NOISE ABATEMENT TECHNICAL NOTE

Duqm
هيئة المنطقة الاقتصادية الخاصة
Special Economic Zone Authority

Environment Regulatory Department

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LIST OF ACRONYMS

BAT	Best Available Technology
BMP	Best Management Practices
BS	British Standard
CEMP	Construction Environmental Management Plan
CRTN	Calculation of Road Traffic Noise
dB	Decibel
DMRB	Design Manual for Road and Bridges
ISO	International Organization for Standardization
S-EIA	Strategic Environmental Impact Assessment
MD	Ministerial Decision
MECA	Ministry of Environment and Climate Affairs
NATN	Noise Abatement Technical Note
NSR	Noise Sensitive Receptor
OEMP	Operational Environmental Management Plan
PPGN	Pollution Prevention Guidance Notes
SEZ	Special Economic Zone
SEZAD	Special Economic Zone Authority at Duqm
SPL	Sound Power Level

1 INTRODUCTION

1.1 Objectives

This Noise Abatement Technical Note (NATN) has been developed as part of a set of technical notes for the environmental requirements of the Special Economic Zone (SEZ) at Duqm. The NATN includes a description of the relevant national and international noise related standards, methodologies for undertaking noise monitoring and assessments, and the general and industry-specific pollution prevention guidelines.

The NATN is intended for applicants whose proposed industries may adversely impact noise levels during construction, operation and decommissioning phases of the Project. The purpose of this document is to set forth a comprehensive framework that will ensure compliance with the required noise standards and minimal impact to sensitive receptors. Applications that give rise to concerns regarding noise levels will be assessed and reviewed by the Special Economic Zone Authority at Duqm (SEZAD) Environmental Regulatory Department with specific requirements detailed on a case by case basis.

1.2 Project Information

The SEZ at Duqm is an integrated economic development area that covers 2,000 square kilometres. The SEZ is located in the Wilayat of Duqm on the south-east coast of Oman. The coastline of Wilayat Duqm is approximately 170 km in length, with the northern boundary lying between Nafun and Sidera, and the southern boundary being approximately 120 km south of Ra‟s al Madrakah. Ghubbat Al Hashish and Barr Al Hikman lie to the north of the Al Wusta Region and Ra‟s al Madrakah in the south.

The SEZ is composed of zones that include the Duqm port, the ship dry dock, the oil refinery, the regional airport, the residential, commercial and tourism area, the logistic services area, fisheries area and the industrial.

This Noise Abatement Technical Note applies to all industries in the SEZ area. Figure 1-1 specifies the boundaries of the SEZ as per RD 5/2016.

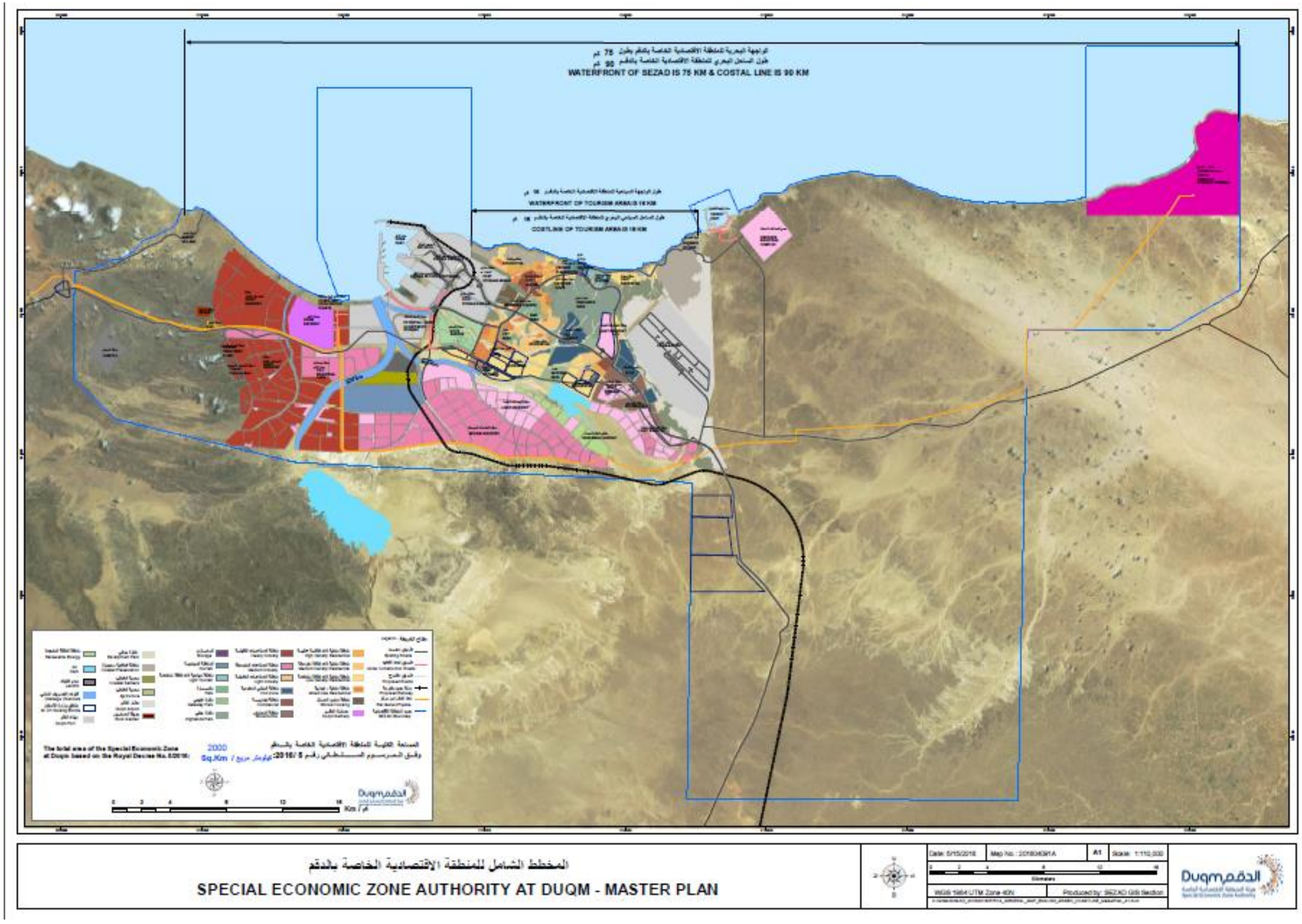

Figure 1-1: SEZD Area

2 APPLICABLE STANDARDS

This Section details the applicable noise standards. At all times local requirements will override international requirements. The international standards are to be complied with, only in the absence of local standards.

In accordance with RD 79/2013, the Special Economic Zone Authority at Duqm (SEZAD) Environmental Regulatory Department shall have the functions of the Ministry of Environment and Climate Affairs (MECA) in relation to issuing environmental permits for projects and implementing environmental regulations within the SEZ.

2.1 National Noise Quality Standards

Table 2-1 depicts the relevant legislations and guidance applicable to the evaluation of noise impacts associated with the Project. This Section discusses Noise Quality Standards and the standards applicable in Oman.

*** It shall be noted that within SEZ, SEZAD will have the authority of concerned Ministries mentioned in the below regulations.**

Table 2-1: National Legislations and Guidelines

Laws Associated With Noise Control	Description
RD 114/2001	Law for the conservation of the environment and prevention of pollution.
MD 79/94	Regulation for noise pollution control in public environment
MD 80/94	Regulation for noise pollution control in working environment

2.1.1 Royal Decree 114/2001 - Conservation of the Environment and Prevention of Pollution

The Law on Environmental Protection and Pollution Control is the main law related to the environment in Oman and is the fundamental text upon which the Ministry for the Environment and Climate Affairs (MECA) operates.

The Law aims at preventing any type of pollution “in such quantities or concentrations that may cause damage to the characteristics of the environment, human or wildlife health or natural heritage”.

2.1.2 Ministerial Decision 79/94 – Noise Pollution Control in Public Environment

The relevant national legislation applicable to the evaluation of noise quality impacts associated with the SEZ is **Ministerial Decree (MD) 79/1994** on ***Noise Pollution Control in Public Environment.*** The applicant is required to refer to the complete official copy of this Decree in-order to identify all applicable requirements (MECA, 2013).

Considering the activities that will be undertaken in SEZ, the four (4) external noise sources to be considered in this NATN are ‘Industrial

Plants and Public Works', 'Road Traffic', 'Airports' and 'Airborne Operations of Commercial and General Aviation'.

- 'Industrial Plants and Public Works' include factories, commercial facilities, public works, power plants and installation for extraction, pumping and refining of water, oil, gas, sewage treatment etc.
- 'Road Traffic', include motorized traffic in cities, on motorways and local ways etc. It should be noted that "noise from road traffic" in this NATN, refers to noise generated from construction vehicles and the additional traffic that a particular industry will add to the existing traffic situation.
- 'Airports' include ground operations on airports dealing with commercial and general aviation such as transport operations, which include vehicles serving and testing aircraft, equipment and installations as well as the equipment of workshops, test beds, fuel stations etc.
- 'Airborne operations of commercial and general aviation' include Any operation of brake release immediately before takes off to turn away from run-way after landing.

Article (7) of MD 79/1994 provides noise limits for 'Industrial Plants and Public Works' and 'Road Traffic', in terms of equivalent continuous A-weighted sound pressure level over each particular time period. The ambient noise limits are presented in Table 2-2 to Table 2-5 respectively.

Table 2-2: Ambient Noise Limits from Noise Generated from Industrial Plants and Public Works

Type of District	Leq, T, dB (A) - Over Time Period		
	Day Time (7 AM – 6 PM) workdays	Evening Time (6 PM – 11 PM) workdays	Night Time (11 PM – 7 AM) Workdays and Holidays
Rural Residential Recreational	45	40	35
Suburban Residential	50	45	40
Urban Residential	55	50	45
Urban Residential with some Workshops or Business; City Hub	60	55	50
Industrial and Commercial	70	70	70

Table 2-3: Ambient Noise Limits from Noise Generated from Road Traffic

Type of District	Leq, T, dB (A) - Over Time Period		
	Day Time (7 AM – 6 PM) workdays	Evening Time (6 PM – 11 PM) workdays	Night Time (11 PM – 7 AM) Workdays and Holidays
Rural Residential Recreational	60	55	50
Suburban Residential	65	60	55

Type of District	Leq, T, dB (A) - Over Time Period		
	Day Time (7 AM – 6 PM) workdays	Evening Time (6 PM – 11 PM) workdays	Night Time (11 PM – 7 AM) Workdays and Holidays
Urban Residential	65	60	55
Urban Residential with some Workshops or Business; City Hub	65	60	55
Industrial and Commercial	70	65	60

Table 2-4: Ambient Noise Limits from Noise Generated from Airport

Type of District	Leq, T, dB (A) - Over Time Period		
	Day Time (7 AM – 6 PM) workdays	Evening Time (6 PM – 11 PM) workdays	Night Time (11 PM – 7 AM) Workdays and Holidays
Rural Residential Recreational	45	40	35
Suburban Residential	50	45	40
Urban Residential	55	50	45
Urban Residential with some Workshops or Business; City Hub	60	55	50
Industrial and Commercial	70	70	70

Table 2-5: Ambient Noise Limits from Noise Generated from airborne operations of commercial and general aviation

Type of District	LDEN T, dB (A) Over Time period
Rural Residential Recreational	50
Suburban Residential	55
Urban Residential	55
Urban residential with some workshops or business; city hub.	55
Industrial and Commercial	**60**

2.1.3 Ministerial Decision 80/94 – Noise Pollution Control in Working Environment

Ministerial decree MD 80/1994 on noise control in working environment provide details on environmental standards and requirements for noise abatement in various projects.

Article 4 of the regulation specifies that the noise level, which an employee working in a workshop is exposed to, shall be 85 dB (A).

Article 5 requires the employer, to provide suitable means of noise abatement to the employee exposed to noise level 85 dB (A) during normal working conditions.

Ear protectors shall be provided by the employer to an employee exposed to a noise level exceeding8 5 dB(A). The attenuation of such protectors shall be at least equal to the amount by which the noise level exceeds 80 dB (A).

2.2 International Noise Quality Standards

Occupational Safety and Health Administration (OSHA), World Health Organsation (WHO) and Environmental, Health, and Safety (EHS) standards may be referred to, in relevant areas, wherever national regulations are not available.

2.2.1 General EHS Guideline - IFC

As per Environmental, Health, and Safety (EHS) General Guidelines for Environmental Noise Management, noise impacts should not exceed the levels presented in Table 2.6, or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.

Table 2-6: Noise Guideline[1]

Receptor	One Hour L_{Aeq} dB(A)	
	Daytime 7.00 – 22.00	**Night-time 22.00 – 7.00**
Residential; institutional; educational	55	45
Industrial and Commercial	70	70

2.2.2 International Standards for Noise Monitoring

In the absence of national guidance on noise monitoring and assessment, reference has been made to various international standards for methodologies on noise monitoring and assessment. These methodologies are further detailed in Section 4. The international sources include:

- BS 7445:2003 "*Description and Measurement of Environmental Noise – Part 1: Guide to quantities and procedures*".
- BS 4142:2014 "*Methods for Rating and Assessing Industrial and Commercial Sound".*
- BS 5228:2009 "*Code of Practice for Noise and Vibration Control on Construction and Open Sites"*
- Scottish Government "*Design Manual for Road and Bridges (DMRB)|*
- UK Department for Transport Memorandum*, Calculation of Road Traffic Noise (CRTN).*

[1] Guidelines values are for noise levels measured out of doors. Source: Guidelines for Community Noise, World Health Organization (WHO), 1999.

3 ENVIRONMENTAL PERMITTING REQUIREMENTS

3.1 Environmental Regulatory Procedure

The environmental permitting requirements within SEZ is governed by SEZAD Environmental Regulatory Department. A summary of the permitting procedure is outlined below:

1. In accordance with SEZAD Decision 326/2015, the SEZAD Environmental Regulatory Department have developed a list of projects within the SEZ that require an Environmental Impact Assessment (EIA).
2. MECA regulation promulgated under MD 48/2017, issued in May 2017, has categorised the projects into three types and has listed the projects, which require EIA study. MD 48/2017 shall also be taken into consideration during the permitting requirement.
3. For projects requiring an EIA study, the development shall undergo the following:
    - Scoping study, identifying the topics and methodology, that need to be included in the EIA. Reviewing of scoping report takes up to 15 days.
    - On approval of scoping study, an EIA study is conducted and submitted to SEZAD. The reviewing of an EIA report shall take 40 days as per SD 326/2015.
4. On approval of the EIA report, a permit application is submitted to SEZAD with required documents.
5. For projects, which do not require an EIA study, the development can directly go for permitting, with the required documents.
6. For projects not listed in SD 326/2015 and/or which falls in Category C of MD 48/2017, a screening exercise is conducted by SEZAD Environmental Regulatory Department, depending on the project application, and a screening opinion,[2] is provided.

3.2 Environmental Impact Assessment (EIA)

The EIA study shall be developed by a MECA registered environmental consultant[3]. SEZAD have the authorization to reject environmental reports which are conducted by companies who are not registered with MECA to undertake these studies.

Detailed EIA is a procedure undertaken for those projects with major/significant impacts to the environment. For an industrial

[2] SEZAD reserves the right to request EIA study for projects that are not listed in the regulations. This shall be decided during the screening stage of the project and depending on type of project and likely impacts

[3] A list of the MECA registered environmental consultants can be obtained from MECA.

project, the EIA generally would assist in determining site suitability as well as the necessary environmental control and mitigation measures.

The objectives of the EIA are summarised as follows:

- To examine and select the best from the project options available;
- To identify, predict and assess significant residual environmental impacts;
- To recommend and incorporate into the project plan, appropriate abatement and mitigating measures; and
- To identify the environmental costs and benefits of the project to the community.

For details on Environmental Impact Assessment, Refer SEZAD Environmental Impact Assessment Guideline.

3.2.1 Construction Environmental Management Plan (CEMP) / Operational Environmental Management Plan (OEMP) / Decommissioning Environmental Management Plan (DEMP)

A CEMP/OEMP/DEMP is a practical plan of management measures which are designed to minimise environmental impacts from the construction and operation phase of a project. The document will need to outline the below requirements (at a minimum):

- Site specific activities of the development.
- Address the associated environmental and heritage issues.
- Provide planned management strategies to avoid and minimise impacts.
- A CEMP/OEMP/DEMP will also provide a management plan for how wastes generated by the activities will be contained and cleaned-up appropriately.

Refer SEZAD Environmental Impact Assessment Guideline for details on CEMP/OEMP.

4 MONITORING AND ASSESSMENT METHODOLOGIES

This Section addresses the noise monitoring and assessment methodologies to identify compliance with national noise limits. In the absence of national guidance on noise monitoring and assessment, reference has been made to relevant and applicable international standards for methodologies on noise monitoring and assessment.

4.1 Monitoring Methodologies

4.1.1 Baseline Monitoring

For site-specific monitoring, it is advised that each industry applicant conducts a baseline noise monitoring survey prior to any construction work to:

- Establish the baseline ambient noise levels surrounding the Project area;
- Compare the baseline noise results to the Omani noise limits as applicable;
- Identify exceedances to recommend suitable mitigation measures during the construction and operation activities; and
- Inform the noise model through the results of the baseline survey.

Part of the baseline survey is to identify the Noise Sensitive Receptors (NSR) around the Project area. The NSRs shall be selected based on their existing land use and distance from the Project boundaries. Generally, a receptor is considered sensitive when it lies within 200m from the Project boundary. Distance of each NSR from the Project boundary shall be recorded, as it will be used later during the noise assessment.

Section 4.1.3 provides the methodology to be used when conducting a baseline noise monitoring survey.

4.1.2 Monitoring during the Different Project Phases

Noise emissions shall also be monitored during construction, operation and decommissioning phases. The purpose of monitoring during the Project phases is to ensure compliance with the MD 79/1994 to minimise or avoid any complaints from noise sensitive receptors throughout the Project life cycle.

Measurements shall be taken regularly by trained environmental personnel, to assess the significance of change in noise levels during the Project phases relative to the ambient baseline noise levels.

The frequency of noise monitoring shall be included in the environmental monitoring plan prepared as part of EIA study and the same will be followed through the project phases unless otherwise decided by SEZAD-Environmental Regulatory Department. This information will be provided to the industry in the permits or other such official communication by SEZAD Environmental Regulatory Department.

Section 4.1.3 provides guidance on the methodology to be used for noise measurement and monitoring during all Project phases.

4.1.3 Detailed Methodology for Noise Monitoring and Measurement

In the absence of Omani guidance on methodology for noise monitoring and measurement, the United Kingdom's BS 7445:2003 "Description and Measurement of Environmental Noise – Part 1: Guide to quantities and procedures" shall be followed. A summary of the noise monitoring requirements is shown below:

- Noise monitoring shall be conducted by trained professionals.
- The instrumentation shall conform to the specifications for sound level meters, preferably of Type 1 but at least of Type 2.
- Results shall be expressed in terms of equivalent continuous A-weighted sound pressure level in decibels (LAeq).
- Noise monitors shall be capable of logging data continuously over this time period, or hourly, or more frequently, as appropriate.
- A comprehensive recalibration of the equipment is prescribed annually.
- A field check shall be made by the user at least before and after each series of measurement, preferably an acoustic check of the microphone.
- The instrumentation and their calibration shall comply with the requirements of International Standards ISO 1996-1:2003.
- *Weather:* Noise propagation is mostly affected by wind speed and direction. Measurements should not be taken at average wind speed exceeding 5 m/s. Dry weather and calm conditions are preferred.
- *Source Strength Variation*: Variations in operating patterns of the industrial facility should be considered when taking measurements. The measurement should be taken over a period that is sufficient enough to obtain a representative sample. If the noise is intermittent or cyclic, a number of cycles may need to be recorded including the noisiest operational modes.
- *Time of Measurement and Duration:* The survey should include night-time measurements unless the facility will not operate at night. Night time measurement will normally take place between midnight to 0400 hours (when traffic noise and other human activity is at its lowest). For each location, day time and night time levels shall be measured during the weekday (24 hours) and the weekend (24 hours).
- *Ground Attenuation Effects:* The presence of acoustical soft ground (ground covered with grass, crops, vegetation) can lead to a reduction in noise level at the receptor due to the absorption of noise energy reflected from the ground.

Therefore, if the effect is seasonal due to variations in ground cover, measurements may need to be taken at a time when ground cover is at a minimum.

- Standard measurement conditions:
    - Outdoor measurements shall be undertaken at a height of approximately 1.2m to 1.5m above the ground and no closer than 3.5m to any reflecting surface (e.g., wall).
    - Outdoor measurements near buildings (where people are affected by public noise) shall be carried out at positions 1m to 2m from the façade and 1.2 to 1.5m above each floor level of interest.
    - Measurements inside buildings shall be carried out in enclosures where the noise is of interest. The preferred measurement positions are at least 1m from the walls or other major reflecting surfaces, 1.2m to 1.5m above the floor and approximately 1.5m from windows.

- *The following information shall be recorded during noise monitoring:*
    - The results of the acoustic measurements;
    - Type of instrumentation, measurement procedure and any calculation employed;
    - Description of the time aspect of measurements;
    - Positions of measurements;
    - Atmospheric conditions: direction and speed of wind, rain, temperature at ground level and other levels, atmospheric pressure, relative humidity;
    - Nature and state of the ground between noise source(s) and measurement position(s);
    - Variability of emission of noise sources;
    - Possibility of locating the origin of the noise;
    - Possibility of identifying the sound source;
    - Nature, character and connotation of the sound source.

4.2 Noise Assessment Methodologies

This section discusses the noise assessment methodologies that shall be followed by each Project applicant for all Project phases. It is important to note that cumulative impact noise modelling has not been discussed within this NATN, as it is not required within individual EIAs and shall be conducted by SEZAD on a project wide scale.

The impact assessment methodologies cover:

1. Construction Impact assessment
    - Road Traffic Noise
    - Construction Equipment/ Machinery Noise
2. Operational Impact Assessment
    - Operational Fixed Plant Noise
    - Operational road traffic noise

3. Decommissioning Impact Assessment
    - Decommissioning Equipment Noise

4.2.1 Road Traffic Noise Impact Assessment Methodology

Road traffic noise is expected to increase as a result of the vehicles transporting materials and labour to and from the Project site. The noise impact assessment shall include the change in ambient noise levels at the noise sensitive receptors from the addition of vehicles during all Project phases. The assessment can be conducted quantitatively or qualitatively.

Quantitatively, the assessment shall be conducted by developing a noise model to estimate the noise levels within the SEZ and determine the expected change in road traffic noise level as a result of the Project activities. To create a noise model, specific data will need to be inputted into a 3D noise modelling software. One popular method is using a calculation methodology provided by the UK Department for Transport Memorandum*, Calculation of Road Traffic Noise (CRTN)* which sets out a step-by-step method for predicting road traffic noise levels using Annual Average Weekday Traffic flows. Noise contour maps shall be generated, where each noise band is represented by a different colour. The noise contour maps are a visual representation of the noise from the Project area, in order to compare the "with" and "without" the Project.

In the absence of specific quantitative data (i.e. number of trucks, size of trucks, road surface, and route taken), a qualitative assessment can be used. As a rule of thumb, doubling of road traffic will lead to an increase in traffic noise by 3 dB(A). During the construction phase of a Project most of the noise generated from vehicles is associated with earthworks activities. If most of the excavated material will be used within the Project site, a limited increase of construction traffic is anticipated.

4.2.2 Construction Equipment Noise Impact Assessment Methodology

Noise generated from construction equipment will result in additional noise sources that might impact the noise sensitive receptors and exceed the Omani noise limits.

When assessing noise from construction equipment, it is preferable to undertake a quantitative assessment if the following data is made available:

- Type of construction activities (i.e. dredging, piling, levelling, excavating, etc.)
- Number of vehicles and equipment.
- Project duration and schedule
- Percentage of time the equipment is used
- Site characteristics (topography, natural/man-made barriers)
- Sound Power Level (SPL) of each equipment
- Site layout (location of each piece of equipment)

To quantify the noise impact from a Project, the realistic worst-case noise level from the source shall be predicted for each noise sensitive receptor.

The Project applicant may choose to start with a rough calculation to indicate the magnitude of expected noise levels. If the calculated noise levels are above the relevant noise management levels, the Project applicant may choose to undertake more detailed calculations using computer models. The additional detail and accuracy gained through the use of a computer model may help in selecting work practices that will be applied to achieve the noise management levels.

For small and short-term construction sites, the predicted noise levels from the source may be calculated by hand, taking into account the distance and a free-field between the source and the sensitive land uses. However, calculation by hand is usually not as accurate as computer modelling because not all noise factors are considered. Therefore, for large or complex projects, intended to have a long construction period, it is recommended to use computer models for noise prediction. Such models generally account for attenuation due to distance, atmospheric conditions, barriers and buildings, effects of topography and weather conditions to calculate overall levels at an assessment location. Preference shall be given to the use of modelling approaches that have been the subject of peer review and have been extensively used on other noise impact assessments. Any modelling would need to be validated by the Project applicant. Where many people are likely to be affected by construction noise, a map showing predicted noise contours surrounding the site may be required.

If sound power levels are unavailable, then estimates of noise levels from typical construction equipment can be determined based on the typical noisiest equipment that is likely to be used during the construction phase. The construction plant noise database contained in British Standard (BS) 5228:2009 *Code of Practice for Noise and Vibration Control on Construction and Open Sites,* can be used as a reference to obtain the SPL for construction equipment (as shown in Table 4-1). Noise levels provided in BS 5228-1-2009 are for an SPL at distance of 10m from the source of the equipment.

Table 4-1: Sound Level Data for Construction Machinery and Equipment

Typical Equipment	Power Rating	Equipment Capacity	LAeq SPL at 10m
Concrete Breaker on wheeled backhoe	59	7.4t	92
Excavator	228	44t	85
Concrete crusher	172	47t	82
Dozer	239	41t	80
Dump truck	306	29t	79
Hydraulic vibratory compactor	-	225 kg	78
Drilling rig	106	-	74
Precast concrete piling using hydraulic hammer	145	-	89

Typical Equipment	Power Rating	Equipment Capacity	LAeq SPL at 10m
Handheld welder	-	-	73
Cement Mixer truck (discharging)	-	-	75
Diesel generator	6.5	-	61
Source: (BS) 5228-1-2009			

One can predict the SPL of an equipment at any distance from the Project boundary, using the noise levels at 10m from typical construction equipment and a distance correction factor provided in BS 5228-1-2009. The combined noise level from use of all equipment simultaneously and at distance *"x"* can also be calculated to give predicted noise value (LAeq SPL) for a specific NSR located at "*x*" m from the Project boundary.

The formula used for calculating the noise attenuation due to distance is provided below:

For a free field (a flat surface without obstructions), every doubling of the distance from the noise source, the sound pressure levels - Lp, will be reduced by 6 decibels.

$$L_{p2} - L_{p1} = 10 \log (R2 / R1)2 = 20 \log (R2 / R1)$$

Where,

L_{p1} = *sound pressure level at location 1 (dB)*

L_{p2} = *sound pressure level at location 2 (dB)*

R_1 = *distance from source to location 1*

R_2 = *distance from source to location 2*

Alternatively, for small construction projects or when detailed information is unavailable, a worst case scenario can be assumed, whereby all construction works will be undertaken at the boundary of the Project closest to the NSRs, and all equipment will be operational for 100% of the construction phase.

Significance of Impact

In accordance with the Scottish Government's Design Manual for Roads and Bridges (DMRB), the significance of an impact can be determined by the magnitude of the impact and sensitivity value of the receptor.

Table 4-2 illustrates the relationship between magnitude of impacts and noise exceedance levels based on criteria set by MECA. The assessment is based on comparing absolute noise levels with the applicable noise standards implemented by MECA, as described in Section 2 of this NATN. The predicted noise levels at each NSR indicate unmitigated noise impact.

Table 4-2: Classification of Magnitude on Noise Impacts (DMRB, 2011)

Noise Level Exceedance (x*= MECA Noise Limit)	Magnitude of Impact
x > 10	Major Adverse
5 ≤ x ≤ 10	Moderate Adverse
3 ≤ x < 5	Minor Adverse
0 ≤ x < 3	Negligible
x < 0	No Adverse Impact

Noise Level Exceedance (x*= MECA Noise Limit)	Magnitude of Impact
x = 0	No Change
-1 < x < 0	Negligible Beneficial
-3 < x ≤ -1	Minor Beneficial
-5 < x ≤ -3	Moderate Beneficial
x ≤ -5	Major Beneficial

The receptor's sensitivity value to noise is based on the assessment methodology described in Table 4-3.

Table 4-3: Environmental Value of Receptor or Resource to be used (DMRB, 2008)

Value (sensitivity)	Description of Value
Very high	High importance and rarity, international scale and limited potential for substitution. School or hospital receptor.
High	High importance and rarity, national scale, and limited potential for substitution. Residential receptor.
Medium	High or medium importance and rarity, regional scale, limited potential for substitution. Commercial or recreational receptor.
Low	Low or medium importance and rarity, local scale.
Negligible	Very low importance and rarity, local scale. Industrial receptor.

Upon identifying the above two factors, the level of significance of the noise impact on the NSR is obtained using the below guidance matrix provided in Table 4-4. The result will indicate the significance of effect on the NSRs without mitigation measures.

Table 4-4: Criteria for Determining Significance of Environmental Effect

Environmental value (Sensitivity)	Magnitude of Impact (Degree of Change)				
	No change	Negligible	Minor	Moderate	Major
Very High	Neutral	Slight	Moderate or large	Large or very large	Very large
High	Neutral	Slight	Slight or moderate	Moderate or large	Large or very large
Medium	Neutral	Neutral or Slight	Slight	Moderate	Moderate or large
Low	Neutral	Neutral or Slight	Neutral or Slight	Slight	Slight or moderate
Negligible	Neutral	Neutral	Neutral or Slight	Neutral or Slight	Slight

Source: DMRB 11.2.5.2 (Table 2.4 Arriving at Significance of Effect Categories) (DMRB,2008)

The SEZAD EIA guideline shall also be referred to for generic classifications for environmental value, magnitude of impact and significance of effect.

4.2.3 Operational Fixed Plant Noise Impact Assessment Methodology

During the Project operation phase, a number of industrial fixed plant services shall be required depending on the type of industry.

Fixed plant noise during the operation phase shall be assessed based on guidance provided in BS 4142:2014 “Methods for Rating and Assessing Industrial and Commercial Sound”. This standard is normally used to assess whether noise levels from machinery and industrial premises are likely to give rise to complaints from people living nearby. The industrial noise level is adjusted to allow for any tonal or impulsive characteristics (+ 5 dB), and is called the Rating Level. The difference between the rating level and the ambient noise levels at the same location will indicate the likelihood of complaints arising.

Specific information on fixed plant and equipment (character/type of noise source, specific noise level, etc.) shall be made available to quantitatively assess the noise from fixed plant during operation. Additionally, fixed plant and equipment generally work on a 24-hour basis. The assessment shall therefore consider night time limits set by MECA. Based on the information set out in Table 4-2, to achieve a negligible impact an increase of 3 dB would be allowed above the MECA limit. This noise limit considers the combination of the baseline and the equipment noise levels.

4.2.4 Road Traffic Noise Impact Assessment Methodology

The methodology specified in Section 4.2.1, shall be followed for the operational phase also.

4.2.5 Decommissioning Equipment Noise Impact Assessment Methodology

Normally, the construction equipment noise assessment is representative of the decommissioning noise assessment, as the equipment and procedures used are similar. Thus, it is unlikely that decommissioning activities will increase the noise levels by more than that experienced for the construction phase. As such no further assessment shall be needed for the decommissioning phase.

5 GENERAL POLLUTION PREVENTION GUIDANCE NOTES

This Section gives an overview of the general Pollution Prevention Guidance Notes (PPGN) during the Project phases. International Best Management Practices for the proposed industries in the SEZ area are also provided within this section to reduce noise levels from industry-specific operating activities.

If the level of noise generation at source cannot be reduced, two methods of noise control are commonly used; increasing distance or increasing attenuation. Increasing distance from source to receiver is usually only possible at the planning stage, and can be extremely effective, but in many cases the sound wave must be attenuated through additional means.

5.1 Construction and Decommissioning International Best Management Guidelines

From the noise assessment undertaken in Section 4.2, it is known that construction and decommissioning noise impacts range from Major Adverse to Negligible impacts.

The following mitigation measures are recommended to reduce noise levels during the construction and decommissioning phases of the Project:

- Equipment shall be selected with a lower SPL;
- Vehicles not compliant with MD 79/1994, due to poor engine adjustment or damage of noise abatement equipment, shall not operate until corrective measures have been taken;
- All equipment shall be fitted with effective silencers;
- Sound-reducing covers shall be kept closed when the equipment is operating;
- Stationary equipment, especially if working continuously at night, shall be located and/or screened away from potentially noise sensitive directions;
- All equipment shall be well and regularly maintained as per their instructions manual so as to minimise mechanical wear and consequent increases in noise emissions;
- The equipment and plant shall be turned off when not being used;
- In the event that any activities cannot comply with the MECA regulatory limits, noise affected receptors shall be pre-notified of what is expected and how long it will last;
- 24-hour contact details shall be provided through letters and site signage;
- Within working hours, where it is reasonable to do so:
    - Noisy activities shall be scheduled for less sensitive times.
    - Periods of rest shall be provided from noisier works (for example, periodic breaks from jackhammer noise).

- All vehicular movements to and from the site shall only occur during the scheduled normal working hours, unless approval has been granted by SEZAD;
- Where possible, no truck associated with the work shall be left standing with its engine operating in a street adjacent to a residential area;
- Work shall not be scheduled in the evenings or during the weekend if the Project site is situated close to residential sensitive receptors;
- Access roads to the Project area shall be positioned such that vehicular movements cause minimum disturbances to residential buildings.

It is recommended that noise monitoring is conducted at the nearest NSR once the construction and decommissioning works have commenced and best management practices have been implemented. Where monitoring results show an exceedance of 10dB above the ambient noise levels, and where it is not possible to reduce the construction noise impact, it may be necessary to re-house some of the closest residents for short periods during the works, subject to results of detailed assessment and monitoring.

5.2 Operational International Best Management Guidelines

An operational management plan shall be established to incorporate routine auditing and reporting requirements, which will ensure the implementation of the following mitigation measures:

- **Routine maintenance or servicing** of the plant and of the noise control equipment (i.e. engine silencers, acoustic panelling, etc.)
- **Good operational site practices,** which include:
  - Closing doors and windows in noisy buildings and acoustic enclosures;
  - Ensuring that generator or vehicle engine hatches are kept closed;
  - Locating mobile plant away from noise sensitive receptors where possible;
  - Avoiding dropping metallic materials from a height;
  - Switching off plants when not in use;
  - Stock piling materials so as to provide acoustic screening between noise sources and receptors; and
  - Arranging delivery or on-site vehicle routes away from sensitive receptors.
- Restricting operating hours of noisy activities to the less sensitive daytime (7:00 to 19:00), weekday periods in order to keep noise emissions to a minimum at night.
- Community Liaison is a key player in avoiding complaints. The impact of occasional unavoidable noisy activities can be reduced by warning the community beforehand. In addition, complaints should be treated in a constructive manner, Appendix B provides a standard form to illustrate the key

information that should be noted from a complainant. A general procedure for handling a noise complaint is as follows:

- The complaint is logged.
- The facility under consideration is visited immediately to inquire if the operator knows what the source of the noise could be and if the noise could be due to an unusual activity.
- The source of excessive noise is investigated by inspection to see if there is an obvious remedy, if so it is implemented and the complainant is updated.
- If no remedy is implemented, and excessive noise is suspected, noise monitoring is carried out to help identify the source and the extent of any noise impact.
- If monitoring identifies a noise impact, remedial work is planned and implemented, the complainant is advised of progress.
- Repeat monitoring is carried out to establish whether the remedial work has been successful.
- The complainant is advised and the logged complaint is signed-off as having been properly addressed.

5.3 Industry Specific Noise Management Guidelines

5.3.1 Petrochemicals Industry

Based on the EU-IPPC (2003), refineries produce significant noise from flares, compressors, pumps, turbines and air coolers. The operational best management guidelines shall specifically target noise levels from this type of plant.

5.3.2 Silica Sand/Glass, Metal Casting Industry

Foundries, if operated using a coke fired cupola furnace, will produce significant noise from the operation itself and from the associated activities such as handling of scrap metal, overhead crane and charger operations. Abatement measures to reduce the impact of noise shall include the development of an enclosed electric melt facility in an acoustically designed building, the use of low noise extraction systems and positioning of Plant as far as possible from noise sensitive receptors (Environment Agency, 2001).

5.3.3 Limestone/Cement Industry

Lime and cement industries produce noise pollution through raw material extraction, grinding and storage, intermediate and final product handling and transportation, and operation of exhaust fans. Control of noise shall include the use of silencers for fans, room enclosures for mill operators, and noise barriers (World Bank Group, 2007).

5.3.4 Fisheries Industry

Noise generation from fish processing facilities are generally low, however the process can result in localised impacts resulting directly from noisy machinery (e.g. compressors, automatic packing machinery, condensers, ventilation units, and pressurized air). Abatement measures to reduce impact of localised noise shall include sound insulated equipment (World Bank Group, 2007).

5.3.5 Automotive Industry

Tools and machinery used in the automotive servicing and repairs industry can be very noisy. Noise from pneumatic wrenches, compressors, grinders and drills can result in excessive noise and result in complaints from neighbours. Abatement measures include regularly servicing noisy equipment, installing sound reduction measures (e.g. mufflers, silencers, sound absorbing boxes), ensuring exhaust noise levels of vehicle does not increase, and installing horns and car alarms that do not exceed noise limits (EPA NSW, 2008)

5.3.6 Power Generation Industry

There are numerous main sources of noise within a power plant. Typical noise sources include fans, pumps, turbine/generator, combustion exhaust, steam discharges, fuel handling operations, pipe radiation, and electrical transformers. The noise can be mitigated by applying noise control devices (e.g. acoustic enclosures, barrier walls, silencers) or specify low-noise equipment

5.3.7 Desalination Industry

In a desalination plant, noise may originate from high energy pumps used to pressurize seawater during Reverse Osmosis process, blowers and back-up generators. Measures to control noise emissions include: avoid using an impact pile driver and enclose noise generating equipment.

5.3.8 Infrastructure (Port, Harbour and Terminals, Airport, Gas Distribution Network)

Infrastructure project may include airport, ports, harbour and terminals, gas distribution network, etc. The noise source from infrastructure project varies depending on the type of project as well as operational activities.

5.3.8.1 Port Harbour and Terminals

Noise and vibration may be generated during land-based construction activities such as blasting, piling, dredging, reclamation, and construction of breakwaters and access/internal roads as well as from port operations include cargo handling, vehicular traffic, and loading/unloading of containers and ships.

Underwater noise and vibration may be generated from several sources, including pile driving, dredging, and ship traffic, during ports' construction and operational phases etc. Underwater noise will adversely impact aquatic habitats including fish, marine mammals, and sea turtles.

Management measures to prevent, minimize, and control terrestrial noise sources in port facilities include:

- Establishing noise deflection walls;
- Replacing forklifts and reach-stackers with gantry cranes with rubber tires;
- Insulating machineries;

- Coordinating and scheduling offshore piling and dredging activities to avoid or minimize the presence of sensitive aquatic species, for example by respecting migratory patterns and calving/breeding seasons;
- Employing observers during offshore piling and dredging activities to detect the presence of sensitive aquatic species, and allow for these species to vacate the area;
- Using soft-start/slow ramp-up during pile driving and dredging activities to allow time for sensitive aquatic species to vacate the area; and
- Implementing noise mitigation techniques for offshore pile driving, including bubble curtains, pile caps, and cofferdams (where practicable) to absorb/scatter pile driving energy.

5.3.8.2 Airports

The significant sources of noise from airport operations are aircraft during the landing and takeoff, aircraft taxiing; operation of ground support vehicles, aircraft auxiliary power units and aircraft engine testing activities in airports with aircraft maintenance activities. Indirect sources of noise include ground vehicle traffic from access roads leading to the airport.

Noise management practices include:

- Planning of site for airport location and orientation of routes for arriving and departing aircraft relative to actual and projected residential development and other noise sensitive receptors in the surrounding area;
- Implementation of preferred procedures and routes for landing and take-off to minimize potential noise from approaching and departing aircraft for noise-sensitive areas;
- Use of night-time or other operating restrictions, as feasible;
- If necessary, working with local authorities to identify and implement noise prevention and control strategies in noise abatement zones (e.g. sound insulation of buildings that are exposed to aircraft noise above levels stipulated by local authorities or limitations on night-time operation of certain landing routes);
- Reducing noise of ground operations at the source or through the use of sound barriers and deflectors etc

5.3.9 Mining

Noise emission associated with mining include noise from vehicle engines, loading and unloading of rock, chutes, power generation, and other sources related to construction and mining activities.

Recommended management strategies include:

- Noise level at the nearest sensitive receptor should meet noise guideline;

- Where necessary, noise emissions should be minimized through implementation of enclosure and cladding of processing plants;
- Installation of proper sound barriers and / or noise containments, with enclosures and curtains at or near the source equipment (e.g. crushers, grinders, and screens)

5.4 International Best Available Technology (BAT)

This section provides a description of the BAT that is available to attenuate noise from commonly encountered sources of noise. This technology is of two types; 'conventional/passive noise control equipment' such as acoustic enclosures and barriers, and 'active noise control' which uses modern electronics to produce an acoustic signal that partly cancels out the unwanted noise.

5.4.1 Conventional/Passive Noise Control Equipment

Table 5-1, extracted from the UK Environment Agency, presents the various noise control equipment that can be applied to common industrial noise sources. Noise Control Equipment Information Sheets are presented in Appendix B for reference.

In case the industry will significantly increase the traffic flow around the site, long lengths of noise barrier or bund would need to be employed alongside the roads in order to reduce the impact of the traffic flow and speed. Ordinarily, this can improve the noise levels by up to 10dB.

Also, it is possible to use low noise road surfacing along the length of the busy route, which could reduce the noise level by as much as 3dB, when compared with traditional hot rolled asphalt.

5.4.2 Active Noise Control Equipment

Active noise control equipment introduces a sound wave that is an inverse, or mirror-image of the unwanted noise, causing a cancellation wave, which is of equal amplitude and frequency, interfering with the noise without physically blocking the sound path.

This system is particularly used where low frequency noise cannot be attenuated by other means.

However, this technique has disadvantages, as it is expensive, has limited applications, it is not effective on high frequencies and it is less suited for outside applications as it can be damaged by high temperatures or wet conditions.

Table 5-1: Conventional Noise Control Equipment

Noise Source	Noise Control Equipment										
	Acoustic Enclosure	**Acoustic Louvre**	**Noise Barrier**	**Acoustic Panelling**	**Acoustic Lagging**	**Acoustics Damping**	**Impact Damping**	**Attenuator**	**Steam Trap Diffuser**	**Vibration Isolation Mount**	**Inertia Bases**
	Sheet 1	Sheet 2	Sheet 3	Sheet 4	Sheet 5	Sheet 6	Sheet 7	Sheet 8	Sheet 9	Sheet 10	Sheet 11
Boiler		x		x	x	x		x	x	x	x
Chiller		x	X	x	x			x		x	x
Conveyor	x		X	x	x	x	x				
Compressor	x	x	X	x	x				x	x	x
Duct					x	x		x		x	
Fan	x	x	X	x	x	x		x		x	x
Generator	x	x	X	x	x			x		x	
Hopper			X	x	x	x	x				
Lorry/digger			X		x	x	x	x			
Material handling		x	X	x		x	x				
Pump	x	x	X	x	x	x				x	x
Press	x		X	x	x	x	x			x	x
Gas discharge			X					x	x		
Source: **(Environment Agency, 2001)**											

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APPENDICES

APPENDIX A- NOISE CONTROL EQUIPMENT INFORMATION SHEETS (ENVIRONMENTAL AGENCY, 2001)

<table>
<tr><td colspan="2">Sheet 1 Acoustic Enclosures
  </td><td>Acoustic enclosures form a complete box around a piece of equipment and include acoustics doors, windows and attenuated ventilation or cooling systems.</td></tr>
<tr><td colspan="2">Description</td><td>Application</td></tr>
<tr><td colspan="2">Where equipment can operate in a confined space it can be completely enclosed by high performance metal acoustic panels. Doors, windows and other openings require special attention and proprietary enclosures ensure optimal design. Openings to provide adequate air flow for cooling are usually the acoustically weak points and high performance attenuators are required.

Vibration isolation is usually required between the equipment and the floor.</td><td>Generators, compressors, pumps, process equipment requiring substantial attenuation but minimal access and maintenance.</td></tr>
<tr><td colspan="3">Performance</td></tr>
<tr><td colspan="3">20-30 dB(A) is limited mainly by silencing of openings and doors.</td></tr>
</table>

Sheet 2 **Acoustic Louvres**

Acoustic Louvres are similar to weather louvres but provide additional attenuation of noise that passes through them.

Description	***Application***
Acoustic Louvres can be used to replace weather louvres in building openings to reduce noise transfer to outside. Alternatively free-standing acoustic louvres can be placed around external equipment that requires air flow for cooling. Air is allowed to flow between the louvre blades, but noise is attenuated by absorptive material within each blade. Acoustic louvres can produce high pressure drops to the air flowing through them which may create heat load problems to the plant.	Chillers, compressors, pumps, heat pumps, other external equipment requiring air flow.

Performance
Low frequency performance is limited. The noise path over the top of a louvre screen will usually limit performance to up to about 10 dB(A). Back to back acoustic louvres (i.e. two louvres fixed together) can increase performance to about 15 dB(A).

Sheet 3 Noise Barriers  Picture used with the permission of Industrial Acoustics Ltd	**Acoustic Barriers are solid structures located close to equipment to provide acoustic screening between source and receiver**
Description	***Application***
Noise barriers can be made from acoustic panels, but usually brick/ block walls or solid wooden fences are adequate unless reverberation behind the barrier is a concern. Barriers require a minimum density so that noise passing through the barrier is attenuated to below that passing over the top. Barriers are most effective when located close to the noise source and can be painted or landscaped to minimise visual impact. Transparent materials have also been used. Earth bunds can be effective barriers, trees cannot. Barriers must be solid without any holes or openings.	Most equipment whose noise sources are close to the ground or a flat roof.
Performance	
Performance increases with the 'path difference'; the difference between the direct path (through the barrier) and diffracted noise path over the top edge of the barrier. A path difference of zero (i.e. when the line of sight from noise source to the receiver is just broken) implies 5 dB(A) attenuation. In practice a performance of greater than about 15 dB(A) requires very large barriers and is rarely practicable.	

Sheet 4 **Acoustic Panelling** 	**There are many types of acoustic panel, but most are designed to absorb sound incident from one side.**
Description	***Application***
Acoustic panels are generally between 40 and 200 mm thick and are made from a sandwich of coated steel sheets, with a mineral fibre infill. On one side of the panel the metal sheet is perforated to allow sound to pass inside where it is absorbed by the in-fill material. Acoustic panels can be designed to offer very high attenuation to noise transmission that is better than an equivalent solid structure of the same weight. Also, their absorptive properties are used to control reverberation in confined spaces.	Acoustic Panels are the building blocks of many acoustic products. Used alone they can replace conventional walls or partitions, or used to line plant rooms within existing structures.
Performance	
Attenuation to sound transmission can be up to about 40 dB(A). Absorption can be over 90% at middle and high frequencies.	

Sheet 5 **Acoustic Lagging** 	**A flexible material wrapped around noise sources in the same way as thermal lagging.**
Description	***Application***
Acoustic lagging is generally made of a laminated quilt comprising a tough outer skin, mineral fibre quilting and a heavy (often lead) internal layer providing mass. Such lagging is flexible and can be fitted around complex shapes and is ideal for sealing holes and gaps around solid acoustic elements. A similar product can be hung as acoustic curtain around plant that is moved frequently of in very confined spaces.	Lagging to pipes and ducts. Sealing around most acoustic installations. Acoustic curtain for pumps, fans, hand tools etc.
Performance	
10 to 15 dB(A)	

Sheet 6 **Vibration Damping** 	**Damping materials applied as an adhesive, flexible 'putty' or sheeting to vibrating metal sheeting.**
Description	***Application***
Metal sheeting, has a tendency to 'ring' when vibrated by heavy machinery. Large unsupported areas of metal can be very efficient at converting vibrational energy into audible frequencies and radiating noise, rather like a loud speaker cone. Casings and guards can be damped using various damping or 'anti-drumming' compounds.	Casings and guards to most machinery, e.g. conveyors, pumps. Rotating parts.
Performance	
Performance varies, but 10 dB(A) is achievable. Damping of machinery casing is most effective on large areas of thin gauge metal.	

Sheet 7 Impact Deadening 	**Noise generated by impacts on metal surfaces such as loading material into dump trucks, can be reduced by applying a resilient surface treatment.**
Description	***Application***
Deadening materials can be useful on metal floors, chutes or containers, but there are practical problems with wear and tear. For metal floors blended resin compounds have been developed that damp noise generated by trolley wheels and foot falls whilst offering adequate grip, strength and weatherproofing. Metal chutes and lorry holds can be surfaced with abrasion-resistant rubber to reduce noise generated by material impacts. Resilient materials can also be used to help reduce noise generated by inherently noisy material, e.g. barrels, scrap metal and pipes.	Metal floors or wall coverings in warehouses or industrial stores. Lorries, metal chutes, hoppers.
Performance	
Impact noise can be reduced by 10 dB(A) or more.	

Sheet 8 Attenuators 	**Attenuators are designed to allow air to flow between a series of splitters which absorb noise. They come in all shapes and sizes**.
Description	***Application***
Attenuators can be part of a ducted air flow system or can be inserted in a wall, partition or enclosure opening. Several splitters divide the air flow. Splitters comprise perforated metal or rigid mesh enclosing an acoustic in-fill which is generally some form of mineral fibre. Problems include degradation of the infill material and pressure loss (energy consumption) due to restricting the air flow. Excessive air flow speed can regenerate noise. These problems do not prevent attenuators being very widely used in industry	Standard attenuators: heating, ventilation and air conditioning systems, fans. Specialist attenuators: as used on motor vehicles, modified materials allow high temperature and corrosive gas discharges to be silenced.
Performance	
Performance is a function of attenuator length and the ratio of the cross-sectional areas of the splitters and the whole attenuator. Performance up to 45 dB(A).	

Sheet 9 Steam and Air Diffusers 	**Metal fittings attached to the outlets of high pressure steam or air discharge.**
Description	***Application***
Steam traps and compressed air valves, used in petrochemical, food and other process plants to release excessive pressure, generate noise because of the high pressure and velocity of the discharge. The discharge flow can be passed through a diffuser of enlarged diameter filled with a flow resistant material such as stainless steel wool to slow down the gas speed, thus reducing noise generation.	Steam and high pressure air system discharges.
Performance	
Performance is best at mid to high frequencies and typically gives up to about 15 dB(A).	

Sheet 10 Vibration Isolation Mounts 	**Spring or rubber mounts located between vibrating plant and their supporting structure reduce the transfer of vibrational energy into the structure where it may transferred and re-radiate as unwanted noise.**
Description	***Application***
Stiff springs or low compliance rubber/neoprene pads are housed in metal retaining fittings forming a mount or hanger to which the plant is bolted. The mount is designed to be deflected under static load and to absorb the predominant frequencies at which the plant oscillates. In practice this means selecting a mount whose natural frequency is well below the driving frequencies in the plant. Poor installation can lead to flanking paths, poor performance or amplification.	Vibration isolation mounts can be fitted to most mechanical equipment, including pumps, fans, generators, compressors, and also to pipes, and ductwork.
Performance	
Vibration isolation can be almost complete for correctly selected mounts. Installation is harder for large heavy plant and performance can be compromised at lower frequencies. Noise reduction performance will depend on the surrounding structure and its noise transfer and radiation characteristics.	

Sheet 11 Inertia Bases 	**A massive, usually concrete, block onto which the plant is mounted via anti-vibration mounts or pads.**
Description	***Application***
Mounting equipment on spring or rubber isolators makes the system inherently unstable and can compromise the safe operation of the plant. These problems can usually be overcome with inertia bases which provide the following benefits; lower centre of gravity, reduced movement during start up, and even spreading of load. Where plant is permitted a degree of freedom to move on such systems, flexible connectors may be required in pipework or other services to prevent fatigue and vibration transfer via flanking paths.	Mainly applicable to large heavy machinery in combination with vibration isolation mounts or sometimes rubber/neoprene pads for extra stability
Performance	
See vibration isolation Mounts (sheet 10).	