AIR QUALITY PROTECTION TECHNICAL NOTE

Duqm الدقم
هيئة المنطقة الاقتصادية الخاصة
Special Economic Zone Authority

Environment Regulatory Department

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LIST OF ACRONYMS

AAQS	Ambient Air Quality Standards
AQP	Air Quality Protection
BAT	Best Available Technology
BMP	Best Management Practices
CAAQMS	Continuous Ambient Air Quality Monitoring Station
CEMP	Construction Environmental Management Plan
CO	Carbon Monoxide
EIA	Environmental Impact Assessment
EPA	United States Environmental Protection Agency
ERD	Environment Regulatory Department, SEZAD
EU	European Union
GHG	Greenhouse Gases
GLC	Ground Level Concentration
LNB	Low NOx Burner
MD	Ministerial Decision
MECA	Ministry of Environment and Climate Affairs
NO_2	Nitrogen Dioxide
ODS	Ozone Depleting Substances
OEMP	Operational Environmental Management Plan
PAH	Polycyclic Aromatic Hydrocarbons
PM	Particulate Matter
PPGN	Pollution Prevention Guidance Notes
SCR	Selective Catalytic Reduction
SEZD	Special Economic Zone Duqm
SEZAD	Special Economic Zone Authority at Duqm
SNCR	Selective Non-Catalytic Reduction
SO_2	Sulphur Dioxide
TSP	Total Suspended Particles
UHC	Unburned Hydrocarbon
UKEA	United Kingdom Environment Agency
VOC	Volatile Organic Compounds
WB	World Bank
WHO	World Health Organisation

1. INTRODUCTION

1.1. Objectives

This Air Quality Protection (AQP) Technical Note has been developed as part of a set of technical notes for the environmental requirements of the Special Economic Zone (SEZ) at Duqm. The AQP Technical Note includes a description of the relevant national and international air quality related standards, methodologies for undertaking air quality monitoring and assessments, relevant Pollution Prevention Guidance Notes (PPGN) and Best Management Practices for air quality protection.

The purpose of this AQP Technical Note is to set forth a comprehensive framework that will ensure compliance with the required standards and legislations and provide guidance to all interested and applicable bodies.

This AQP Technical Note is aimed primarily at applicants where proposed industries may have significant emissions generated from a particular industrial process. The overall objective is to provide guidance for the applicants to ensure their operations have minimal impact to the air, climate and the sensitive receptors that have been identified within the area.

Industries should seek to prevent adverse impacts on the quality of the air and ensure that any emissions they produce do not result in an exceedance of the objectives detailed within this AQP Technical Note. Applications that give rise to concerns regarding air quality will be assessed by SEZAD with specific requirements for compliance will be 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 AQP Technical Note applies to all industries in the SEZ area. Figure 1-1 specifies the boundaries of the SEZ as per RD 5/2016.

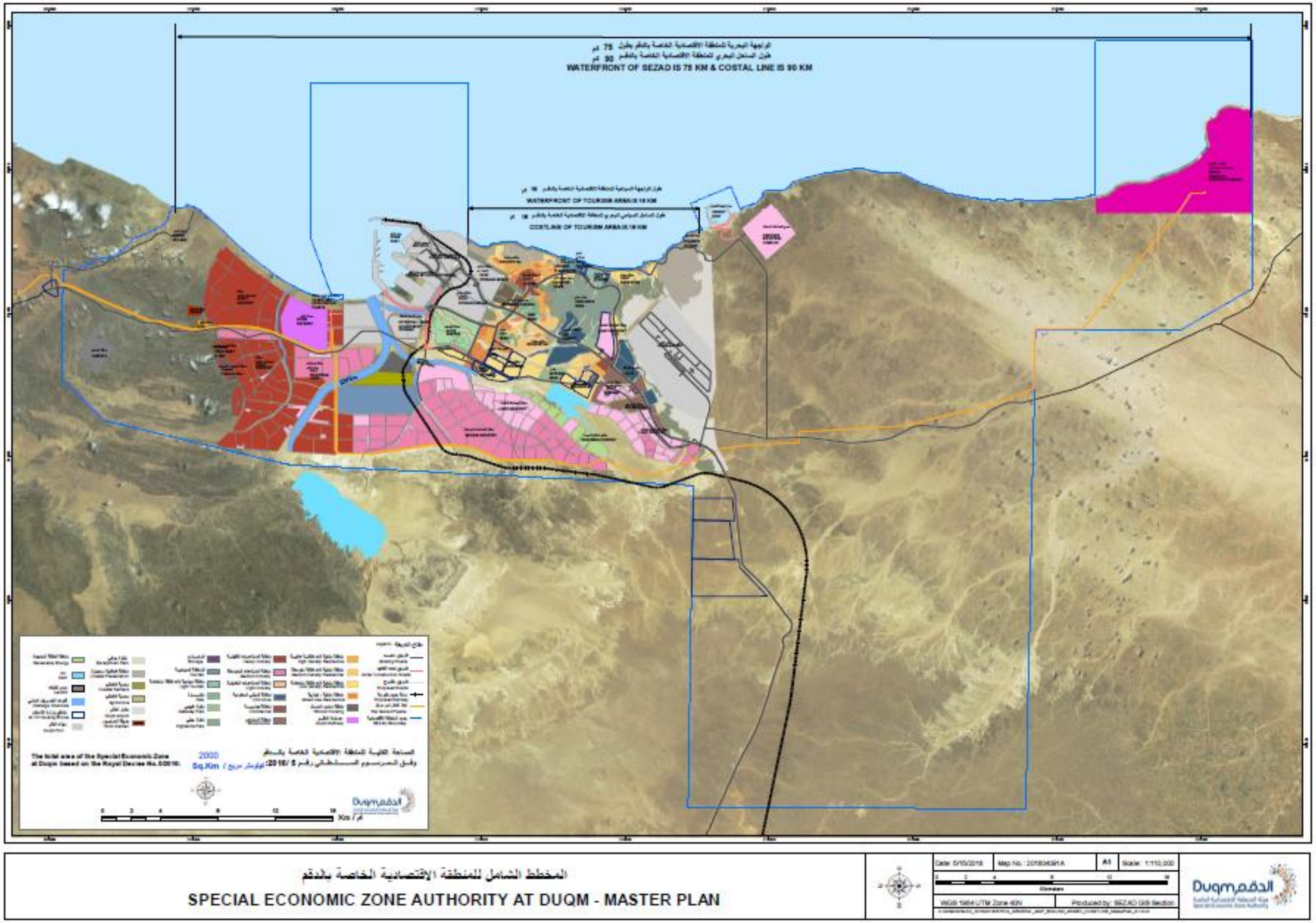

Figure 1-1: SEZD Area

2. APPLICABLE STANDARDS AND GUIDELINES

In accordance with RD 79/2013, the Special Economic Zone Authority at Duqm (SEZAD) has 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. Environmental compliance within the SEZ is governed by the SEZAD Environmental Regulatory Department. At all times local requirements will override international requirements. The international standards are to be complied with, only in the absence of local standards.

2.1. Air Quality Monitoring and Assessment Guidelines

Project applicants shall comply with the methodologies outlined in the following applicable guidelines when monitoring and assessing air quality impacts:

- General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality (World Bank, 2007)
- Diffusion Tubes for Ambient NO2 Monitoring: Practical Guidance (AEA Energy and Environment, 2008)
- Quality Assurance Handbook for Air Pollution Measurement Systems (US EPA, 2008)a

Further details on the methodologies that shall be used for the monitoring and assessment of air quality impacts are included in Section 4.

2.2. Air Quality Standards

Table 2-1 depicts the relevant legislations and guidance applicable to the evaluation of air quality impacts associated with the Project.

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

Table 2-1: Air Quality National Legislations and Guidelines

Laws Associated With Air Quality	Description
RD 114/2001	Law for the conservation of the environment and prevention of pollution.
MD 200/2000	Regulations for Crushers, Quarries and the Transport of Sand from Coasts, Beaches and Wadis
MD 243/2005	Regulation for the control and management of Ozone Depleting Substances (ODS) (amendment to MD 37/2001)
MD 118/2004	Regulation for air pollution control from stationary sources.
MD 107/2013	Regulation for the protection of Ozone layer.

Laws Associated With Air Quality	Description
MD 20/2016	Regulation for Management of Climate Affairs (amends MD 18/2012)
MD 41/2017	Omani ambient air quality regulation
International legislation	Kyoto Protocol to the UN Framework Convention on Climate Change
International legislation	Montreal Protocol (Ozone Depletion) MD 37/2001

2.2.1. RD 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".

2.2.2. MD 200/2000: Crushers Quarries and the Transport of Sand from Coasts, Beaches and Wadis

MD 200/2000 regulates crusher's, quarries, and transport of sand from coasts, beaches, and wadis. It provides information on environmental permitting of crushers and quarries' sites. This also provides guidance on the control measures required to control environmental impacts.

2.2.3. MD 118/2004: Air Pollution from Stationary Sources

The rules and regulations specified within MD 118/2004 shall apply for controlling air pollutants released from stationary sources. These rules and regulations supersede those issued under MD 5/86. MD 118/ 2004 provides regulation on air pollution control from stationary sources relates to permissible emissions from combustion sources and is the key legislation relevant to air emissions.

The articles of MD 118/2004 and the standards derived out of this have been detailed in Section 2.4.

2.2.4. MD 243/3005: Control and management of Ozone Depleting Substances (ODS)

The regulation lists the ODS that are to be phased out in accordance with the Montreal Protocol. This also provides guidance on the import, export and re-export of ODS.

2.2.5. MD 107/2013: Protection of Ozone Layer

The decision specifies regulation for the Protection of Ozone Layer during any stage of the project. The requirement of climate affair license for all establishments as well as management and registration of ODS are specified in the regulation. Substance that deplete ozone and phase-out schedule for the ODS adopted in National Strategy for Phasing is listed in Appendix (3) of regulation.

2.2.6. MD 20/2016: Management of Climate Affairs

Through the above regulation, MECA has amended and issued a list of climate change management practices to be followed by all industries and projects that need environmental clearances.

The decision gives existing companies and projects three years to align with the list of regulations. The decision has been taken in line with the global developments to counter negative effects of global warming and climatic change and to adhere to the United Nation Framework Convention on Climate Change and the Kyoto Protocol, which commits state parties to reduce greenhouse gas emissions.

Under this law, companies or licensees should commit to a list of management guidelines, which include using high-quality technologies, resulting in low energy consumption and lower carbon emissions and other greenhouse gases during the design and operation of the project or entity.

The licensee would have to present a plan for afforestation of the project site, choosing the trees that best suit the local environment and help increase absorption of harmful gases from the atmosphere. It will also be required to use renewable energy resources according to its financial and technical benefits. The company would also be required to follow procedures to limit effects of high temperature on the project and applying efficient water management procedures.

Taking into account the expected negative effects of climate changes on the site of the project, the licensee also need to take all adaptation measures and precautions to protect the site. Projects that consume more than 2,500 megawatt/hour of electricity per year would need to adopt appropriate technical options to reduce energy consumption when designing the buildings.

The decision also included fines for violators ranging from RO3,000 to RO5,000.

2.3. The Kyoto Protocol

The Sultanate of Oman signed and ratified the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) in January 2005. Under this Convention, Member States have an obligation to improve energy efficiency, protect sinks and sources of greenhouse gases, promote sustainable agriculture, promote renewable energy and sequestration of CO2, and control emissions of greenhouse gases. Member States are obliged to report their progress on these matters to the Secretariat.

2.4. Ambient Air Quality Standards (AAQS)

This Section discusses Ambient Air Quality Standards applicable in Oman.

2.4.1. Omani Ambient Air Quality Standards

MECA has developed and issued the ambient air quality standards for sultanate of Oman through MD 41/2017. Table 2-2 specifies the standards promulgated under the regulation for ambient air quality. Relevant articles from the regulation is provided below.

- The owner shall monitor the ambient air pollutants according to the international standard methods adopted and provide periodic monitoring data from the monitoring station every 3 months to the competent department and whenever requested as and as specified in Article 3 of the regulation;
- Article 4: The owner shall monitor the ambient air pollutants according to the international standard methods adopted in this regard and provide periodic monitoring data from the monitoring station every 3 months to the competent department and whenever requested;
- Article 6: The Ministry has the right to oblige the owner -whose air pollutants exceed the permitted limits- to connect the monitoring station to the network of monitoring stations of the Ministry, to provide monitoring data on these pollutants electronically and to take action to reduce the concentration of these pollutants.

Table 2-2: Omani AAQS

Pollutant	Max Limit of pollutant conc.level		Avg.period for measuring pollutant (h)
	ppm	µg/m3	
Sulphur dioxide (SO2)	0.124	350	1
	0.0532	150	24
Hydrogen Sulphide (H2S)	0.020	30	1
Nitrogen Dioxide (NO2)	0.123	250	1
	0.642	130	24
Ozone (O3)	0.0568	120	8
PM10	-	150	24
PM2.5	-	65	24
Carbon monoxide (CO)	24.3	30 mg/m3	1
	8.11	10mg/m3	8
Non-methane Hydrocarbon NMHC	0.24	160	3
Lead Pb		1.5	3
NH3		200	24

2.4.2. International Ambient Air Quality Standards

Relevant international standards for ambient air quality are shown in Table 2-3 to Table 2-6. These standards are derived from the following regulatory bodies:

- European Union (EU)

- World Health Organisation (WHO)
- United States Environmental Protection Agency (EPA)
- United Kingdom Environment Agency (UKEA)

Table 2-3: US EPA National Ambient Air Quality Standards

Parameter	Threshold Value (ppm or µg/m^3)	Averaging Period	Note
CO	35 ppm	1 Hour	[i]
	9 ppm	8 Hours	[i]
Lead	0.15 µg/m^3	Rolling 3 month average	
NO_2	0.1 ppm	1 Hour	[ii]
	0.053 ppm	1 Year	
Ozone	0.07 ppm	8 Hours	[iii]
PM 2.5	35 µg/m^3	24 Hours	[iv]
	12.0 µg/m^3	1 Year	[v]
	15.0 µg/m^3	1 Year	[vi]
PM 10	150 µg/m3	24 Hours	[vii]
SO_2	0.075 ppm	1 Hour	[viii]
	0.5 ppm	3 Hours	[i]
Source: US EPA website (https://www.epa.gov/criteria-air-pollutants/naaqs-table)			

Notes:
[i] – not to be exceeded more than once per year.
[ii] – 98th percentile of 1-hour daily maximum concentrations averaged over 3 years.
[iii] – Annual fourth-highest daily maximum 8-hour concentration averaged over 3 years.
[iv] - 98th percentile averaged over 3 years.
[v] – Annual mean averaged over 3 years for "Primary" air quality standard.
[vi] - Annual mean averaged over 3 years for "Secondary" air quality standard.
[vii] – Not to be exceeded more than once per year on average over 3 years.
[viii] – 99th percentile of 1-hour daily maximum concentrations averaged over 3 years.

Table 2-4: EU Ambient Air Quality Standards

Parameter	Threshold Value (ppm or µg/m^3)	Averaging Period	Permitted exceedances each year
$PM_{2.5}$	25 µg/m^3	1 Year	
SO_2	350 µg/m^3	1 Hour	24
	125 µg/m^3	24 Hours	3
NO_2	200 µg/m^3	1 Hour	18
	40 µg/m^3	1 Year	
PM_{10}	50 µg/m^3	24 Hours	35
	40 µg/m^3	1 Year	
Lead	0.5 µg/m^3	1 Year	
CO	10 mg/m^3	8 Hours	
Benzene	5 µg/m^3	1 Year	
Ozone	120 µg/m^3	8 Hours	25 days averaged over 3 years
Arsenic	6 ng/m^3	1 Year	
Cadmium	5 ng/m^3	1 Year	
Nickel	20 ng/m^3	1 Year	
PAH	1 ng/m^3	1 Year	
Source: European Commission website (http://ec.europa.eu/environment/air/quality/standards.htm)			

Table 2-5: WHO Ambient Air Quality Standards

Parameter	Threshold Value ppm or µg/m^3	Averaging Period
$PM_{2.5}$	25 µg/m^3	24 Hours
	10 µg/m^3	1 Year

Parameter	Threshold Value ppm or µg/m³	Averaging Period
PM_{10}	50 µg/m³	24 Hours
	20 µg/m³	1 Year
Ozone	100 µg/m³	8 Hours
NO_2	200 µg/m³	1 Hour
	40 µg/m³	1 Year
SO_2	500 µg/m³	10 minutes
	20 µg/m³	24 Hours
Source: WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide – Global Update 2005 (WHO, 2005)		

Table 2-6: UK Environment Agency Ambient Air Quality Standards

Parameter	Threshold Value ppm or µg/m³	Averaging Period	Note
SO_2	350 µg/m³	1 Hour	[i]
	125 µg/m³	24 Hours	[ii]
NO_2	200 µg/m³	1 Hour	[iii]
	40 µg/m³	1 Year	
Benzene	5 µg/m³	1 Year	
Lead	0.5 µg/m³	1 Year	
PM_{10}	50 µg/m³	24 Hours	[iv]
	40 µg/m³	1 Year	
$PM_{2.5}$	25 µg/m³	1 Year	
CO	10,000 µg/m³	8 Hours	
Source: UK Environmental Protection. The Air Quality Standards Regulations 2010 (http://www.legislation.gov.uk/uksi/2010/1001/pdfs/uksi_20101001_en.pdf)			

Notes:
[i] – not to be exceeded more than 24 times per year.
[ii] – not to be exceeded more than 3 times per year.
[iii] – not to be exceeded more than 18 times per year.
[iv] – not to be exceeded more than 35 times per year.

2.5. Standards for Emissions from Industrial Developments

As per Article (6) of MD 118/2004: A facility shall submit an application for an Environmental Permit and shall not commission or operate the plant unless the height of the chimney serving the plant has been approved and is sufficient enough to prevent the smoke, grit, dust and toxic gases from becoming prejudicial to health or nuisance. The minimum stack heights (from ground level) are as follows:

Table 2-7: Minimum Stack Height

Types of Industries	Minimum Stack Height (from ground level)
Power Plants	
Plants fired by natural gas	26 m
Plants fired by diesel oil	35 m
Boilers	
Boilers fired by natural gas	15 m
Boilers fired by diesel oil	20 m
Incinerators	
Medical, municipal and industrial waste incinerator	15 to 20 m
Furnaces	
Cement manufacturing ovens	40 m
Ceramic manufacturing ovens	20 m
Melting Kins	
Metallic and non-metallic elements	45 m

For other categories, the stack height shall be at least 2.5 times the height of the tallest building around the facility.

- Article (8)– Environmental inspectors from the Ministry may enter the facility to inspect any processes causing emission of any noxious or offensive substances, to ensure efficiency of emission control systems and to monitor the quantity and quality of emissions;
- Article (9)– The facility shall provide access and assistance to the concerned environmental inspectors from the Ministry to perform their duties for inspection and to carry out the necessary tests; and,
- Article (10) – Any change of ownership or production process of the facility shall be communicated in writing to the Ministry.

Air emissions permissible limits applicable to industries based on the pollutants from stationary sources have been specified under MD 118/2004 and provided in Table 2-8.

Table 2-8: Emission Standards as per MD 118/2004

Pollutants	Max Permissible Limits (g/m^3)*
General	
Grit and dust Dark smoke- products of combustion shall not emits smoke as dark as or darker than shade one on the Ringlemann scale (20 % opacity)	0.05
Asphalt works	
Bitumen fumes	0.03

Pollutants	Max Permissible Limits (g/m^3)*
Total particulates	0.05
Flaring in Refinery and Petroleum	
Carbon Monoxide	0.05
Sulphur Dioxide	0.035
Nitrogen Dioxide	0.15
Carbon Dioxide	5
Unburnt Hydrocarbons	0.01
Particulates	0.1
Power Plants – Natural Gas Fired	
Nitrogen Dioxide	0.15
Particulates	0.05
Unburnt Hydrocarbons	0.01
Carbon Dioxide	5
Nitrogen Dioxide	0.15
Power Plants – Diesel oil fired (less than 0.5% Sulphur)	
Sulphur Dioxide	0.035
Carbon Monoxide	0.05
Nitrogen Dioxide	0.15
Particulates	0.1
Unburnt Hydrocarbons	0.01
Incineration Works	
Hydrogen Chloride	0.05
Hydrogen Fluoride	0.01
Oxides of Nitrogen, calculated as Nitrogen Dioxide	0.2
Phosphorous compounds, calculated as Phosphorus Pentoxide	0.050
Hydrogen Sulphide	5 ppm
Dioxins (as furans)	0.5 ng/m3
Total Particulates	0.050
Metals Works- Electric Furnace	
Carbon Monoxide	0.050

Pollutants	Max Permissible Limits (g/m^3)*
Fluorine	0.003
Particulates	0.1
Petroleum works	
Particulates from catalytic crackers	0.1
Sulphur recovery unit	Min 99.9% efficiency
Volatile Organic Compounds from fume recovery units	0.035
Hydrogen Sulphide	5 ppm
Cement works	
Dust particulates	0.100
Sulphur Dioxide	0.035
Urea/ammonia fertilizer factories	
Ammonia	0.020
Urea Particulates	0.050
Nitrogen Dioxide	0.150
Carbon Dioxide	5
Unburnt Hydrocarbons	0.010
Petrochemical works	
Hydrocarbons	0.010
Nitrogen Oxides	0.150
Carbon Monoxide	0.050
Total Particulates	0.1
Sulphur Dioxide	0.035
Firing/combustion Sources generated by diesel oil	
Carbon Monoxide	0.050
Sulphur Dioxide	0.035
Nitrogen Dioxide	0.150
Particulates	0.100
Unburnt Hydrocarbon	0.010

Pollutants	Max Permissible Limits (g/m^3)*
Firing/combustion Sources generated by natural gas	
Nitrogen Dioxide	0.150
Nitrogen Dioxide	0.150
Unburnt Hydrocarbons	0.010
Carbon Dioxide	5.000
Desalination Plants	
Chlorine (fugitive emission)	0.005

**The units for the concentrations are as provided in MD 118/2004*

2.6. International Standards for Emissions from Small Combustion Facilities

International standards for air emissions have been derived from the World Bank *Environmental, Health, and Safety Guidelines – General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality* guidelines for small combustion facilities (World Bank, 2007). These emissions standards are outlined in Table 2-9.

Table 2-9: Small Combustion Facilities Emissions Guidelines (3MWth – 50MWth) – (in mg/Nm^3 or as indicated)

Combustion Technology / Fuel	Particulate Matter (PM)	Sulphur Dioxide (SO_2)	Nitrogen Oxides (NOx)	Dry Gas, Excess O_2 Content (%)
Engine				
Gas	N/A	N/A	200 (Spark Ignition) 400 (Dual Fuel) 1,600 (Compressed Ignition)	15
Liquid	50 or up to 100 if justified by project specific considerations (e.g. Economic feasibility of using lower ash content fuel, or adding secondary treatment to meet 50, and available environmental capacity of the site)	1.5 percent Sulphur or up to 3.0 percent Sulphur if justified by project specific considerations (e.g. Economic feasibility of using lower S content fuel, or adding secondary treatment to meet levels of using 1.5 percent Sulphur, and available environmental capacity of the site).	If bore size diameter (mm) <400: 1460 (or up to 1,600 if justified to maintain high energy efficiency). If bore size diameter (mm) > or = 400: 1,850	15
Turbine				
Natural Gas =3MWth to < 15MWth	N/A	N/A	42 ppm (Electric generation) 100 ppm (Mechanical drive)	15
Natural Gas =15MWth to < 50MWth	N/A	N/A	25 ppm	15
Fuels other than Natural Gas =3MWth to < 15MWth	N/A	0.5 percent Sulphur or lower percent Sulphur) e.g. 0.2 percent Sulphur) if commercially available without significant excess fuel cost	96 ppm (Electric generation) 150 ppm (Mechanical drive)	15
Fuels other than Natural Gas = 15MWth to <50MWth	N/A	0.5% S or lower % S (0.2%S) if commercially available without significant excess fuel cost	74 ppm	15
Boiler				

Gas	N/A	N/A	320	3
Liquid	50 or up to 150 if justified by environmental assessment	2000	460	3
Solid	50 or up to 150 if justified by environmental assessment	2000	650	6
Notes: N/A = no emissions guideline; Higher performance levels than these in the Table should be applicable to facilities located in urban/industrial areas with degraded air sheds or close to ecologically sensitive areas where more stringent emissions controls may be needed; MWth is heat input on HHV basis; Solid fuels include biomass; Nm3 is at one atmosphere pressure, 0°C; MWth category is to apply to the entire facility consisting of multiple units that are reasonably considered to be emitted from a common stack except for NOx and PM limits for turbines and boilers. Guidelines values apply to facilities operating more than 500 hours per year with an annual capacity utilization factor of more than 30 percent.				
Source: World Bank General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality standards 2007				

2.7. SEZAD Guideline for Coal Trade and Usage as Fuel for Cement and Thermal Power Plants at SEZD

SEZAD has recently issued guidelines for coal usage, import and shipping, loading in ports, transport, storage and trade. The guideline also specifies the emissions standards from stationary sources using coal as fuel and are outlined in Table 2-10.

The use of coal in SEZD shall be based on final approval of type of coal from SEZAD. Natural gas shall replace coal as fuel in the plants, to reduce emissions, once NG becomes available in Duqm, unless otherwise approved by SEZAD.

Table 2-10: Emission Standards from Fixed Source using coal as fuel

Parameter	Units	Guideline Value
Particulate Matter	mg/m^3	30
Total solid particles to the coolant piping and cement mills and coal	mg/m^3	30
Sulphur dioxide	mg/m^3	100
Nitrogen oxides	mg/m^3	100
Total organic carbon	mg/m^3	10
Hydrogen chloride	mg/m^3	10
Hydrogen fluoride	mg/m^3	1
Dioxin /furan	Nano gm/m^3	0.1
Mercury steam	mg/m^3	0.03
Cadmium, thallium	mg/m^3	0.05
Antimony, Arsenic, lead, cobalt, chrome, copper, manganese, nickel ,vanadium	mg/m^3	0.5
***In the absence of Omani standards for coal usage, it shall be noted that if the project is able to meet standards different than the levels and measures presented in SEZAD Guideline, projects shall meet the standards whichever is more stringent.**		

3. ENVIRONMENTAL PERMITTING REQUIREMENTS

3.1. Environmental Regulatory Procedure

The environmental permitting requirements within SEZ are 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,[1] is provided.

3.2. Environmental Impact Assessment (EIA)

The EIA study shall be developed by a MECA registered environmental consultant[2]. SEZAD have the authority to reject environmental reports which are conducted by companies who are not registered with MECA to undertake these studies.

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

[1] 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

[2] 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 summarized 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.

3.3. 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 minimize environmental impacts from the construction and operation phase of a project. The document outlines 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 minimize 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

To ensure compliance with national air quality standards, the air quality shall be monitored and assessed to determine which mitigation measures are required. The mitigation measures shall include Best Available Technology (BAT) and international best management practices, which are discussed in Section 5. The Project air quality shall be measured, assessed and reported for all Project phases in accordance with the methodologies described below.

4.1. Monitoring Methodologies

For each Project phase the monitoring requirements shall be determined by the Project specific environmental assessment. Depending on the Project requirements, either passive or active monitoring methods, or a combination of both, shall be employed to monitor air quality. Typically, passive monitoring is conducted using Palmes type diffusion tubes and active monitoring is conducted using either temporary or permanent monitoring stations.

4.1.1. Diffusion Tubes

Passive monitoring using diffusion tubes is an "indicative" monitoring technique. This is because there is relatively high uncertainty with the use of diffusion tubes, often quoted as ± 25% accuracy. This section covers the methods that shall be used when conducting diffusion tube monitoring.

Diffusion tubes are particularly useful:

- when simple, indicative techniques will suffice;
- to give an indication of longer-term average concentrations;
- for indicative comparison with ambient air quality standards based on the annual mean;
- for highlighting areas of high concentration; and
- where installation of an automatic analyser is not feasible.

They are useful for identifying areas of high concentration when dealing with sources such as traffic emissions, which do not change much from day to day. They are less useful for monitoring ambient concentrations around specific emission sources, such as an industrial plant, as they cannot identify short-term fluctuations that may result from fluctuations in wind direction.

4.1.1.1. Selecting Diffusion Tube Sites

The selection of sites will depend on the requirements of the Project environmental assessment. However, for Local Air Quality Management (LAQM) purposes, sites should be located in areas where there is relevant public exposure. Safety shall be an important consideration when siting tubes at height or near to roads.

The immediate area around the sampler location must be open, allowing free circulation of air around the tube. Ideally, samplers would be placed at breathing height, but in order to reduce theft of tubes, it is recommended that tubes are placed at a height of 2-4 m. Concentrations of pollutants typically decrease with height above street level, so tubes placed some metres above street level may under-estimate the actual concentrations to which the public are exposed. As far as is practical, all tubes within the monitoring programme shall be placed at similar heights.

Roadside and Kerbside Sites

Roadside and kerbside sites often reflect the maximum concentration of a pollutant to which people may be regularly exposed, even if only for short periods, close to a busy main road. The road with maximum traffic flow within the area may not produce the highest ambient concentrations if it is situated in an open area, for instance a dual carriageway. Higher concentrations may be observed at a less busy road with tall buildings on either side (the street canyon effect), for instance in a town centre. In general, unless data from other sources exist, local knowledge will be required to select the most appropriate sites.

Kerbside sites shall be within 1 m of the kerb, and are usually fixed to street furniture. Roadside diffusion tubes shall be sited between 1 and 5 m from the kerb edge, and mounted ideally either on a lamp post or road sign on the pavement, or with an appropriate fixing on the face of a building adjoining the pavement. Avoid locations where the tubes are likely to be affected by turbulence from passing fast traffic, as this may cause them to over-estimate the pollutant concentration.

Measurements from roadside and kerbside sites will only be representative over a very small area, as pollutant concentrations close to sources vary considerably, even over short distances.

In some instances, “Near-Road” sites may also be relevant. These are sites at which air quality is affected by a nearby major road, despite being more than 5 m away, and therefore do not technically fall into the “Roadside” category above. The same siting considerations apply.

Urban Centre, Urban Background, and Suburban (i.e. urban non-road) Sites

At distances of more than 50 m from a busy road, it is anticipated that pollutant concentrations will have been diluted to the local urban background concentration. Hence, measurements made in this type of location are likely to be representative of a fairly large area, and can be reliably compared with similar locations in other urban areas.

Urban background sites shall be located:

- >50 m from any major source of pollutant, such as multi-storey car parks
- >30 m from any very busy road (> 30,000 vehicles per day)

- >20 m from a busy road (10,000 – 30,000 vehicles per day) or from any medium sized sources of pollutants, e.g. fuel filling stations
- >10 m from any main road. (Quiet roads, for example within residential estates, are acceptable)
- >5 m from anywhere where vehicles may stop with their engines idling

Examples of typical urban background sites are on lamp posts or street signs in quiet residential areas, schools or other public buildings close to the residential centre. When street furniture is used, even on quiet roads, the tubes shall be more than 1 m from the kerb.

4.1.1.2. Detailed Siting of the Diffusion Tubes

Diffusion tubes shall be held vertically with the open end downwards during sampling (Figure 4-1). Generally, a permanent clip is mounted so that the tubes can be changed easily (Figure 4-2). The clip and spacer may be simply mounted at the monitoring site with PVC tape, double sided tape, or cable tie as appropriate.

It is important that the open end of the tube is exposed to free circulation of air. Also, certain surfaces may act as absorbers for a pollutant leading to a thin layer of reduced atmospheric concentrations immediately adjacent to the surface. For these reasons tubes must not be fixed directly to walls etc., even when the objective is to monitor at a building façade. A spacer block of at least 5 cm shall be used between the surface and the tube, as indicated in Figure 4-2. A small block of wood or plastic shall be used as the spacer. The open end of the tube shall be located below the lower surface of the spacer, as shown in Figure 4-2. Ideally the tube with spacer block should be mounted on some projection 0.5 - 1 m horizontal distance from the face of the building, or on a drainpipe or similar structure. Avoid placing diffusion tubes in any form of recess. Some examples of how diffusion tubes can be fixed in place are shown in Figure 4-3.

Figure 4-1: Palmes Diffusion Tube

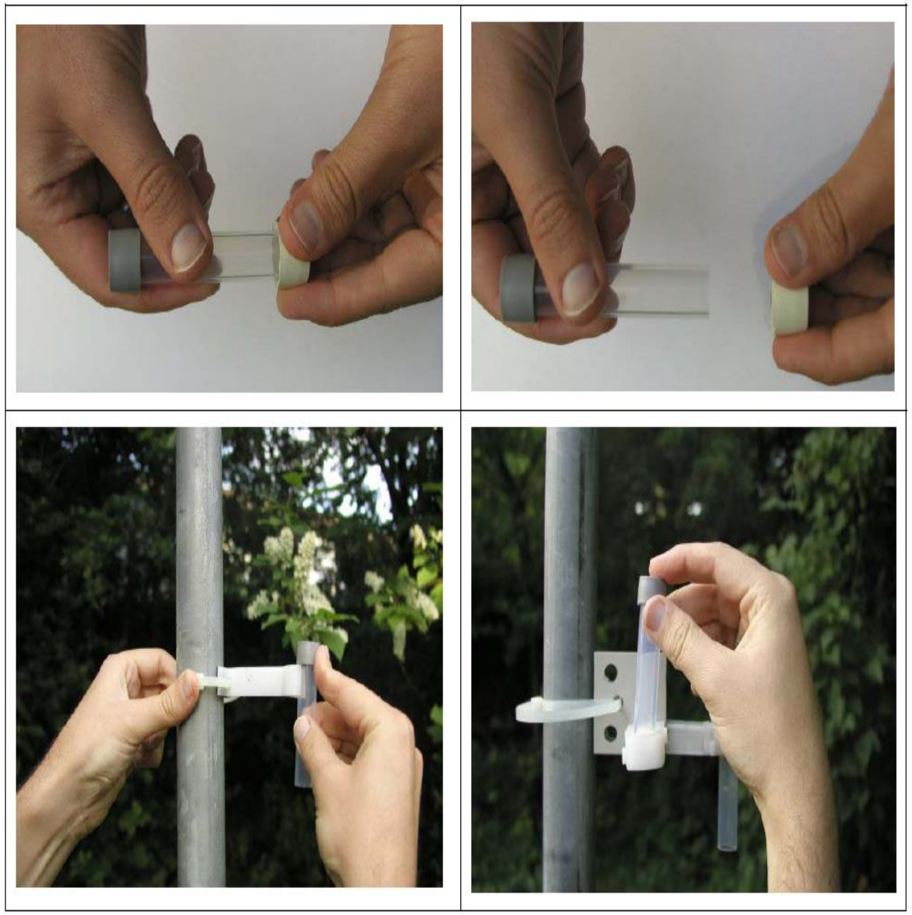

Figure 4-2: Deployment of Diffusion Tubes

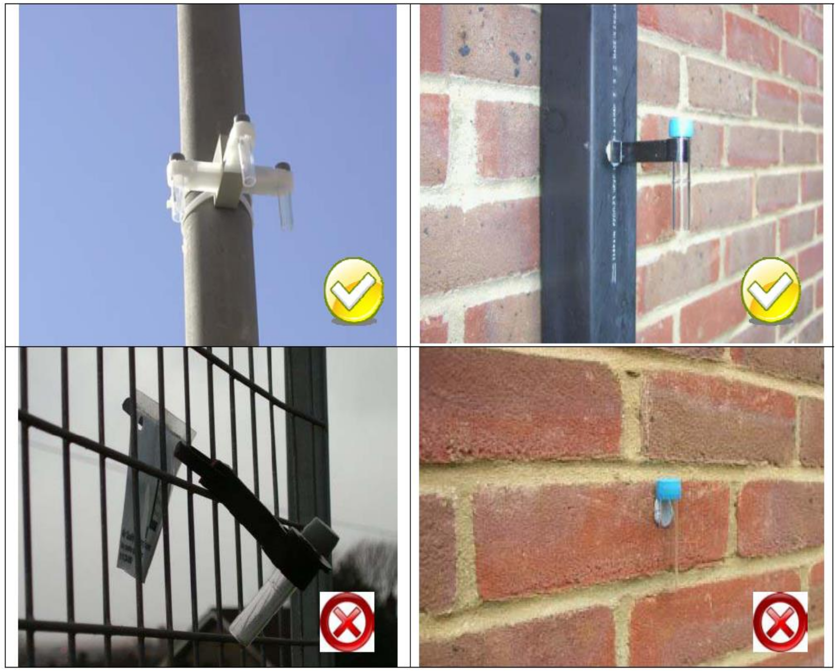

Figure 4-3: Examples of right and wrong ways to attach diffusion tubes

Although it is important to place diffusion tubes where there is free circulation of air around the tube, the opposite extreme shall also be avoided, i.e. areas of higher than usual turbulence. For this reason, the tube shall not be located on the corner of a building. Care shall be taken to avoid any very localised sources, or sinks of a pollutant, or disturbances to the airflow. For example, close proximity (less than 10 m) to the following shall be avoided:

- Bushes or trees overhanging or surrounding the tube location
- Air conditioning outlets
- Extractor vents

The site shall be open to the sky, with no overhanging vegetation or buildings.

4.1.1.3. Duration of Monitoring

The duration of the monitoring shall depend on the requirements of the Project environmental assessment. The monitoring duration shall be determined by the SEZAD Environmental Regulatory Department and shall be detailed in the environmental permit for each project. The monitoring duration shall include consideration for seasonal variations in pollutants, such as nitrogen dioxide. It is recommended that individual exposures of diffusion tubes shall ideally be 2-4 weeks (no longer than 5 weeks and no shorter than 1 week).

4.1.1.4. Detailed Methodology for Exposing Diffusion Tubes

It is important that the exposure of the diffusion tubes is carried out with appropriate quality assurance (QA). This section covers the important issues on deployment, exposure and collection. The following procedures shall be followed:

- Remove tubes from the refrigerator on the day that they are to be put out, and ensure each one is clearly labelled with a unique identification number (if this hasn't already been done by the supplying laboratory). The labelling must be weatherproof (i.e. waterproof labels or permanent pen).

- Take tubes to the site in a sealable plastic bag or plastic container. Travel blanks, where applicable, should be identified and their code numbers noted on the exposure details form provided by the laboratory.
- At each site, select a tube. Record its identification number, and the site at which it is to be exposed, on the exposure details form.
- With the absorbent (coloured) end cap uppermost, remove the bottom end cap (usually white or clear in colour) and clip/place the tube into the holder. Ensure the tube is positioned vertically with its open end downwards.
- Record the date and time of the start of the exposure period on the exposure details form, and make a note of any site irregularities (for example building/road works, traffic diversions).
- Keep the end caps in the bag/container, for use when the exposure period is completed.

On the appropriate date, the diffusion tubes will need to be changed and a new batch of tubes identified for exposure. The following procedures should be followed:

- Transport the new batch of unexposed tubes to site, together with the end caps from the last batch, any travel blanks as appropriate, and exposure details forms for both batches.
- At each site, remove the exposed tube from the sample holder and replace the end cap tightly.
- Record the time and date of the end of the exposure period on the exposure details form, against the appropriate tube number.
- Make a note on the form of any site irregularities (building/road works, traffic diversions), also anything which might affect, or even invalidate, the tube's results (for example tube found on the ground, insects, dirt, or liquid inside the tube).
- Select a new tube for exposure. Remove its end cap and place it open end down in the holder, as above. Record tube identity details, date and time. Tubes that are damaged or have splits in the end-caps should not be used.
- Keep the tubes in a sealed container, in a cool place (a fridge is best) until they can be returned to the laboratory for analysis, which should happen as soon as possible.
- Ensure that the tubes are used and analysed within 4 months of preparation.

- Tubes should always be capped securely after exposure; any tubes returned uncapped to the laboratory should be rejected. When visiting sites, it is recommended that the operator takes some spare tube end caps, also some spare mounting clips and spacer blocks to replace any missing or damaged.

More precise results will be obtained by using groups of three or more tubes together, rather than single tubes alone. However, this has to be balanced against the additional cost, and multiple tube exposure is not essential if good precision is demonstrated.

Laboratory analysis shall be conducted by laboratories permitted or certified for this purpose and Quality Assurance/Quality Control (QA/QC) plans shall be prepared and implemented. QA/QC documentation shall be included in monitoring reports.

4.1.2. Mobile and Permanent Monitoring Stations

Mobile and permanent air quality monitoring (AQM) stations shall be used when there is a requirement for continuous air quality monitoring within a defined period e.g. continuous monitoring for 24 hours. The benefit of using mobile monitoring stations is that multiple air pollutants can be monitored at a number of different monitoring sites. An example of a mobile monitoring station is shown in Figure 4-4.

Figure 4-4: Example of a mobile monitoring station

The AQM station consists of an enclosure typically containing a control module, power module, thermal management system, gas treatment module, a number of gas sensor modules, a RH/T sensor and associated cabling and plumbing.

The pollutants to be monitored shall depend on the requirements of the Project environmental assessment. However, typically the AQM can simultaneously monitor the following pollutants:

- Sulphur dioxide (SO_2)
- Nitrogen oxides (NO, NO_2, NO_x)
- Carbon monoxide (CO)
- Carbon dioxide (CO_2)
- Methane and non-methane hydrocarbons (MNHC)
- Hydrogen sulphide (H_2S)

- Ozone (O3)
- Benzene, toluene, ethyl benzene and xylene (BTEX)
- Particulate matter (PM10 and PM2.5)

The AQM shall run for no less than 24 hours at each site for mobile stations using solar power and batteries systems to ensure day and night continuous operation. The sampling inlet shall be installed at 1.8 m above the ground level.

The AQM shall be equipped with a multipoint automatic calibrator and an automatic data acquisition system (ADAS). The ADAS system shall be equipped with remote data acquisition capabilities. Data shall be viewable by SEZAD environmental personnel in real-time as received from the station. The system shall be capable of providing daily summaries which are accessible to SEZAD personal for reviewing 365 days per year for quality and accuracy control. The software shall be capable of:

- Local configuration management
- Real-time trend and tabular displays
- Data annotation
- Site logbook

4.1.2.1. Weather stations

Both mobile and permanent air quality monitoring stations shall incorporate weather stations so that the meteorological parameters can be simultaneously monitored with air pollutants. The weather stations shall monitor the following meteorological parameters:

- Wind speed and direction
- Ambient air temperature
- Relative humidity
- Rainfall
- Atmospheric pressure
- Solar radiation

In accordance with the US EPA Quality Assurance Handbook for Air Pollution Measurement Systems (US EPA, 2008), the weather stations shall be located at a distance beyond the influence of obstructions, such as buildings and trees. The weather stations shall also be sited at a location that ensures the measurements are representative of the meteorological conditions in the project area of interest.

4.1.3. Baseline Monitoring

The purpose of conducting a baseline air quality monitoring survey prior to any construction work, is to:

- Establish the baseline ambient air quality surrounding the Project area

- Compare the baseline air quality results to the Omani ambient air quality standards found in Section 2 (Applicable Standards)
- Identify exceedances to recommend suitable mitigation measures during the construction and operation activities
- Inform the air quality model through the results of the baseline survey

Part of the baseline survey is to identify the sensitive receptors around the Project area which may be impacted by air pollutants. The distance of each sensitive receptor from the Project boundary shall be recorded, as it will be used later during the air quality assessment.

The selection of monitoring sites shall depend on the requirements of the Project environmental assessment. In particular, a number of issues shall to be taken into account, including a decision on the number of sites that are to be established, whether they are to remain in a permanent position throughout the construction works and potentially during operations. For permanent monitoring stations there are a number of practical issues that also shall be considered, such as the availability of electrical power, access to the monitoring sites, and security.

The parameters to be analysed during the baseline monitoring are those listed in the Omani Ambient Air Quality Standards (AAQS), which include the following:

- NO2
- SO2
- CO
- H2S
- O3
- HCNM

If required, laboratory analysis shall be conducted by laboratories or air monitoring equipment permitted or certified for this purpose and Quality Assurance/Quality Control (QA/QC) plans shall be prepared and implemented. QA/QC documentation shall be included in monitoring reports.

4.1.4. Monitoring during Construction

The most significant air emission expected from construction activities is dust. The monitoring during construction activities shall include particulates, which is commonly measured as PM10.

This is not only of potential nuisance to adjacent or nearby occupants (particularly sensitive land uses such as schools, hospitals or residential areas) but in some instances also poses a potential health risk. However, it is usually the local amenity or nuisance impacts that are of concern to nearby premises. Local amenity and nuisance impacts could include the fouling of washing hung out to dry, freshly painted surfaces (houses) and washed surfaces (cars) through particulate fallout.

Other emissions from construction sites include those generated from the diesel engines operating vehicles and machinery. Diesel-fired engines emit particulate matter (soot) and gaseous emissions such as carbon monoxide, sulphur oxides, nitrogen oxides and organic compounds including polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs).

Air emissions can occur during construction or decommissioning works on sites to varying degrees and with different durations and frequencies. For example, road dust generated from vehicular movements within the site may occur at regular intervals. Other activities may only occur at a certain stage of the construction process, e.g. earthmoving, demolition, grit and sand blasting or spray painting.

The monitoring locations and frequency of monitoring during the construction phase shall be detailed in the project Construction Environmental Management Plan (CEMP). The frequency shall be specific to the construction activities, for example monitoring may be more frequent during earthworks activities.

4.1.5. Monitoring during Operation

The air emissions during operations will be specific for each project and shall be detailed in the Project Operational Environmental Management Plant (OEMP). The pollutants of concern will differ between industries and certain emission characteristics from the different industrial processes shall be considered. An emissions inventory shall be included in the Project OEMP to identify specific pollutants.

The emissions inventory shall serve to assess a priority list of important sources according to the amount of pollutants emitted, and indicates the relative influence of different sources. For example, traffic as compared to industrial sources. The emissions inventory also allows an estimate of air pollutant concentrations for those pollutants for which ambient concentration measurements are difficult or too expensive to monitor.

All operational monitoring shall be as per the EIA study, the monitoring plan proposed in the EIA study and initial/final environmental permit unless otherwise specified by SEZAD.

Table 4-1 lists the air pollutants typical for the industrial sources of pollution common to the SEZ area.

Monitoring during operations shall be representative of the emissions discharged by the project over time. For example, time-dependent variations in the manufacturing process, including batch process manufacturing and seasonal process variations shall be considered in the monitoring programme. Emissions from highly variable processes may need to be sampled more frequently or through composite methods. Emissions monitoring frequency and duration may also range from continuous, for some combustion process operating parameters, to less frequent, monthly, quarterly or yearly stack tests.

The Operational Environmental Management Plan (OEMP) shall include details of the monitoring locations, frequency of monitoring and pollutants to be monitored during operations.

It should be noted that additional air quality monitoring may be determined necessary with the upgrade of any major infrastructure components. Further depending on the monitoring reports or any complaints regarding the project SEZAD reserves the right to change the frequency of monitoring or add additional parameters, as deemed necessary.

Table 4-1: Air Pollutants from Industrial Sources Common to the SEZ Area

Parameters	Fish meal & Processing Facilities	Silica sand & Glass	Metal Casting & Production	Limestone & Cement	Petro chemical	Power Generation	Desalination (thermal plant)	Mining	Food Industry	Infrastructure
Suspended Particulate Matter (PM_{10})		x	x	x	x	x	x	x		x
Suspended Particulate Matter ($PM_{2.5}$)		x	x	x	x	x	x	x		x
Sulphur Dioxide (SO_2)		x	x	x	x	x	x	x		x
Nitrogen Compounds (NOx)		x	x	x	x	x	x			x
Carbon Monoxide (CO)		x	x	x	x	x	x			x
Volatile Organic Compounds (VOC)		x	x		x	x	x			x
BTEX					x					
Greenhouse Gases (GHG)		x	x	x	x	x	x		x	x
Lead (Pb)			x							
Fluoride (F)		x			x	x	x			
Ammonia	x				x	x	x		x	
Amines & Amides	x								x	

Parameters	Fish meal & Processing Facilities	Silica sand & Glass	Metal Casting & Production	Limestone & Cement	Petro chemical	Power Generation	Desalination (thermal plant)	Mining	Food Industry	Infrastructure
Hydrogen Sulphide, Sulphides, and Mercaptans	x				x	x	x		x	x
Hydrogen Chloride				x	x	x	x			
Hydrogen Fluoride				x						
Total Organic Carbon				x						
Metals (excluding lead, mercury and cadmium)				x	x	x	x			
Polycyclic Aromatic Hydrocarbons (PAH)					x	x	x			
Dioxins, Polychlorinated Biphenyl (PCB)				x		x	x			
Mercury, Cadmium				x	x	x	x			
Thallium				x						

Source:

World Bank Environmental, Health and Safety Guidelines: Fish Processing (April 2007).
Spiegel J.M Environmental pollution control and prevention (1998)
European Environment Agency (EEA) Emission inventory guidebook - 1.A.1 Energy Industries (2013)
World Bank Environmental, Health, and Safety Guidelines – Cement and Lime Manufacturing (April 2007)
World Bank Environmental, Health, and Safety Guidelines – Infrastructure, food industry and mining

4.1.6. Monitoring during Decommissioning

Normally, the methodology for monitoring air quality during construction is representative of the methodology adopted during decommissioning, as the equipment and procedures employed are similar. Thus, it is unlikely that decommissioning activities will cause a change in the impact on air quality from that experienced during the construction phase. As such no further details are needed for the decommissioning phase.

4.2. Assessment Methodology

This section discusses the air quality assessment methodologies that shall be followed by each Project applicant for all Project phases. The methodology is considered common for all proposed industries.

For small projects, the predicted levels of air emissions can be assessed using a qualitative impact assessment, taking into account the estimated emissions and distance between the source and the residences or other sensitive land uses.

For large or complex projects, in accordance with World Bank General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality standards, air quality impacts should be assessed through the use of baseline air quality monitoring and atmospheric dispersion models to assess potential ground level concentrations. The local atmospheric and climatic data, protection against atmospheric downwash, wakes, or eddy effects of the source, nearby structures, and terrain features shall be applied to the baseline air quality data when modelling dispersion. The dispersion model applied shall be internationally recognized or comparable. The applicant is required to refer to the complete official copy of the relevant World Bank standard to thoroughly understand the assessment methodology. The modelling approaches include screening models for single source evaluations (SCREEN3 or AERSCREEN) as well as more complex and refined models (AERMOD, ADMS or CALPUFF). Model selection is dependent on the complexity and geomorphology of the project site (e.g. mountainous terrain, urban or rural area). Any modelling would need to be validated by the Project applicant.

It is important to note that cumulative impact air quality modelling has not been discussed within this technical note, as it is not required within individual EIAs and shall be conducted by SEZAD on a project wide scale.

4.2.1. Identification of Exceedance

Prior to assessing an impact on air quality, the results of the air quality monitoring shall be compared against the relevant Omani standards. The Project applicant is required to refer to the complete official copy of the Omani standards. Where Omani standards are not available, comparisons shall be made against the relevant international standards (see Section 2).

4.2.2. Impact Assessment

If exceedances are identified, the significance of the impact shall be determined by comparing the value and sensitivity of the receptor against the magnitude of impact of the resultant effect. The assessment follows a three-step process:

- Evaluating the sensitivity of the receptor;
- Assessing the magnitude of the impact of the proposed industry on the ambient air quality, be it adverse or beneficial; and
- Determining the significance of effect resulting from impact (of a certain magnitude) on the resource (of particular value).

Refer SEZAD EIA guideline for generic classifications for environmental value, magnitude of impact and significance of effect.

5. GENERAL POLLUTION PREVENTION GUIDANCE NOTES

This chapter gives an overview of the Pollution Prevention Guidance Notes (PPGN) commonly used during each Project phase and international Best Management Practices for the proposed industries.

5.1. Construction and Decommissioning Pollution Prevention Guidelines

Construction sites vary in size and in the nature of activities that occur on them. Typically, they can include the following types of works:

- Clearing of land and related excavation and compaction activities.
- Operation of heavy machinery and related equipment for earthmoving and construction purposes (excavators, bulldozers, cranes, etc.) and the engines associated with such machines.
- Erection of structures using steel, concrete, brick, glass, timber, and other materials.
- Mechanical activities including grinding, hammering, drilling, grit blasting and demolition.
- Metal joining and finishing including welding, brazing, soldering and other techniques.
- Generation of solid wastes and debris, their stockpiling and transfer through chutes and loading onto trucks or into skips.
- Transport of building materials and supplies onto the site, and transport of wastes off site.
- Movement of vehicles along roadways and paths, in and out of the site and within the site, together with any establishment and maintenance of the roadways (e.g. grading).
- Application of surface coatings and finishes using paints and adhesives.

To prevent air pollution during the Project construction phase, specific details shall be included in the Dust Management Plan, as part of the Construction Environmental Management Plan (CEMP), which shall be developed and implemented by the construction contractor.

It should be noted that Pollution Prevention Guidance Notes (PPGN) for the decommissioning phase shall require a Decommissioning Environmental Management Plan (DEMP) which shall include a Dust Management Plan that details the mitigation measures to reduce air quality impacts during decommissioning and demolition activities. Therefore, this section can be considered applicable to the decommissioning phase.

The PPGN during the construction phase shall include, but is not limited to, the following guidelines:

- Odours from the premises shall not be detectable at the nearest sensitive land use.
- Water sprays and dust suppression surfactants shall be applied during demolition and earth moving activities.
- Disturbed areas of earth shall be minimised by scheduling construction activities to minimise dust entrainment.
- Disturbed earth surfaces shall be kept moist until vegetation cover has been established.
- Wind breaks shall be used where feasible.
- Stockpiles of building materials and earth shall be kept moist or the surfaces stabilised.
- Sand blasting and grit blasting shall be carried out in enclosed areas with efficient extraction ventilation discharged through fabric filters.
- Surface finishing by spray painting shall not to be carried out
    - where off-site overspray is possible, or
    - when wind direction and speed are such that off-site impacts are possible.
- Operations prone to generating dust shall be restricted when dust emissions increase significantly and to cease when average wind speed exceeds 15 m/s.
- Special measure to suppress and contain dust shall be adopted when old, lead-based paints are being removed.
- No burning of waste or vegetation shall be allowed.
- Haulage vehicles leaving the site shall pass through wheel washers.
- Unsealed roads shall be routinely watered.
- Diesel equipment shall be maintained in good condition and smoke emissions minimised.
- If contaminated land is encountered during construction activities, with possible emissions of toxic or odorous vapours, the site shall be re-assessed and treated as a contaminated site, as appropriate.
- Monitoring of control equipment shall be assessed based on
    - extent of emissions
    - toxicity or odorous potential of emissions, and
    - sensitivity of the activity.

- All activities, including housekeeping, shall be carried out according to industry best practice.
- Hours of operation shall be restricted where appropriate to reduce air quality impacts on sensitive receptors.

5.2. Pollution Prevention Guidelines during Operation

To prevent air pollution during the Project operation phase, specific details shall be included in the Air Quality Management Plan, as part of the Operational Environmental Management Plan (OEMP), which shall be developed and implemented by the Project applicant.

5.2.1. Point Sources

In accordance with the World Bank General EHS Guidelines: *Environmental Air Emissions and Ambient Air Quality standards,* emissions from point sources shall be avoided and controlled according to international best industry practice applicable to the relevant industry, depending on ambient conditions, through the combined application of process modifications and emissions controls.

5.2.1.1. Stack Height

The minimum stack heights shall comply with the requirements of MD 118/2004 (Table 2-7). The stack height for all point sources of emissions, whether 'significant' or not, shall be designed according to international best practice to avoid excessive ground level concentrations due to downwash, wakes, and eddy effects, and to ensure reasonable diffusion to minimize impacts. For projects where there are multiple sources of emissions, stack heights shall be established with due consideration to emissions from all other project sources, both point and fugitive. Non-significant sources of emissions including small combustion sources, shall also use international best practice in stack design.

5.2.2. Fugitive Sources

Fugitive source air emissions refer to emissions that are distributed spatially over a wide area and not confined to a specific discharge point. They originate in operations where exhausts are not captured and passed through a stack. Fugitive emissions have the potential for much greater ground-level impacts per unit than stationary source emissions, since they are discharged and dispersed close to the ground. The two main types of fugitive emissions are Volatile Organic Compounds (VOCs) and particulate matter (PM). Other contaminants (NOx, SO_2 and CO) are mainly associated with combustion processes. Projects with potentially significant fugitive sources of emissions shall establish the need for ambient quality assessment and monitoring. Open burning of solid wastes, whether hazardous or non-hazardous, is not considered good practice and shall be avoided, as the generation of polluting emissions from this type of source cannot be controlled effectively.

5.2.2.1. *Volatile Organic Compounds (VOCs)*

The most common sources of fugitive VOC emissions are associated with industrial activities that produce, store, and use VOC-containing liquids or gases where the material is under pressure, exposed to a lower vapour pressure, or displaced from an enclosed space. Typical sources include equipment leaks, open vats and mixing tanks, storage tanks, unit operations in wastewater treatment systems, and accidental releases. Equipment leaks include valves, fittings, and elbows which are subject to leaks under pressure. The recommended best industry practice to control VOC emissions associated with equipment leaks shall include implementing a leak detection and repair (LDAR) program that controls fugitive emissions by regularly monitoring to detect leaks, and implementing repairs within a predefined time period.

5.2.2.2. *Particulate Matter (PM)*

The most common pollutant involved in fugitive emissions is dust or particulate matter (PM). This is released during certain operations, such as transport and open storage of solid materials, and from exposed soil surfaces, including unpaved roads. The recommended best industry practice to control these emissions shall include:

- Use of dust control methods, such as covers, water suppression, or increased moisture content for open materials stock piles
- Use of water suppression for control of loose materials on paved or unpaved road surfaces. Oil and oil by-products is not a recommended method to control road dust

5.2.3. Ozone Depleting Substances (ODS)

Several chemicals are classified as ozone depleting substances (ODSs) and are scheduled for phase-out under the Montreal Protocol on Substances that Deplete the Ozone Layer. No new systems or processes shall be installed using CFCs, halons, 1,1,1-trichloroethane, carbon tetrachloride, methyl bromide or HBFCs.

5.2.4. Greenhouse Gases (GHGs)

Industries that may have potentially significant emissions of greenhouse gases (GHGs) include energy, transport, heavy industry (e.g. cement production, iron / steel manufacturing, aluminium smelting, petrochemical industries, petroleum refining, fertilizer manufacturing), agriculture, forestry and waste management. GHGs may be generated from direct emissions from facilities within the physical project boundary and indirect emissions associated with the off-site production of power used by the project.

The recommended management guidelines for reduction of greenhouse gases shall include:

- Carbon financing
- Enhancement of energy efficiency

- Promotion, development and increased use of renewable forms of energy
- Carbon capture and storage technologies
- Limitation and / or reduction of methane emissions through recovery and use in waste management, as well as in the production, transport and distribution of energy (coal, oil, and gas)

5.3. International Best Available Technology (BAT)

This section provides a description of the Best Available Technology (BAT) that is available to reduce impacts to air quality from industrial processes.

5.3.1. Nitrogen Oxide Controls

The first level of NOx control, in the case of boilers, shall be a low-NOx burner (LNB). These burners are designed to operate at cooler temperatures in order to minimize the formation of thermal NOx. The effect of low-NOx burners is to purposely operate slightly inefficiently, which will result in an increase in carbon monoxide (CO) emissions and a decrease in NOx.

NOx shall be controlled by selective non-catalytic reduction (SNCR), which involves the injection of ammonia or urea into the exhaust to react with NOx to form nitrogen and water. Without the benefit of a catalyst, the reaction temperature is very high (1,400 to 1,500°F), which makes SNCR only effective in a relatively high, narrow temperature range.

Selective catalytic reduction (SCR) is one of the most effective NOx controls for combustion sources. The catalyst allows an efficient reaction to take place at lower temperatures, typically 500–900°F, depending on the type of catalyst.

Additional controls of NOx emissions shall include low excess air firing, staged combustion, flue gas recirculation and water/steam injection. Further details of NOx controls are shown in Table 5-1.

5.3.2. Particulate Controls

To reduce air emissions of particulate matter the following controls shall be used:

- mechanical collectors
- electrostatic precipitators
- fabric filters
- wet scrubbers

Mechanical collectors, such as cyclones, shall be used in a pre-control capacity to remove the larger particulates.

Electrostatic precipitators shall be used mostly for high exhaust rate, high emission rate applications such as coal-fired power plants and steel mills.

Fabric filters shall be used to control a wide range of particulate emissions from large scale to very small emission sources. There are many fabrics that are used, depending on exhaust characteristics such as particulate loading, temperature and moisture content. Although there have been advances in high-temperature fabrics, fabric filters are temperature-limited.

Wet scrubbers have many different designs to improve the contact efficiency between the water and the particulate. Because the use of wet scrubbers requires control of the wastewater, applications shall be generally on large-particulate emission sources.

Further details on particulate controls are shown in Table 5-2 and Table 5-3.

5.3.3. Volatile Organic Compounds Controls

The volatile organic compounds (VOC) controls shall include the following:

- condensation techniques
- thermal oxidation
- bio-filtration
- carbon adsorption

Condensation (refrigeration) control, which cools the exhaust and precipitates out volatiles, is an earlier-generation technique popular with gasoline terminals before the development of carbon adsorption systems.

Thermal oxidation is a simple and effective way to destroy the VOC. However, the effort to control VOCs will produce combustion by-product emissions (primarily NOx and CO).

Bio-filters have not had widespread use, with most applications being for odour controls in composting operations.

Carbon adsorption is one of the most efficient VOC control techniques. The ideal application for carbon adsorption is for recoverable VOC material. Common examples of the use of carbon adsorption with a recovery system are gasoline terminals and coatings facilities that utilize a single solvent.

For VOC emissions associated with handling of chemicals in open vats and mixing processes, the recommended controls shall include:

- Substitution of less volatile substances, such as aqueous solvents;
- Collection of vapours through air extractors and subsequent treatment of gas stream by removing VOCs with control devices such as condensers or activated carbon absorption;
- Collection of vapours through air extractors and subsequent treatment with destructive control devices such as:

  - Catalytic Incinerators: Used to reduce VOCs from process exhaust gases exiting paint spray booths, ovens, and other process operations
  - Thermal Incinerators: Used to control VOC levels in a gas stream by passing the stream through a combustion chamber where the VOCs are burned in air at temperatures between 700º C to 1,300º C
  - Enclosed Oxidizing Flares: Used to convert VOCs into CO_2 and H_2O by way of direct combustion
- Use of floating roofs on storage tanks to reduce the opportunity for volatilization by eliminating the headspace present in conventional storage tanks.

5.3.4. Sulphur Dioxide Controls

The reduction of sulphur dioxide (SO_2) is primarily focused on fossil-fuel combustion sources. Reductions shall be accomplished through the use of lower sulphur–containing fuel and/or installation of wet or dry scrubbers. The economic impact analysis for an option such as dry scrubbing can show an economic benefit, as the waste may be saleable for the manufacture of wallboard. Additional information on sulphur dioxide controls is shown in Table 5-2.

5.3.5. Odour Controls

The recommended odour control techniques shall include the following:

- Install condensers on all appropriate process equipment (e.g., cookers and evaporators) to treat air emissions for odour, including sulphides and mercaptans;
- Install biofilters as the final method of air treatment and acid scrubbers for ammonia removal ahead of the biofilter;
- Install cyclones and filtration (fabric filters normally are adequate) to remove particulates;
- Reduce fugitive odour sources from open doors, open windows, and general room ventilation through the use of negative pressure-controlled ventilation systems.

Table 5-1: NOx Emissions Controls

<table>
<tr><th colspan="2">Oxides of Nitrogen (NOx)</th><th colspan="3">Percent Reduction by Fuel Type</th><th>Comments</th></tr>
<tr><td rowspan="10">Associated with combustion of fuel. May occur in several forms of nitrogen oxide; namely nitric oxide (NO), nitrogen dioxide (NO_2) and nitrous oxide (N_2O), which is also a greenhouse gas. The term NOx serves as a composite between NO and NO2 and emissions are usually reported as NOx. Here the NO is multiplied by the ratio of molecular weights of NO_2 to NO and added to the NO_2 emissions.

Means of reducing NOx emissions are based on the modification of operating conditions such as minimizing the resident time at peak temperatures, reducing the peak temperatures by increasing heat transfer rates or minimizing the availability of oxygen.</td><th>Combustion modification (Illustrative of boilers)</th><th>Coal</th><th>Oil</th><th>Gas</th><td rowspan="6">These modifications are capable of reducing NOx emissions by 50 to 95%. The method of combustion control used depends on the type of boiler and the method of firing fuel.</td></tr>
<tr><td>Low-excess-air firing</td><td>10–30</td><td>10–30</td><td>10–30</td></tr>
<tr><td>Staged Combustion</td><td>20–50</td><td>20–50</td><td>20–50</td></tr>
<tr><td>Flue Gas Recirculation</td><td>N/A</td><td>20–50</td><td>20–50</td></tr>
<tr><td>Water/Steam Injection</td><td>N/A</td><td>10–50</td><td>N/A</td></tr>
<tr><td>Low-NOx Burners</td><td>30–40</td><td>30–40</td><td>30–40</td></tr>
<tr><th>Flue Gas Treatment</th><th>Coal</th><th>Oil</th><th>Gas</th><td rowspan="3">Flue gas treatment is more effective in reducing NOx emissions than are combustion controls. Techniques can be classified as SCR, SNCR, and adsorption. SCR involves the injection of ammonia as a reducing agent to convert NOx to nitrogen in the presence of a catalyst in a converter upstream of the air heater. Generally, some ammonia slips through and is part of the emissions. SNCR also involves the injection of ammonia or urea based products without the presence of a catalyst.</td></tr>
<tr><td>Selective Catalytic Reduction (SCR)</td><td>60 – 90</td><td>60 – 90</td><td>60 – 90</td></tr>
<tr><td>Selective Non-Catalytic Reduction (SNCR)</td><td>N/A</td><td>30-70</td><td>30-70</td></tr>
<tr><td colspan="6">Source: World Bank General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality standards 2007</td></tr>
</table>

Table 5-2: Particulate and SO_2 Emissions Controls

Principal Sources and Issues	General Prevention / Process Modification Approach	Control Options	Reduction Efficiency (%)	Gas Condition	Comments
Particulate Matter (PM)					
Main sources are the combustion of fossil fuels and numerous manufacturing processes that collect PM through air extraction and ventilation systems. Volcanoes, ocean spray, forest fires and blowing dust (most prevalent in dry and semiarid climates) contribute to background levels.	Fuel switching (e.g. selection of lower sulphur fuels) or reducing the amount of fine particulates added to a process.	Fabric Filters	99 - 99.7%	Dry gas, temp <400F	Applicability depends on flue gas properties including temperature, chemical properties, abrasion and load. Typical air to cloth ratio range of 2.0 to 3.5 cfm/ft2. Achievable outlet concentrations of 23 mg/Nm3
		Electrostatic Precipitator (ESP)	97 – 99%	Varies depending of particle type	Precondition gas to remove large particles. Efficiency dependent on resistivity of particle. Achievable outlet concentration of 23 mg/Nm^3
		Cyclone	74 – 95%	None	Most efficient for large particles. Achievable outlet concentrations of 30 – 40 mg/Nm^3
		Wet Scrubber	93 – 95%	None	Wet sludge may be a disposal problem depending on local infrastructure. Achievable outlet concentrations of 30 - 40 mg/Nm^3
Sulphur dioxide (SO2)					
Mainly produced by the combustion of fuels such as oil and coal and as a by-product from some chemical production or wastewater treatment processes.	Control system selection is heavily dependent on the inlet concentration. For SO_2 concentrations in excess of 10%, the stream is passed through an acid plant not only to lower the SO_2 emissions but also to generate high grade sulphur for sale. Levels below	Fuel Switching	>90%		Alternate fuels may include low sulphur coal, light diesel or natural gas with consequent reduction in particulate emissions related to sulphur in the fuel. Fuel cleaning or beneficiation of fuels prior to combustion is another viable option but may have economic consequences.
		Sorbent Injection	30% - 70%		Calcium or lime is injected into the flue gas and the SO2 is adsorbed onto the sorbent

Principal Sources and Issues	General Prevention / Process Modification Approach	Control Options	Reduction Efficiency (%)	Gas Condition	Comments
	10% are not rich enough for this process and should therefore utilize absorption or 'scrubbing,' where SO_2 molecules are captured into a liquid phase or adsorption, where SO_2 molecules are captured on the surface of a solid adsorbent.	Dry Flue Gas Desulfurization	70%-90%		Can be re-generable or throwaway.
		Wet Flue Gas Desulfurization	>90%		Produces gypsum as a by-product
Source: World Bank General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality standards 2007					

Table 5-3: Fugitive Particulate Emissions Controls

Control Type	Control Efficiency
Chemical Stabilisation	0% - 98%
Hygroscopic salts, Bitumen/adhesives	60% - 96%
Surfactants	0% - 68%
Wet Suppression - Watering	12% - 98%
Speed Reduction	0% - 80%
Traffic Reduction	Not quantified
Paving (Asphalt/Concrete)	85% - 99%
Covering with Gravel, Slag or "Road Carpet"	30% - 50%
Vacuum Sweeping	0% - 58%
Water Flushing/Broom Sweeping	0% - 96%
Source: World Bank General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality standards 2007	

5.4. Industry Specific Air Quality Management Guidelines

5.4.1. Petrochemical Industry

Air emissions from the petrochemical industry can be classified as combustion emissions, process emissions, fugitive emissions, emissions from storage and handling of petroleum liquids and secondary emissions. Combustion emissions are produced from onsite burning of fuels for energy production and transportation purposes. Flaring is a specific source of combustion emissions in the petrochemical industry. It is used to control pressure and remove gas that cannot be otherwise used. Fugitive emissions are release through leaking valves, pumps or other process devices. Process emissions are generated in the process units and released from process vents. Storage and handling emissions are contributed from the storage and manipulation of natural gas, crude oil and the petroleum derivatives. The water systems of the production or processing site are the main source of secondary emissions.

Typical controls for air emissions in the petrochemical industry shall include:

- Scrubbers
- Electrostatic precipitators
- Steam strippers

5.4.2. Silica Sand/Glass Industry

There are two types of air emissions generated in the silica sand/glass industry, emissions from the combustion of fuel for operating the glass-melting furnaces, and fine particulates from the vaporization and recrystallization of materials in the melt.

Oxygen-enriched and oxyfuel furnaces shall be used in specialty glass operations to reduce emissions or to make possible higher production rates with the same size furnace. Although oxyfuel furnaces may produce higher NOx emissions on a concentration basis, they are expected to yield very low levels of nitrogen oxides on a mass basis (kg/t of product). Low-NOx furnaces, staged firing, and flue gas recirculation shall be used to reduce both concentration and the mass of nitrogen oxide emissions. These controls are also available for air-fuel-fired furnaces.

The type of combustion fuel used affects the amount of sulphur oxides and nitrogen oxides emitted. Use of natural gas results in negligible sulphur dioxide emissions from the fuel compared with high-sulphur fuel oils. Fuel oil with a low sulphur content is preferable to fuel oil with a high sulphur content if natural gas is not available.

An efficient furnace design will reduce gaseous emissions and energy consumption. Improvements in design shall include modifications to the burner design and firing patterns, higher preheater temperatures, preheating of raw material, and electric melting.

Changing the composition of the raw materials shall be considered, for example, to reduce chlorides, fluorides, and sulphates used in certain specialty glasses. The use of outside-sourced cullet and recycled glass will reduce energy requirements (for an estimated 2% savings for each 10% of cullet used in the manufacture of melt) and thus air emissions (up to 10% for 50% cullet in the mix). Typical recycling rates are 10–20% in the flat glass industry and over 50% for the blown and pressed glass industries.

The amount of heavy metals used as refining and colouring or decolouring agents, as well as use of potassium nitrate, shall be minimized to the extent possible.

In the furnace, particulates are formed through the volatilization of materials, leading to formation of condensates and of slag that clogs the furnace checkers. Disposal of the slag requires testing to determine the most suitable disposal method. It is important to inspect the checkers regularly to determine whether cleaning is required.

Particulate matter shall be reduced by enclosing conveyors, pelletizing raw material, reducing melt temperatures, and blanketing the furnace melt with raw material.

Electrostatic precipitators are the preferred choice for removing particulates, although fabric filters can also be used. Dry scrubbing using calcium hydroxide shall be used to reduce sulphur dioxide, hydrogen fluoride, and hydrogen chloride. Secondary measures for NOx control shall include selective catalytic reduction (SCR), selective non-catalytic reduction (SNCR), and certain proprietary processes such as the Pilkington 3R process.

5.4.3. Limestone/Cement Industry

The main sources of air pollution in the cement industry include excavation activities, dumps, tips, conveyer belts, crushing mills and kiln emissions. The most significant air emissions from sources other than the kiln is dust (particulate matter). The dust shall be captured using a hood or other partial enclosure and then transported through a series of ducts to the collectors. The type of dust collector to be used is based on factors such as particle size, dust loading, flow rate, moisture content, and gas temperature. The best disposal method for collected dust is to send it through the kiln creating the clinker. However, if the alkali content of the raw materials is too high, the dust must be discarded, or must be pre-treated before introduction into the kiln.

Air emissions from the kiln shall be controlled using the technologies included in Table 5-1.

5.4.4. Fisheries Industry

Odour is often the most significant form of air pollution in the fish processing industry. Major sources include storage sites for processing waste, cooking by-products during fish meal production, fish drying processes, and odour emitted during filling and emptying of bulk tanks and silos. Fish quality may deteriorate under the anaerobic conditions found in on-board storage on fishing vessels and in the raw material silos of fish processing facilities. This deterioration causes the formation of odorous compounds such as ammonia, mercaptans, and hydrogen sulphide gas.

The following recommended measures shall be undertaken to prevent the generation of odour emissions:

- Avoid processing batches of raw material that are of considerably lower than average quality; this will reduce the odour components;
- Reduce the stock of raw materials, waste, and by-products and store this stock for short periods of time only in a cold, closed, well-ventilated place;
- Seal by-products in covered, leak-proof containers;
- Keep all working and storage areas clean and remove waste products immediately from the production line;
- Empty and clean fat traps on a regular basis;
- Cover all transfer systems, wastewater canals, and wastewater treatment facilities to reduce the escape of foul odours;
- Install condensers on all appropriate process equipment (e.g., cookers and evaporators) to treat air emissions for odour, including sulphides and mercaptans;
- Reduce fugitive odour sources from open doors, open windows, and general room ventilation through the use of negative pressure-controlled ventilation systems.

5.4.5. Power Generation Industry

Power generation facilities can be either large utility plants or industrial combustion plants, providing power (e.g. in the form of electricity or mechanical power), steam, or heat to industrial production processes and are operated according to energy demand and requirement. The facilities can be operated either on a continuous basis to provide a base power load or intermittently to provide power during periods of peak demand.

The primary emissions to air from the combustion of fossil fuels are sulphur dioxide (SO_2), nitrogen oxides (NO_X), particulate matter (PM), carbon monoxide (CO), and greenhouse gases, such as carbon dioxide (CO_2). Depending on the fuel type and quality, mainly waste fuels or solid fuels, other substances such as heavy metals (i.e., mercury, arsenic, cadmium, vanadium, nickel, etc.), halide compounds (including hydrogen fluoride), unburned hydrocarbons and other volatile organic compounds (VOCs) may be emitted in smaller quantities, but may have a significant influence on the environment due to their toxicity and/or persistence. Sulphur dioxide and nitrogen oxide are also implicated in long-range and trans-boundary acid deposition.

The following recommended measures shall be undertaken to reduce emissions of air pollutants from power plants:

- When burning coal, give preference to high-heat-content, low-ash, and low-sulphur coal;
- Consider the use of higher energy-efficient systems, such as combined cycle gas turbine system for natural gas and oil-fired units, and supercritical, ultra-supercritical or integrated coal gasification combined cycle (IGCC) technology for coal-fired units)
- Design stack heights in accordance with MD 118/2004 requirements;
- Considering use of combined heat and power (CHP, or cogeneration) facilities;
- Use of fuel gas leak detection systems and alarms;
- Use fuels with a lower content of sulphur where economically feasible;
- Use of lime (CaO) or limestone ($CaCO_3$) in coal-fired fluidized bed combustion boilers to have integrated desulfurization which can achieve a removal efficiency of up to 80-90 % through use of Fluidized Bed Combustion;
- Use of flue gas desulfurization (FGD) for large boilers using coal or oil and for large reciprocating engines. Technologies for FGD include sea water scrubbing, wet limestone scrubbing, spray dry scrubbing and dry sorbent scrubbing;
- Use of low NOx burners with other combustion modifications, such as low excess air (LEA) firing, air staging, flue gas recirculation, reduced air preheat, fuel staging and over fire air (OFA);
- Use of a selective catalytic reduction (SCR) system for pulverized coal-fired, oil-fired, and gas-fired boilers or a selective non-catalytic reduction (SNCR) system for a fluidized-bed boiler;
- Use of dry low-NOx combustors for combustion turbines burning natural gas;
- Use of water injection or SCR for combustion turbines and reciprocating engines burning liquid fuels;
- Optimization of operational parameters for existing reciprocating engines burning natural gas to reduce NOx emissions;
- Use of lean-burn concept or SCR for new gas engines;

- Use of combined SO2/NOx removal techniques such as desorption, gas/solid catalytic operation, electron beam irradiation, alkali injection and wet scrubbing;
- Installation of dust controls capable of over 99% removal efficiency, such as electrostatic precipitators (ESPs) or fabric filters (baghouses), for coal-fired power plants. The advanced control for particulates is a wet ESP, which further increases the removal efficiency and also collects condensable (e.g., sulphuric acid mist) that are not effectively captured by an ESP or a fabric filter;
- Use of loading and unloading equipment that minimizes the height of fuel drop to the stockpile to reduce the generation of fugitive dust;
- The use of enclosed silos vented to fabric filters or cyclone dust collectors;
- Use of water spray systems, binders, stockpile management techniques and wind breaks to reduce the formation of fugitive dust from solid fuel storage in arid environments;
- Use of enclosed conveyors with well designed, extraction and filtration equipment on conveyor transfer points to prevent the emission of dust;
- For solid fuels of which fine fugitive dust could contain vanadium, nickel and Polycyclic Aromatic Hydrocarbons (PAHs) (e.g., in coal and petroleum coke), use of full enclosure during transportation and covering stockpiles where necessary;
- Storage of lime or limestone in silos with well designed, extraction and filtration equipment;
- Use of wind fences in open storage of coal or use of enclosed storage structures to minimize fugitive dust emissions;
- Applying special ventilation systems in enclosed storage areas to avoid dust explosions (e.g. Use of cyclone separators at coal transfer points);
- Fuel cleaning to removal heavy metals from coal using mechanical devices, dense media washing and froth flotation;
- Use of conventional secondary controls such as fabric filters or ESPs operated in combination with FGD techniques, such as limestone FGD, dry lime FGD, or sorbent injection;
- Use of a high dust SCR system along with Powered Activated Carbon (PAC);
- Use of bromine-enhanced Powdered Activated Carbon or other sorbents;
- Use of less carbon intensive fossil fuels (i.e., less carbon containing fuel per unit of calorific value -- gas is less than oil and oil is less than coal) or co-firing with carbon neutral fuels (i.e., biomass);

- Use of high performance monitoring and process control techniques, good design and maintenance of the combustion system so that initially designed efficiency performance can be maintained with good combustion control;
- Consideration for use of carbon capture and disposal technologies;
- When transferring volatile liquids subsurface filling via (anti-syphon) filling pipes extended to the bottom of the container, the use of vapour balance lines that transfer the vapour from the container being filled to the one being emptied, or an enclosed system with extraction to suitable abatement plant should be used;
- Vent systems should be chosen to minimize breathing emissions (for example pressure/ vacuum valves) and, where relevant, should be fitted with knock-out pots and appropriate abatement equipment;
- Maintenance of bulk storage temperatures as low as practicable, taking into account changes due to solar heating;
- Use of techniques to reduce fugitive losses from storage tanks, including using tank paint with low solar absorbency, temperature control, tank insulation, inventory management, floating roof tanks, bladder roof tanks, pressure/vacuum valves and specific release treatment (such as adsorption condensation).

5.4.6. Desalination Industry

Desalination plants can be either thermal or Reverse Osmosis (RO). If a desalination plant requires thermal energy the air emissions are due to fuel combustion. Air emissions from fuel combustion include sulphur dioxide (SO_2), nitrogen oxides (NOX), particulate matter (PM), carbon monoxide (CO), and greenhouse gases, such as carbon dioxide (CO_2).

The BMPs that shall be undertaken to reduce emissions of air pollutants from desalination plants that use thermal energy are the same as the power generation BMPs outlined in Section 5.4.5.

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

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

Air emissions from port and terminal activities include combustion exhaust emissions resulting from diesel engines used for the propulsion of ships, and ship-based auxiliary engines and boilers for power generation. In addition, combustion exhaust emissions are generated from land-based activities involving the use of vehicles, cargo handling equipment, and other engines and boilers. Other sources of air emissions include volatile organic compound (VOC) emissions from fuel storage tanks and fuel transfer activities, in addition to dust emissions.

The following recommended measures shall be undertaken to reduce emissions of air pollutants from infrastructure projects:

5.4.7.1. Airports

- Minimizing fugitive air emissions from jet kerosene and other fuel storage and handling activities

5.4.7.2. Gas Distribution Network

- Gas pipelines and pipeline components, should meet international standards for structural integrity and operational performance;
- Corrosion prevention of pipelines should be undertaken using coating or cathodic protection techniques. For underground applications, the use of polyethylene pipe, which is not subject to corrosion, should be considered as an alternative to ferrous metal pipeline materials;
- Testing of pipelines and pipeline components for pressure specifications and presence of leaks should be undertaken prior to commissioning. The system should be gas tight when tested at a higher pressure than the normal maximum operation gas pressure;
- Leak and corrosion detection programs should be undertaken, including use of appropriate leak detection
- assessment techniques and equipment.
- Maintenance programs to repair and replace infrastructure should be undertaken as indicated by detection results.
- Regulating stations and vaults, both above and below

ground, may contain equipment (e.g. safety valves, filters) that may emit fugitive emissions of gas. Pipelines, valves, and other component infrastructure should be regularly maintained, and ventilation and gas detection / alarm equipment installed in station buildings or vaults.

reduce emissions of air pollutants from infrastructure projects:

5.4.7.3. Ports, Harbors and Terminals

- Validate ship engine performance documentation and certification to ensure compliance with combustion emissions specifications (including NOx, SOx, and PM),
- Require use of low-sulphur fuels in port, if feasible, or as required by international regulations
- When practical and without affecting the safety of vessel navigation, use reduced ship propulsion power in port access areas.
- Where practicable, design port layouts and facilities to minimize travel distances and transfer points, for example from ships’ off-loading and on-loading facilities to storage areas, and to avoid/minimize re-storage and re-shuffling of cargo.

- Maintain cargo transfer equipment (e.g., cranes, forklifts, and trucks) in good working condition to reduce air emissions.
- VOC emissions from fuel and cargo storage, and transfer activities should be minimized through vapor recovery systems for fuel storage, loading/offloading, and fueling activities, the use of floating top storage tanks, and the adoption of management practices

5.4.8. Mining

Air emissions associated with mining activity include emissions during exploration, development, construction, and operational activities. The principal sources include fugitive dust from blasting, exposed surfaces such as stockpiles, waste dumps, haul roads and infrastructure, and emissions associated with combustion of fuels in stationary and mobile power generating units. Air emissions from fuel combustion include sulphur dioxide (SO_2), nitrogen oxides (NOX), particulate matter (PM), carbon monoxide (CO), and greenhouse gases, such as carbon dioxide (CO_2). This is covered under Section 5.4.5.

The following recommended measures shall be undertaken to reduce dust emissions during mining:

- Dust suppression techniques (e.g. wetting down, use of all-weather surfaces, use of agglomeration additives) for roads and work areas, optimization of traffic patterns, and reduction of travel speeds;
- Exposed soils and other erodible materials should be revegetated or covered promptly;
- New areas should be cleared and opened-up only when absolutely necessary;
- Storage for dusty materials should be enclosed or operated with efficient dust suppressing measures;
- Loading, transfer, and discharge of materials should take place with a minimum height of fall, covered, and be shielded against the wind, and consider use of dust suppression spray systems.

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