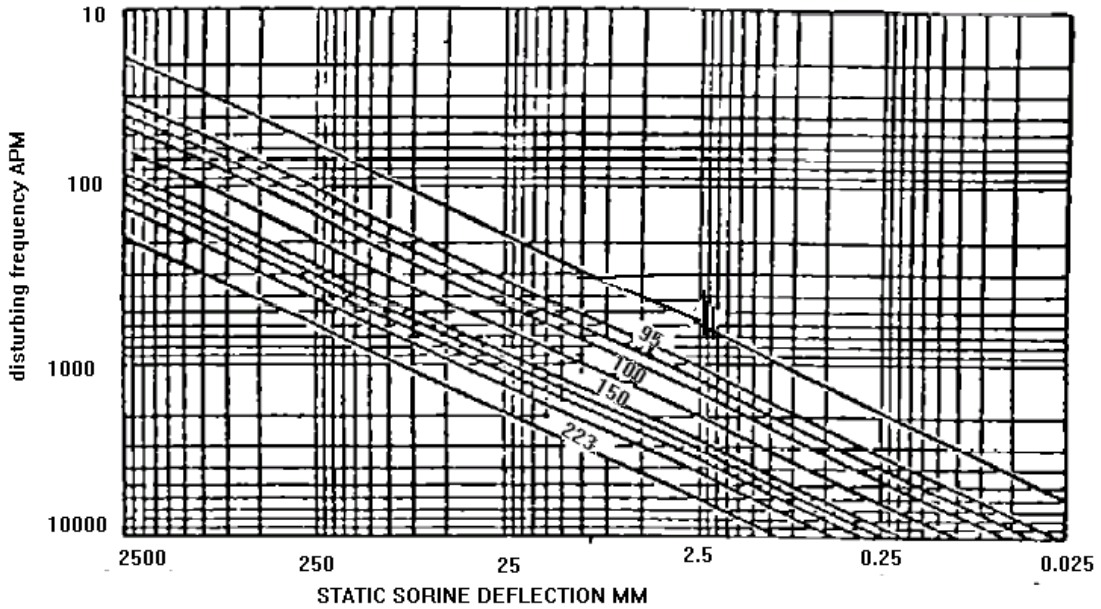
Fig. 3



FORCING FREQUENCY ISOLATOR NATURAL FREQUENCY

TRANSMISSIBILITY FOR VARIOUS DAMPING FACTORS

Fig. 4



STATIC DEFLECTION CURVE FOR A SPRING ISOLATOR

Fig. 5

19.3 General Vibration Considerations

1) Always specify that rotating machinery be statically and dynamically balanced.

2) Design supporting structures to have no natural frequencies within 30 percent of the operating speed of the machinery.

3) Choose equipment which minimizes vibrational problems. (If a compressor must be located in a critical area, a quieter centrifugal type can be used instead of the noisier reciprocating one).

4) Use vibration isolating mounts as required on large fans, transformers, etc. Use flexible connections to isolated pipes and ductwork.

5) Floor slabs should be heavier and stiffer to support machinery that is a potential vibration source.

6) Weight of accelerated parts should be reduced whenever possible.

7) All moving parts should have smooth finishes.

19.4 Vibration Damping

The physical mechanism of most noise problems is acoustical radiation from vibrating structures, it reduces the noise by means of vibration damping. The term "damping" refers to the design property of materials which converts vibrational energy into heat energy.

19.5 General Equipment Considerations

Consider the following items in designing any equipment for noise reduction:

a) Balance equipment to reduce vibration.

b) Reduce weight of accelerated parts where possible.

c) Reduce accelerations and decelerations of machine parts to the minimum, while still performing the required function.

d) Check that all moving parts have smooth finishes.

e) Reduce mechanical noise where possible.

f) Enclose the sound source.

g) Use acoustical absorption materials such as glass fiber to absorb sound.

h) Reduce impact sound by using soft surfaces.

i) Provide vibration isolators and flexible connectors.

j) Reduce air, liquid, or gas turbulence where possible.

k) Cover any holes in enclosures.

When the noise cannot be treated at the source, either external silencers, enclosures, barriers, or path treatment should be provided.

APPENDICES

APPENDIX A
RESTRICTED AREA WARNING SIGN

The colors for the sign, a white symbol on a blue background, shall be in accordance with BS 5499-5.

APPENDIX B

DOCUMENTS TO BE SUBMITTED TO COMPANY'S NOISE CONTROL AUTHORITIES

The following documents shall be made available:

- Basis of design,
- project specification,
- plot plan, area classification,
- 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 authorities if close guidance by the Company is required. The appropriate issue or issues shall be decided by the authorities concerned.

- Equipment summary, project specification.
- Equipment data requisitions for:
  - Heat exchangers (air coolers only),
  - furnaces, reformes, burners,
  - mechanical handling equipment,
  - extruders, ejectors,
  - pumps, compressors, including 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).

TABLE B-1 - MEASURING OF THE NOISE LEVELS OF THE VARIOUS EQUIPMENT ITEMS

Type of equipment	Points of sound pressure measurements
1 - Electric motors	**1 to 4** - Measurements at a distance of 1 m from the item
2 - Compressors and internal combustion engines	
3 - Fans, turboblowers (excluding air coolers and cooling towers)	
4 - Gear reducers	
5 - Air inlets, vents silences	**5** - Measurements to be carried out one meter from orifices, 90° from the air passage axis, on 6 points, 60° apart
6 - Steam generators	**6 to 11** - With fittings and at half the item's weight *
7 - Forced draft heaters and incinerators	
8 - Pumps	
9 - Gas and steam turbines	
10 - Piping, control valves	
11 - Ejectors, condensers	
12 - Natural draft heaters: • Hot plate ignition • Wall ignition	**12a** - Measurements 1 m below the floor of the incinerator and 1.7 m above it, with a 2 m spacing. If the orifices of the overpressure chamber are not below the floor, measurements should be 1 m from these openings, 2 m apart **12b** - Measurements 1 m from the burner (one point on the centerline and two points at 90°) measurements 1 m from the openings in the overpressure chamber, 2 m apart
13 - Miscellaneous	**13** - Not specified
14 - Intermittent operation vents	**14** - Measurements 1 m from openings, 90° from the air passage axis, on six points at 60°
15 - Air coolers (for each fan)	**15** - Measurements to be carried out on an hemisphere centered on the center of the opening and located above, a cylinder also centered on the opening and extending to floor, both with a 10 m radius. Nine measuring points on the hemisphere (with one according to the fan centerline) and four on the cylinder
16 - Cooling towers (each cell, plus the water noise)	**16** - Measurements to be carried out on the same areas, 1 m from the fan (four points) and at air inlets (two points on each side)
17 - Flare at grade	**17** – Measurements to be made in two points at right angle, located 100 m from the flare and 12 m above grade
18 - Above grade flare	**18** – Measurements to be made in two points at right angle located 300 m from the flare and at ground level

APPENDIX C

MODEL FORMAT FOR THE NOISE CONTROL REPORT

The report specified in 16.2 and nominated as Action Item A16 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 have been 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, even in the case that no plant sound power limit is required;
- separate evaluation of plant pipe noise;
-calculations of expected noise levels inside buildings and shelters.

6) Restricted areas.

7) Outstanding items.

APPENDIX D

Data/requisition sheet (cont. sheet) for **EQUIPMENT NOISE LIMITATION**	Contr. Job No. :
	MESC No. :
Type of equipment	Mechanical Power: kW
Supplier / Manufacturer	Speed: r / min
Type no.	Size l x b x h: m

1. GENERAL

This requisition covers the noise limits of the equipment, given below.

2. NOISE LIMITS TO BE MET BY THE EQUIPMENT

The noise generated by the equipment shall not exceed the more stringent of the noise limits given in the table below, for any of the conditions of operation for which the equipment may normally be expected to be used.
Lp is the maximum sound pressure level, in dB re 20 µPa, for the mode of operation indicated at any location at 1 m from the equipment surface or operator position, if specified..
Lw is the maximum sound power level, in dB re 1 pW, for the mode of operation indicated.
If the equipment generates noise with tonal or impulsive components, the limits shall be taken 5 dB(A) more stringent.
Noise levels will be verified according to the following standards: ISO 3740 series, ISO 11200 series or ISO 9614.

3. INFORMATION TO BE SUBMITTED WITH THE TENDER

This noise data sheet shall be returned with the tender and with guaranteed noise data filled in.
Supplier shall state which add-on silencing measures were taken to meet the noise requirements.
Where applicable the completed silencer and/or acoustic enclosure data requisition sheet shall also be returned (see DEP 31.10.00.95-Gen. and DEP 31.10.00.96-Gen.)

Equipment items/locations	a		Sound pressure/power levels guaranteed by supplier in dB (upper tolerance + 0 dB)									b	Remarks
			Un-weighted octave-band levels								Total	Noise limit	
			63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	dB (A)	dB (A)	Silencing measures
		Lp											
		Lw											
		Lp											
		Lw											
		Lp											
		Lw											
		LP											
		Lw											
		Lp											
		Lw											
		Lp											
		Lw											
		Lp											
		Lw											
		Lp											
		Lw											

Purchaser shall indicate:
- In column "b", the A-weighted sound pressure/power limit
- In column "a" using the appropriate number, which of the following applies to the required noise levels:
  1) without acoustic provisions
  2) with acoustic provisions
  3) special low-noise design
  4) suppliers best estimate, not necessarily guaranteed
  5) .....

		Sheet no.	continued on sheet no.
Eng. by:		Equipm. No.	
Principal:		Req. No.	

Data / requisition sheet for
VENT/BLOW-DOWN/AIR-FLOW/IN-LINE SILENCERS

Design book No.: page:
Contr. Job No.:
MESC No.:

1 1. TYPE OF EQUIPMENT TO BE SILENCED: *Blower/compressor/vent/relief valve/control valve.....

2	1. Equipment tag number:		* 6 Power kW } for									
3	* 2. Control valve characteristic C_v or C_g:		* 7 Number of blades } rotating									
4	* 3. Pressure upstream of control valve: bar abs (max.)		* 8 Speed r/min } equipment									
5	* 4. Noise type: continuous/intermittent											
6	5. If intermittent, state max. duration: per consecutive 8-hour period											
7	2. ACOUSTIC CRITERIA*	31.5	63	125	250	500	1k	2k	4k	8k	dB(A)	
8	Octave band centre frequency Hz											
9	* 1.Unsilenced sound pressure level dB re 20 µPa											
10	* 2. Silenced sound pressure level dB re 20 µPa											
11	* 3. Unsilenced sound power level dB re 1 pW											
12	* 4. Silenced sound power level dB re 1 pW											
13	* 5. 'Dynamic insertion loss' dB re 20 µPa											

14 6. Sound pressure level to be based on a distance of meteres from equipment surface (give details); 1 m if not specified otherwise

15	3. PROCESS DETAILS OF SILENCERS	6 SILENCER MECHANICAL DETAILS	
16	* 1. Gas/vapour (give details):	1. Type of silencer required:	
17	2. Flow rate, norm./design/max. / / kg/s	inlet/discharge: vent/blow-down/in-line	
18	3. Inlet pressure: / bar abs (max./design)	2. Inlet flange size/rating:	mm/ANSI*
19	4. Outlet pressure: / bar abs (max./.....)	* 3. Outlet flange size/rating:	mm/ANSI*
20	5. Differential pressure: / bar (max./design)	4. Design pressure	bar ga
21	6. Inlet temperature; max./min.: / °C	* 5. Installed: in the { open/under cover	
22	7. Mol. weight of gas:	{ horizontal/vertical	
23	4. SILENCER MATERIALS SPECIFICATION	* 6. Impervious membrane: yes/no	
24	1. Outer casing material: Certificate type:	* 7. Environment (e.g. climate):	
25	2. Absorptive material:	* 8. Rain cap: yes/no	
26	* 3. Impervious membrane material:	* 9. Drain: yes;size: /no	
27	4. Internal Metallic parts: Certificate type:	10. Wind velocity (design):	km/h
28	5. Corrosion protection - internal:	11. External forces	
29	- external:	* 12. Supporting structure required: yes/no/MP[1)]	
30	5. SILENCER SPECIFICATIONS	13. Replacement of acoustic material required: yes/no	
31	1. Silencer(s) to be constructed in accordance with	* 14. External insulation required: yes/no/MP[1)]	
32	OCMA publication NWG 4	15. Max. allowable weight:	kg
33	2. Noise measurements, calculations, etc., to comply with	16. Space available for silencer x	m
34	OCMA publication NWG 1		
35	* 3. Pressure vessel code:	17. Hydrostatic test pressure:	bar ga
36	4. Details of identification marks:		

37 7. INFORMATION TO BE SUBMITTED WITH THE TENDER
38 1. Guaranteed dynamic insertion loss in octave bands 31.5 to 8 kHz for operating conditions mentioned under 3.
39 2. Drawing(s) showing external dimensions, arrangement of internal fittings, materials of construction, surface treatment, and position
40 and type of drains.
41 3. Absorptive/non-absorptive type: give details.
42 4. Method for replacing acoustic material and whether it can be carried out in situ.
43 5. Method for securing internal fittings (state whether riverted, bolted or welded).
44 6. Sketch of silencer supporting structure, where applicable.
45 7. Guaranteed pressure drop at maximum flow rate.
46 8. Maximum fluid velocity in m/s in absorptive section; if>33m/s supplier to guarantee that acoustic material will not be blown out.
47 9. Position, style and size of identification marks and indication of flow direction.
48 10. Weight of complete unit (silencer and supporting structure).
49
50
51 * Delete as necessary
52 [1)] MP = Manufacturer's proposal

Made by:		Date	EQUIPMENT :	Rev. letter						
				Date						
Checked by:		Date	PLANT :	Sign.						
Appr. by:		Date	CONSIGNEE :	Sheet No. continued on sheet No.						
Eng. by :				Equip. No.						
Principal :				Req. No.						

Data / requisition sheet for
ROTATING EQUIPMENT ACOUSTIC ENCLOSURES

Design book No.: page:
Contr. Job No.:
MESC No.:

1. EQUIPMENT TO BE SILENCED: (specify scope)

2. ACOUSTIC DATA

Octave band centre frequency Hz	31.5	63	125	250	500	1k	2k	4k	8k	dB(A)	Remarks
(a) Noise emission of unsilenced equipment											
* Driver sound power level dB re 1 pW											
* Gear box sound power level dB re 1 pW											
* Driven equipment sound power level dB re 1 pW											
* Complete unit sound power level dB re 1 pW											
* Max. sound pressure at 1 m dB re 20 µPa											
(b) Required acoustic performance of equipment (Noise limits)											
* Complete unit sound power level dB re 1 pW											
* Max. sound pressure at 1 m dB re 20 µPa											
Dynamic insertion loss (dB re 20 µPa)											
Designated measuring positions (give details)											

3. EQUIPMENT DETAILS

	Equipment type	Manufacturer	Model/type	r/min	Power kW	Operating temperature °C	Heat release from equipment kJ/h	Medium handled by equipment
Driver								
Driven								
Gear box								

4. DESIGN OF ACOUSTIC ENCLOSURE: Indicate whether 'close fitting' * 'or large'*

A. Access
1. Observation windows: yes/no
2. Access doors: yes/no
If yes, specify min. head room m, and number required
3. Removable panels: yes/no
4. Minimum clearance between equipment and enclosure m
5. External connections through enclosure (give details)

B. Ventilation/Lighting:
1. Ventilation to be provided by supplier/others*
2. Type of ventilation: forced/induced/natural*
3. No. of enclosure air replacements/h (normally 20/h)
4. Minimum/maximum pressure in enclosure / m bar
5. No of fans required
6. Spare fan required: yes/no
7. Fan failure alarm: yes/no
8. Lighting required: yes/no
9. State area classification for fan motors and lights

C. Instrumentation: List guages/indicators, etc., to be installed on acoustic enclosure: (Provided by supplier/others*)

D. Safety requirements
1. Explosion meter monitor: *yes/no/alarm/trip
(State number of compartments and number required in each compartment)
2. H_2S/toxic gas monitor. *yes/no/alarm/trip: (give details)
3. Fire-fighting system: *yes/no/alarm/trip
(specify type of system required and number of points)

E. Construction
1. Single composite construction - lift-off type: *yes/no
2. Composite enclosure made-up of removable (manually/mechanically) handled panels: *yes/no
3. Acoustic lining with membrane/without membrane
4. To be installed under cover/in the open* Type of climate:
5. Painting/anti-corrosive treatment:
6. Lifting facilities: yes/no (if yes, specify, max. lift required) tonnes

5. SPECIFICATIONS
Noise measuring, calculations, etc., shall be carried out in accordance with DEP 31.10.00.31-Gen.
Acoustinc enclosure shall be constructed in accordance with EEMUA 161

6. INFORMATION TO BE SUBMITTED WITH THE TENDER
1. Sound power/pressure levels and dynamic insertion loss in octave bands 31.5 to 8k
2. Drawings showing overall dimensions and internals.
3. Materials of construction: outer case/absorption packing/other materials.
4. Method of replacing noise absorption material
5. Details of silencers in ventilation system.
6. Weight of acoustic enclosure and weight of heaviest section.
7. Method of sealing panels from noise leakage paths.
8. Method of vibration isolation from equipment and piping.
9. Details of door construction, hinges, panic-action catches, etc.

* Delete as necessary

Made by:		Date	EQUIPMENT :	Rev. letter			
				Date			
Checked by:		Date	PLANT :	Sign.			
Appr. by:		Date	CONSIGNEE :	Sheet No. continued on sheet No.			
Eng. by :				Equip. No.			
Principal :				Req. No.			