Appendix A: National Environmental Quality Standards

Exhibit A.1: NEQS for Municipal and Liquid Industrial Effluents[1, 2]
(mg/l, unless otherwise defined)

No.	*Parameter*	*Standards*		
		Into Inland Waters	*Into Sewage Treatment*[3]	*Into Sea*[4]
1.	Temperature increase[5]	=<3°C	=<3°C	=<3°C
2.	pH value	6 to 9	6 to 9	6 to 9
3.	Five-day bio-chemical oxygen demand (BOD)[5] at 20°C[6]	80	250	80[7]
4.	Chemical oxygen demand (COD)	150	400	400
5.	Total suspended solids (TSS)	200	400	200
6.	Total dissolved solids (TDS)	3,500	3,500	3,500
7.	Grease and oil	10	10	10
8.	Phenolic compounds (as phenol)	0.1	0.3	0.3
9.	Chlorides (as Cl')	1,000	1,000	SC[8]
10.	Fluorides (as F')	10	10	10
11.	Cyanide total (as CN')	1.0	1.0	1.0
12.	Anionic detergents (as MBAS)[9]	20	20	20
13.	Sulfates (SO_4)	600	1,000	SC[8]
14.	Sulfides (s')	1.0	1.0	1.0
15.	Ammonia (NH_3)	40	40	40
16.	Pesticides[10]	0.15	0.15	0.15
17.	Cadmium[11]	0.1	0.1	0.1
18.	Chromium (trivalent and hexavalent)	1.0	1.0	1.0
19.	Copper[4]	1.0	1.0	1.0
20.	Lead[4]	0.5	0.5	0.5
21.	Mercury[4]	0.01	0.01	0.01
22.	Selenium[4]	0.5	0.5	0.5
23.	Nickel[4]	1.0	1.0	1.0
24.	Silver[4]	1.0	1.0	1.0
25.	Total toxic metals	2.0	2.0	2.0

No.	*Parameter*	*Standards*		
		Into Inland Waters	*Into Sewage Treatment*[3]	*Into Sea*[4]
26.	Zinc	5.0	5.0	5.0
27.	Arsenic[4]	1.0	1.0	1.0
28.	Barium[4]	1.5	1.5	1.5
29.	Iron	8.0	8.0	8.0
30.	Manganese	1.5	1.5	1.5
31.	Boron[4]	6.0	6.0	6.0
32.	Chlorine	1.0	1.0	1.0

Explanations:

1. Dilution of liquid effluents to bring them to the NEQS limiting values is not permissible through fresh water mixing with the effluent before discharging into the environment.
2. The concentration of pollutants in water being used will be subtracted from the effluent for calculating the NEQS limits.
3. Applicable only when and where sewage treatment is operational and BOD = 80 mg/l is achieved by the sewage treatment system.
4. Provided discharge is not at shore and not within 10 miles of mangrove or other important estuaries.
5. The effluent should not result in temperature increase of more than $3^{o}C$ at the edge of the zone where initial mixing and dilution take place in the receiving body. In case zone is not define, use 100 m from the point of discharge
6. Assuming minimum dilution 1:10 discharge, lower ratio would attract progressively stringent standards to be determined by the Federal Environmental Protection Agency. By 1:10 dilution means, for example that for each one cubic meter of treated effluent, the recipient water body should have 10 cubic meter of water for dilution of this effluent.
7. The value for industry is 200 mg/l
8. Discharge concentration at or below sea concentration (SC)
9. Modified Benzene Alkyl Sulfate assuming surfacetant as biodegradable.
10. Pesticides include herbicides, fungicides, and insecticides
11. Subject to total toxic metals discharge should not exceed level given at S. No. 25.

Exhibit A.2: National Environmental Quality Standards for Gaseous Emissions

No.	*Parameter*	*Source of Emission*	*Standards*
1.	Smoke	Smoke opacity not to exceed	40% or 2 on Ringlemann Scale or equivalent smoke number
2.	Particulate matter[1]	(a) Boilers and furnaces:	
		i) Oil-fired	300
		ii) Coal-fired	500
		iii) Cement kilns	300
		(b) Grinding, crushing, clinker coolers and related processes, metallurgical processes, converters, blast furnaces and cupolas	500
3.	Hydrogen chloride	Any	400
4.	Chlorine	Any	150
5.	Hydrogen fluoride	Any	150
6.	Hydrogen sulfide	Any	10
7.	Sulfur oxides[2, 3]	Sulfuric acid/sulfonic acid plants	5,000
		Other plants except power plants operating on oil and coal	1,700
8.	Carbon monoxide	Any	800
9.	Lead	Any	50
10.	Mercury	Any	10
11.	Cadmium	Any	20
12.	Arsenic	Any	20
13.	Copper	Any	50
14.	Antimony	Any	20
15.	Zinc	Any	200
16.	Oxides of nitrogen[3]	Nitric acid manufacturing unit	3,000
		Gas-fired	400
		Oil-fired	600
		Coal-fired	1,200

1. Based on the assumption that the size of the particulate is 10 micron or more.
2. Based on 1 per cent sulfur content in fuel oil. Higher content of sulfur will cause standards to be pro-rated.
3. In respect of emissions of sulfur dioxide and nitrogen oxides, the power plants operating on oil and coal as fuel shall in addition to National Environmental Quality Standards (NEQS) special above, comply with the following standards.

Exhibit A.3: Pakistan Standards for Sulfur Dioxide and Nitrogen Oxides for Power Plants Operating on Oil and Coal

A. Sulfur Dioxide

Sulfur Dioxide Background Levels (mg/m^3)			*Standards*	
			Criterion I	*Criterion II*
Background Air Quality (SO_2 basis)	*Annual Average*	*Maximum 24-Hour Interval*	*Max. SO_2 Emissions (TPD)*	*Max. Allowable 1-Year Average Ground Level Increment to Ambient (mg/m^3)*
Unpolluted	< 50	< 200	500	50
Moderately polluted[1]				
Low	50	200	500	50
High	100	400	100	10
Very polluted[2]	> 100	> 400	100	10

1. For intermediate values between 50 and 100 $\mu g/m^3$ linear interpretation should be used.
2. No project with sulfur dioxide emissions will be recommended.

B. Nitrogen Oxides

Annual arithmetic mean of ambient air concentrations of nitrogen oxides (expressed as NO_2) should not exceed		100 $\mu g/m^3$ (0.05 ppm)
Maximum emission levels for stationary source discharges, before mixing with the atmosphere: For fuel fired steam generators		
	Liquid fossil fuel	130 ng/J of heat input
	Solid fossil fuel	300 ng/J of heat input
	Lignite fossil fuel	260 ng/J of heat input

Exhibit A.4: National Environmental Quality Standards for Motor Vehicle Exhaust and Noise

No.	*Parameter*	*Standards (Maximum Permissible Limit)*		*Measuring Method*
1.	Smoke	40% or 2 on the Ringelmann Scale during engine acceleration mode.		To compared with Ringlemann chart at a distance of 6 meters or more.
2.	Carbon Monoxide	Emission Standards:		
		New Vehicles	Used Vehicles	
		4 .5%	6%	Under idling conditions: Nondispersive infrared detection through gas analyzer.
3.	Noise	85 db (A)		Sound-meter at 7.5 meters from the source.

Exhibit A.5: National Environmental Quality Standards for Ambient Air

Pollutants	*Time-weighted Average*	*Concentration in Ambient Air*		*Method of Measurment*
		Effective from 1st July 2010	*Effective from 1st January 2013*	
Sulpher Dioxide (SO_2)	Annual Average*	80 μg/m^3	80 μg/m^3	-Ultra Violet Fluorescence method
	24 hours**	120 μg/m^3	120 μg/m^3	
Oxide of Nitrogen as (NO)	Annual Average*	40 μg/m^3	40 μg/m^3	-Gas Phase Chemiluminescence
	24 hours**	40 μg/m^3	40 μg/m^3	
Oxide of Nitrogen as (NO_2)	Annual Average*	40 μg/m^3	40 μg/m^3	-Gas Phase Chemiluminescence
	24 hours**	40 μg/m^3	80 μg/m^3	
O_3	1 hour	180 μg/m^3	130 μg/m^3	-Non dispersive UV absorption method
Suspended Particulate Matter (SPM)	Annual Average*	400 μg/m^3	360 μg/m^3	-High Volume Sampling, (Average flow rate not less than 1.1 m^3/min)
	24 hours**	550 μg/m^3	500 μg/m^3	
Respirable particulate Matter. PM_{10}	Annual Average*	200 μg/m^3	120 μg/m^3	-β Ray Absorption method
	24 hours**	250 μg/m^3	150 μg/m^3	
Respirable Particulate Matter. $PM_{2.5}$	Annual Average*	25 μg/m^3	15 μg/m^3	-β Ray Absorption method
	24 hours**	40 μg/m^3	35 μg/m^3	
	1 hour	25 μg/m^3	15 μg/m^3	
Lead (Pb)	Annual Average*	1.5 μg/m^3	1 μg/m^3	ASS Method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	2 μg/m^3	1.5 μg/m^3	
Carbon Monoxide (CO)	8 hours**	5 mg/m^3	5 mg/m^3	Non Dispersive Infra Red (NDIR) method
	1 hour	10 mg/m^3	10 mg/m^3	

* Annual arithmetic mean of minimum 104 instruments in a year taken twice a week 24 hourly at uniform interval

** 24 hourly /8 hourly values should be met 98% of the in a year. 2% of the time, it may exceed but not on two consecutive days.

Appendix B: IFC's EHS Guidelines for Thermal Power Plant

Please see following page.

Environmental, Health, and Safety Guidelines for Thermal Power Plants

Introduction

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP)[1]. When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the **General EHS Guidelines** document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary. A complete list of industry-sector guidelines can be found at: www.ifc.org/ifcext/sustainability.nsf/Content/EnvironmentalGuidelines

The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, based on environmental assessments and/or environmental audits as appropriate, with an appropriate timetable for achieving them. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account. The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

Applicability

This document includes information relevant to combustion processes fueled by gaseous, liquid and solid fossil fuels and biomass and designed to deliver electrical or mechanical power, steam, heat, or any combination of these, regardless of the fuel type (except for solid waste which is covered under a separate Guideline for Waste Management Facilities), with a total rated heat input capacity above 50 Megawatt thermal input (MWth) on Higher Heating Value (HHV) basis.[2] It applies to boilers, reciprocating engines, and combustion turbines in new and existing facilities. Annex A contains a detailed description of industry activities for this sector, and Annex B contains guidance for Environmental Assessment (EA) of thermal power projects. Emissions guidelines applicable to facilities with a total heat input capacity of less than 50 MWth are presented in Section 1.1 of the **General EHS Guidelines.** Depending on the characteristics of the project and its associated activities (i.e., fuel sourcing and evacuation of generated electricity), readers should also consult

[1] Defined as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity as well as varying levels of financial and technical feasibility.

[2] Total capacity applicable to a facility with multiple units.

the EHS Guidelines for Mining and the EHS Guidelines for Electric Power Transmission and Distribution.

Decisions to invest in this sector by one or more members of the World Bank Group are made within the context of the World Bank Group strategy on climate change.

This document is organized according to the following sections:

Section 1.0 – Industry Specific Impacts and Management
Section 2.0 – Performance Indicators and Monitoring
Section 3.0 – References and Additional Sources
Annex A – General Description of Industry Activities
Annex B – Environmental Assessment Guidance for Thermal Power Projects.

1.0 Industry-Specific Impacts and Management

The following section provides a summary of the most significant EHS issues associated with thermal power plants, which occur during the operational phase, along with recommendations for their management.

As described in the introduction to the **General EHS Guidelines**, the general approach to the management of EHS issues in industrial development activities, including power plants, should consider potential impacts as early as possible in the project cycle, including the incorporation of EHS considerations into the site selection and plant design processes in order to maximize the range of options available to prevent and control potential negative impacts.

Recommendations for the management of EHS issues common to most large industrial and infrastructure facilities during the construction and decommissioning phases are provided in the **General EHS Guidelines**.

1.1 Environment

Environmental issues in thermal power plant projects primarily include the following:

- Air emissions
- Energy efficiency and Greenhouse Gas emissions
- Water consumption and aquatic habitat alteration
- Effluents
- Solid wastes
- Hazardous materials and oil
- Noise

Air Emissions

The primary emissions to air from the combustion of fossil fuels or biomass are sulfur 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. Sulfur dioxide and nitrogen oxide are also implicated in long-range and trans-boundary acid deposition.

The amount and nature of air emissions depends on factors such as the fuel (e.g., coal, fuel oil, natural gas, or biomass), the type and design of the combustion unit (e.g., reciprocating engines, combustion turbines, or boilers), operating practices, emission control measures (e.g., primary combustion control, secondary flue gas treatment), and the overall system efficiency. For example, gas-fired plants generally produce negligible quantities of particulate matter and sulfur oxides, and levels of nitrogen oxides are about 60% of those from plants using coal (without

emission reduction measures). Natural gas-fired plants also release lower quantities of carbon dioxide, a greenhouse gas.

Some measures, such as choice of fuel and use of measures to increase energy conversion efficiency, will reduce emissions of multiple air pollutants, including CO_2, per unit of energy generation. Optimizing energy utilization efficiency of the generation process depends on a variety of factors, including the nature and quality of fuel, the type of combustion system, the operating temperature of the combustion turbines, the operating pressure and temperature of steam turbines, the local climate conditions, the type of cooling system used, etc. Recommended measures to prevent, minimize, and control air emissions include:

- Use of the cleanest fuel economically available (natural gas is preferable to oil, which is preferable to coal) if that is consistent with the overall energy and environmental policy of the country or the region where the plant is proposed. For most large power plants, fuel choice is often part of the national energy policy, and fuels, combustion technology and pollution control technology, which are all interrelated, should be evaluated very carefully upstream of the project to optimize the project's environmental performance;
- When burning coal, giving preference to high-heat-content, low-ash, and low-sulfur coal;
- Considering beneficiation to reduce ash content, especially for high ash coal;[3]
- Selection of the best power generation technology for the fuel chosen to balance the environmental and economic benefits. The choice of technology and pollution control systems will be based on the site-specific environmental assessment (some examples include 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);
- Designing stack heights according to Good International Industry Practice (GIIP) to avoid excessive ground level concentrations and minimize impacts, including acid deposition;[4]
- Considering use of combined heat and power (CHP, or co-generation) facilities. By making use of otherwise wasted heat, CHP facilities can achieve thermal efficiencies of 70 – 90 percent, compared with 32 – 45 percent for conventional thermal power plants.
- As stated in the General EHS Guidelines, emissions from a single project should not contribute more than 25% of the applicable ambient air quality standards to allow additional, future sustainable development in the same airshed.[5]

Pollutant-specific control recommendations are provided below.

Sulfur Dioxide

The range of options for the control of sulfur oxides varies substantially because of large differences in the sulfur content of different fuels and in control costs as described in Table 1. The choice of technology depends on a benefit-cost analysis of the environmental performance of different fuels, the cost of controls, and the existence of a market for sulfur control by-products[6]. Recommended measures to prevent, minimize, and control SO_2 emissions include:

[3] If sulfur is inorganically bound to the ash, this will also reduce sulfur content.

[4] For specific guidance on calculating stack height see Annex 1.1.3 of the General EHS Guidelines. Raising stack height should not be used to allow more emissions. However, if the proposed emission rates result in significant incremental ambient air quality impacts to the attainment of the relevant ambient air quality standards, options to raise stack height and/or to further reduce emissions should be considered in the EA. Typical examples of GIIP stack heights are up to around 200m for large coal-fired power plants, up to around 80m for HFO-fueled diesel engine power plants, and up to 100m for gas-fired combined cycle gas turbine power plants. Final selection of the stack height will depend on the terrain of the surrounding areas, nearby buildings, meteorological conditions, predicted incremental impacts and the location of existing and future receptors.

[5] For example, the US EPA Prevention of Significant Deterioration Increments Limits applicable to non-degraded airsheds provide the following: SO_2 (91 µg/m^3 for 2nd highest 24-hour, 20 µg/m^3 for annual average), NO_2 (20 µg/m^3 for annual average), and PM_{10} (30 µg/m^3 for 2nd highest 24-hour, and 17 µg/m^3 for annual average).

- Use of fuels with a lower content of sulfur 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[7, 8];
- Depending on the plant size, fuel quality, and potential for significant emissions of SO_2 , use of flue gas desulfurization (FGD) for large boilers using coal or oil and for large reciprocating engines . The optimal type of FGD system (e.g., wet FGD using limestone with 85 to 98% removal efficiency, dry FGD using lime with 70 to 94% removal efficiency, seawater FGD with up to 90% removal efficiency) depends on the capacity of the plant, fuel properties, site conditions, and the cost and availability of reagent as well as by-product disposal and utilization.[9]

Table 1 - Performance / Characteristics of FGDs

Type of FGD	Characteristics	Plant Capital Cost Increase
Wet FGD	• Flue gas is saturated with water • Limestone ($CaCO_3$) as reagent • Removal efficiency up to 98% • Use 1-1.5% of electricity generated • Most widely used • Distance to limestone source and the limestone reactivity to be considered • High water consumption • Need to treat wastewater • Gypsum as a saleable by-product or waste	11-14%
Semi-Dry FGD	• Also called "Dry Scrubbing" – under controlled humidification. • Lime (CaO) as reagent • Removal efficiency up to 94% • Can remove SO_3 as well at higher removal rate than Wet FGD • Use 0.5-1.0% of electricity generated, less than Wet FGD • Lime is more expensive than limestone • No wastewater • Waste – mixture of fly ash, unreacted additive and $CaSO_3$	
Seawater FGD	• Removal efficiency up to 90% • Not practical for high S coal (>1%S) • Impacts on marine environment need to be carefully examined (e.g., reduction of pH, inputs of remaining heavy metals, fly ash, temperature, sulfate, dissolved oxygen, and chemical oxygen demand) • Use 0.8-1.6% of electricity generated • Simple process, no wastewater or solid waste,	7-10%

Sources: EC (2006) and World Bank Group.

Nitrogen Oxides

Formation of nitrogen oxides can be controlled by modifying operational and design parameters of the combustion process (primary measures). Additional treatment of NO_X from the flue gas (secondary measures; see Table 2) may be required in some cases depending on the ambient air quality objectives. Recommended measures to prevent, minimize, and control NO_X emissions include:

- Use of low NO_X burners with other combustion modifications, such as low excess air (LEA) firing, for boiler plants. Installation of additional NO_X controls for boilers may be necessary to meet emissions limits; a selective catalytic reduction (SCR) system can be used 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-NO_X combustors for combustion turbines burning natural gas;
- Use of water injection or SCR for combustion turbines and

[6] Regenerative Flue Gas Desulfurization (FGD) options (either wet or semi-dray) may be considered under these conditions.

[7] EC (2006).

[8] The SO2 removal efficiency of FBC technologies depends on the sulfur and lime content of fuel, sorbent quantity, ratio, and quality.

[9] The use of wet scrubbers, in addition to dust control equipment (e.g. ESP or Fabric Filter), has the advantage of also reducing emissions of HCl, HF, heavy metals, and further dust remaining after ESP or Fabric Filter. Because of higher costs, the wet scrubbing process is generally not used at plants with a capacity of less than 100 MWth (EC 2006).

reciprocating engines burning liquid fuels;[10]

- 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.

Table 2 - Performance / Characteristics of Secondary NOx Reduction Systems

Type	Characteristics	Plant Capital Cost Increase
SCR	• NOx emission reduction rate of 80 – 95% • Use 0.5% of electricity generated • Use ammonia or urea as reagent. • Ammonia slip increases with increasing NH_3/NOx ratio may cause a problem (e.g., too high ammonia in the fly ash). Larger catalyst volume / improving the mixing of NH_3 and NOx in the flue gas may be needed to avoid this problem. • Catalysts may contain heavy metals. Proper handling and disposal / recycle of spent catalysts is needed. • Life of catalysts has been 6-10 years (coal-fired), 8-12 years (oil-fired) and more than 10 years (gas-fired).	4-9% (coal-fired boiler) 1-2% (gas-fired combined cycle gas turbine) 20-30% (reciprocating engines)
SNCR	• NOx emission reduction rate of 30 – 50% • Use 0.1-0.3% of electricity generated • Use ammonia or urea as reagent. • Cannot be used on gas turbines or gas engines. • Operates without using catalysts.	1-2%

Source: EC (2006), World Bank Group

Particulate Matter

Particulate matter[11] is emitted from the combustion process, especially from the use of heavy fuel oil, coal, and solid biomass. The proven technologies for particulate removal in power plants are fabric filters and electrostatic precipitators (ESPs), shown in Table 3. The choice between a fabric filter and an ESP depends on the fuel properties, type of FGD system if used for SO_2 control, and ambient air quality objectives. Particulate matter can also be released during transfer and storage of coal and additives, such as lime. Recommendations to prevent, minimize, and control particulate matter emissions include:

- Installation of dust controls capable of over 99% removal efficiency, such as 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 condensables (e.g., sulfuric acid mist) that are not effectively captured by an ESP or a fabric filter;[12]
- Use of loading and unloading equipment that minimizes the height of fuel drop to the stockpile to reduce the generation of fugitive dust and installing of cyclone dust collectors;
- Use of water spray systems 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;
- Design and operate transport systems to minimize the generation and transport of dust on site;
- 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

[10] Water injection may not be practical for industrial combustion turbines in all cases. Even if water is available, the facilities for water treatment and the operating and maintenance costs of water injection may be costly and may complicate the operation of a small combustion turbine.

[11] Including all particle sizes (e.g. TSP, PM_{10}, and $PM_{2.5}$)

[12] Flue gas conditioning (FGC) is a recommended approach to address the issue of low gas conductivity and lower ESP collection performance which occurs when ESPs are used to collect dust from very low sulfur fuels. One particular FGC design involves introduction of sulfur trioxide (SO_3) gas into the flue gas upstream of the ESP, to increase the conductivity of the flue gas dramatically improve the ESP collection efficiency. There is typically no risk of increased SOx emissions as the SO_3 is highly reactive and adheres to the dust.

emissions where necessary, applying special ventilation systems in enclosed storage to avoid dust explosions (e.g., use of cyclone separators at coal transfer points).

See Annex 1.1.2 of the **General EHS Guidelines** for an additional illustrative presentation of point source emissions prevention and control technologies.

Table 3 – Performance / Characteristics of Dust Removal Systems

Type	Performance / Characteristics
ESP	• Removal efficiency of >96.5% (<1 µm), >99.95% (>10 µm) • 0.1-1.8% of electricity generated is used • It might not work on particulates with very high electrical resistivity. In these cases, flue gas conditioning (FGC) may improve ESP performance. • Can handle very large gas volume with low pressure drops
Fabric Filter	• Removal efficiency of >99.6% (<1 µm), >99.95% (>10 µm). Removes smaller particles than ESPs. • 0.2-3% of electricity generated is used • Filter life decreases as coal S content increases • Operating costs go up considerably as the fabric filter becomes dense to remove more particles • If ash is particularly reactive, it can weaken the fabric and eventually it disintegrates.
Wet Scrubber	• Removal efficiency of >98.5% (<1 µm), >99.9% (>10 µm) • Up to 3% of electricity generated is used. • As a secondary effect, can remove and absorb gaseous heavy metals • Wastewater needs to be treated

Sources: EC (2006) and World Bank Group.

Other Pollutants

Depending on the fuel type and quality, other air pollutants may be present in environmentally significant quantities requiring proper consideration in the evaluation of potential impacts to ambient air quality and in the design and implementation of management actions and environmental controls. Examples of additional pollutants include mercury in coal, vanadium in heavy fuel oil, and other heavy metals present in waste fuels such as petroleum coke (petcoke) and used lubricating oils[13]. Recommendations to prevent, minimize, and control emissions of other air pollutants such as mercury in particular from thermal power plants include the 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.[14] Additional removal of metals such as mercury can be achieved in a high dust SCR system along with powered activated carbon, bromine-enhanced Powdered Activated Carbon (PAC) or other sorbents. Since mercury emissions from thermal power plants pose potentially significant local and transboundary impacts to ecosystems and public health and safety through bioaccumulation, particular consideration should be given to their minimization in the environmental assessment and accordingly in plant design.[15]

Emissions Offsets

Facilities in degraded airsheds should minimize incremental impacts by achieving emissions values outlined in Table 6. Where these emissions values result nonetheless in excessive ambient impacts relative to local regulatory standards (or in their absence, other international recognized standards or guidelines, including World Health Organization guidelines), the project should explore and implement site-specific offsets that result in no net increase in the total emissions of those pollutants (e.g., particulate matter, sulfur dioxide, or nitrogen dioxide) that are responsible for the degradation of the airshed. Offset provisions should be implemented before the power plant comes fully on stream. Suitable offset measures could include reductions in emissions of particulate matter, sulfur dioxide, or nitrogen dioxide, as necessary through (a) the installation of new or more effective controls at other units within the same power plant or at other power plants in

[13] In these cases, the EA should address potential impacts to ambient air quality for such heavy metals as mercury, nickel, vanadium, cadmium, lead, etc.

[14] For Fabric Filters or Electrostatic Precipitators operated in combination with FGD techniques, an average removal rate of 75% or 90 % in the additional presence of SCR can be obtained (EC, 2006).

[15] Although no major industrial country has formally adopted regulatory limits for mercury emissions from thermal power plants, such limitations where under consideration in the United States and European Union as of 2008. Future updates of these EHS Guidelines will reflect changes in the international state of

the same airshed, (b) the installation of new or more effective controls at other large sources, such as district heating plants or industrial plants, in the same airshed, or (c) investments in gas distribution or district heating systems designed to substitute for the use of coal for residential heating and other small boilers. Wherever possible, the offset provisions should be implemented within the framework of an overall air quality management strategy designed to ensure that air quality in the airshed is brought into compliance with ambient standards. The monitoring and enforcement of ambient air quality in the airshed to ensure that offset provisions are complied with would be the responsibility of the local or national agency responsible for granting and supervising environmental permits. Project sponsors who cannot engage in the negotiations necessary to put together an offset agreement (for example, due to the lack of the local or national air quality management framework) should consider the option of relying on an appropriate combination of using cleaner fuels, more effective pollution controls, or reconsidering the selection of the proposed project site. The overall objective is that the new thermal power plants should not contribute to deterioration of the already degraded airshed.

Energy Efficiency and GHG Emissions

Carbon dioxide, one of the major greenhouse gases (GHGs) under the UN Framework Convention on Climate Change, is emitted from the combustion of fossil fuels. Recommendations to avoid, minimize, and offset emissions of carbon dioxide from new and existing thermal power plants include, among others:

- 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 combined heat and power plants (CHP) where feasible;
- Use of higher energy conversion efficiency technology of the same fuel type / power plant size than that of the country/region average. New facilities should be aimed to be in top quartile of the country/region average of the same fuel type and power plant size. Rehabilitation of existing facilities must achieve significant improvements in efficiency. Typical CO_2 emissions performance of different fuels / technologies are presented below in Table 4;
- Consider efficiency-relevant trade-offs between capital and operating costs involved in the use of different technologies. For example, supercritical plants may have a higher capital cost than subcritical plants for the same capacity, but lower operating costs. On the other hand, characteristics of existing and future size of the grid may impose limitations in plant size and hence technological choice. These tradeoffs need to be fully examined in the EA;
- 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;
- Where feasible, arrangement of emissions offsets (including the Kyoto Protocol's flexible mechanisms and the voluntary carbon market), including reforestation, afforestation, or capture and storage of CO_2 or other currently experimental options[16];
- Where feasible, include transmission and distribution loss reduction and demand side measures. For example, an investment in peak load management could reduce cycling requirements of the generation facility thereby improving its operating efficiency. The feasibility of these types of off-set options may vary depending on whether the facility is part of a vertically integrated utility or an independent power producer;
- Consider fuel cycle emissions and off-site factors (e.g., fuel

practice regarding mercury emissions prevention and control.

[16] The application of carbon capture and storage (CCS) from thermal power projects is still in experimental stages worldwide although consideration has started to be given to CCS-ready design. Several options are currently under evaluation including CO_2 storage in coal seams or deep aquifers and oil reservoir injection for enhanced oil recovery.

supply, proximity to load centers, potential for off-site use of waste heat, or use of nearby waste gases (blast furnace gases or coal bed methane) as fuel. etc).

Table 4 - Typical CO_2 Emissions Performance of New Thermal Power Plants

Fuel	Efficiency	CO_2 (gCO_2 / kWh – Gross)
Efficiency (% Net, HHV)		
Coal (*1, *2)	Ultra-Supercritical (*1): 37.6 – 42.7	 676-795
	Supercritical: 35.9-38.3 (*1) 39.1 (w/o CCS) (*2) 24.9 (with CCS) (*2)	 756-836 763 95
	Subcritical: 33.1-35.9 (*1) 36.8 (w/o CCS) (*2) 24.9 (with CCS) (*2)	 807-907 808 102
	IGCC: 39.2-41.8 (*1) 38.2–41.1 (w/o CCS) (*2) 31.7–32.5 (with CCS) (*2)	 654-719 640 – 662 68 – 86
Gas (*2)	Advanced CCGT (*2): 50.8 (w/o CCS) 43.7 (with CCS)	 355 39
Efficiency (% Net, LHV)		
Coal (*3)	42 (Ultra-Supercritical) 40 (Supercritical) 30 – 38 (Subcritical) 46 (IGCC) 38 (IGCC+CCS)	811 851 896-1,050 760 134
Coal and Lignite (*4, *7)	(*4) 43-47 (Coal-PC) >41(Coal-FBC) 42-45 (Lignite-PC) >40 (Lignite-FBC)	(*6) 725-792 (Net) <831 (Net) 808-866 (Net) <909 (Net)
Gas (*4, *7)	(*4) 36–40 (Simple Cycle GT) 38-45 (Gas Engine) 40-42 (Boiler) 54-58 (CCGT)	(*6) 505-561 (Net) 531-449 (Net) 481-505 (Net) 348-374 (Net)
Oil (*4, *7)	(*4) 40 – 45 (HFO/LFO Reciprocating Engine)	(*6) 449-505 (Net)
Efficiency (% Gross, LHV)		
Coal (*5, *7)	(*5) 47 (Ultra-supercritical) 44 (Supercritical) 41-42 (Subcritical) 47-48 (IGCC)	(*6) 725 774 811-831 710-725
Oil (*5, *7)	(*5) 43 (Reciprocating Engine) 41 (Boiler)	(*6) 648 680
Gas (*5)	(*5) 34 (Simple Cycle GT) 51 (CCGT)	(*6) 594 396

Source: (*1) US EPA 2006, (*2) US DOE/NETL 2007, (*3) World Bank, April 2006, (*4) European Commission 2006, (*5) World Bank Group, Sep 2006, (*6) World Bank Group estimates

Water Consumption and Aquatic Habitat Alteration

Steam turbines used with boilers and heat recovery steam generators(HRSG) used in combined cycle gas turbine units require a cooling system to condense steam used to generate electricity. Typical cooling systems used in thermal power plants include: (i) once-through cooling system where sufficient cooling water and receiving surface water are available; (ii) closed circuit wet cooling system; and (iii) closed circuit dry cooling system (e.g., air cooled condensers).

Combustion facilities using once-through cooling systems require large quantities of water which are discharged back to receiving surface water with elevated temperature. Water is also required for boiler makeup, auxiliary station equipment, ash handling, and FGD systems.[17] The withdrawal of such large quantities of water has the potential to compete with other important water uses such as agricultural irrigation or drinking water sources. Withdrawal and discharge with elevated temperature and chemical contaminants such as biocides or other additives, if used, may affect aquatic organisms, including phytoplankton, zooplankton, fish, crustaceans, shellfish, and many other forms of aquatic life. Aquatic organisms drawn into cooling water intake structures are either impinged on components of the cooling water intake structure or entrained in the cooling water system itself. In the case of either impingement or entrainment, aquatic organisms may be killed or subjected to significant harm. In some cases (e.g., sea turtles), organisms are entrapped in the intake canals. There may be special concerns about the potential impacts of cooling water intake structures located in or near habitat areas that support threatened, endangered, or other protected species or where local fishery is active.

Conventional intake structures include traveling screens with relative high through-screen velocities and no fish handling or

[17] The availability of water and impact of water use may affect the choice of FGD

return system.[18] Measures to prevent, minimize, and control environmental impacts associated with water withdrawal should be established based on the results of a project EA, considering the availability and use of water resources locally and the ecological characteristics of the project affected area. Recommended management measures to prevent or control impacts to water resources and aquatic habitats include[19]:

- Conserving water resources, particularly in areas with limited water resources, by:
  - Use of a closed-cycle, recirculating cooling water system (e.g., natural or forced draft cooling tower), or closed circuit dry cooling system (e.g., air cooled condensers) if necessary to prevent unacceptable adverse impacts. Cooling ponds or cooling towers are the primary technologies for a recirculating cooling water system. Once-through cooling water systems may be acceptable if compatible with the hydrology and ecology of the water source and the receiving water and may be the preferred or feasible alternative for certain pollution control technologies such as seawater scrubbers
  - Use of dry scrubbers in situations where these controls are also required or recycling of wastewater in coal-fired plants for use as FGD makeup
  - Use of air-cooled systems
- Reduction of maximum through-screen design intake velocity to 0.5 ft/s;
- Reduction of intake flow to the following levels:
  - For freshwater rivers or streams to a flow sufficient to maintain resource use (i.e., irrigation and fisheries) as well as biodiversity during annual mean low flow conditions[20]
  - For lakes or reservoirs, intake flow must not disrupt the thermal stratification or turnover pattern of the source water
  - For estuaries or tidal rivers, reduction of intake flow to 1% of the tidal excursion volume
- If there are threatened, endangered, or other protected species or if there are fisheries within the hydraulic zone of influence of the intake, reduction of impingement and entrainment of fish and shellfish by the installation of technologies such as barrier nets (seasonal or year-round), fish handling and return systems, fine mesh screens, wedgewire screens, and aquatic filter barrier systems. Examples of operational measures to reduce impingement and entrainment include seasonal shutdowns, if necessary, or reductions in flow or continuous use of screens. Designing the location of the intake structure in a different direction or further out into the water body may also reduce impingement and entrainment.

Effluents

Effluents from thermal power plants include thermal discharges, wastewater effluents, and sanitary wastewater.

Thermal Discharges

As noted above, thermal power plants with steam-powered generators and once-through cooling systems use significant volume of water to cool and condense the steam for return to the boiler. The heated water is normally discharged back to the source water (i.e., river, lake, estuary, or the ocean) or the nearest surface water body. In general, thermal discharge should be designed to ensure that discharge water temperature does not result in exceeding relevant ambient water quality temperature standards outside a scientifically established mixing zone. The mixing zone is typically defined as the zone where initial dilution of a discharge takes place within which relevant water quality

system used (i.e., wet vs. semi-dry).

[18] The velocity generally considered suitable for the management of debris is 1 fps [0.30 m/s] with wide mesh screens; a standard mesh for power plants of 3/8 in (9.5 mm).

[19] For additional information refer to Schimmoller (2004) and USEPA (2001).

[20] Stream flow requirements may be based on mean annual flow or mean low flow. Regulatory requirements may be 5% or higher for mean annual flows and 10% to 25% for mean low flows. Their applicability should be verified on a site-specific

temperature standards are allowed to exceed and takes into account cumulative impact of seasonal variations, ambient water quality, receiving water use, potential receptors and assimilative capacity among other considerations. Establishment of such a mixing zone is project specific and may be established by local regulatory agencies and confirmed or updated through the project's environmental assessment process. Where no regulatory standard exists, the acceptable ambient water temperature change will be established through the environmental assessment process. Thermal discharges should be designed to prevent negative impacts to the receiving water taking into account the following criteria:

- The elevated temperature areas because of thermal discharge from the project should not impair the integrity of the water body as a whole or endanger sensitive areas (such as recreational areas, breeding grounds, or areas with sensitive biota);
- There should be no lethality or significant impact to breeding and feeding habits of organisms passing through the elevated temperature areas;
- There should be no significant risk to human health or the environment due to the elevated temperature or residual levels of water treatment chemicals.

If a once-through cooling system is used for large projects (i.e., a plant with > 1,200MWth steam generating capacity), impacts of thermal discharges should be evaluated in the EA with a mathematical or physical hydrodynamic plume model, which can be a relatively effective method for evaluating a thermal discharge to find the maximum discharge temperatures and flow rates that would meet the environmental objectives of the receiving water.[21]

Recommendations to prevent, minimize, and control thermal discharges include:

- Use of multi-port diffusers;
- Adjustment of the discharge temperature, flow, outfall location, and outfall design to minimize impacts to acceptable level (i.e., extend length of discharge channel before reaching the surface water body for pre-cooling or change location of discharge point to minimize the elevated temperature areas);
- Use of a closed-cycle, recirculating cooling water system as described above (e.g., natural or forced draft cooling tower), or closed circuit dry cooling system (e.g., air cooled condensers) if necessary to prevent unacceptable adverse impacts. Cooling ponds or cooling towers are the primary technologies for a recirculating cooling water system.

Liquid Waste

The wastewater streams in a thermal power plant include cooling tower blowdown; ash handling wastewater; wet FGD system discharges; material storage runoff; metal cleaning wastewater; and low-volume wastewater, such as air heater and precipitator wash water, boiler blowdown, boiler chemical cleaning waste, floor and yard drains and sumps, laboratory wastes, and backflush from ion exchange boiler water purification units. All of these wastewaters are usually present in plants burning coal or biomass; some of these streams (e.g., ash handling wastewater) may be present in reduced quantities or may not be present at all in oil-fired or gas-fired power plants. The characteristics of the wastewaters generated depend on the ways in which the water has been used. Contamination arises from demineralizers; lubricating and auxiliary fuel oils; trace contaminants in the fuel (introduced through the ash-handling wastewater and wet FGD system discharges); and chlorine, biocides, and other chemicals used to manage the quality of water in cooling systems. Cooling tower blowdown tends to be very high in total dissolved solids but is generally classified as non-contact cooling water and, as such,

basis taking into consideration resource use and biodiversity requirements.

[21] An example model is CORMIX (Cornell Mixing Zone Expert System) hydrodynamic mixing zone computer simulation, which has been developed by the U.S. Environmental Protection Agency. This model emphasizes predicting the site- and discharge-specific geometry and dilution characteristics to assess the environmental effects of a proposed discharge.

is typically subject to limits for pH, residual chlorine, and toxic chemicals that may be present in cooling tower additives (including corrosion inhibiting chemicals containing chromium and zinc whose use should be eliminated).

Recommended water treatment and wastewater conservation methods are discussed in Sections 1.3 and 1.4, respectively, of the **General EHS Guidelines**. In addition, recommended measures to prevent, minimize, and control wastewater effluents from thermal power plants include:

- Recycling of wastewater in coal-fired plants for use as FGD makeup. This practice conserves water and reduces the number of wastewater streams requiring treatment and discharge[22];
- In coal-fired power plants without FGD systems, treatment of process wastewater in conventional physical-chemical treatment systems for pH adjustment and removal of total suspended solids (TSS), and oil / grease, at a minimum. Depending on local regulations, these treatment systems can also be used to remove most heavy metals to part-per-billion (ppb) levels by chemical precipitation as either metal hydroxide or metal organosulfide compounds;
- Collection of fly ash in dry form and bottom ash in drag chain conveyor systems in new coal-fired power plants;
- Consider use of soot blowers or other dry methods to remove fireside wastes from heat transfer surfaces so as to minimize the frequency and amount of water used in fireside washes;
- Use of infiltration and runoff control measures such as compacted soils, protective liners, and sedimentation controls for runoff from coal piles;
- Spraying of coal piles with anionic detergents to inhibit bacterial growth and minimize acidity of leachate;[23]
- Use of SO_X removal systems that generate less wastewater, if feasible; however, the environmental and cost characteristics of both inputs and wastes should be assessed on a case-by-case basis;
- Treatment of low-volume wastewater streams that are typically collected in the boiler and turbine room sumps in conventional oil-water separators before discharge;
- Treatment of acidic low-volume wastewater streams, such as those associated with the regeneration of makeup demineralizer and deep-bed condensate polishing systems, by chemical neutralization in-situ before discharge;
- Pretreatment of cooling tower makeup water, installation of automated bleed/feed controllers, and use of inert construction materials to reduce chemical treatment requirements for cooling towers;
- Elimination of metals such as chromium and zinc from chemical additives used to control scaling and corrosion in cooling towers;
- Use the minimum required quantities of chlorinated biocides in place of brominated biocides or alternatively apply intermittent shock dosing of chlorine as opposed to continuous low level feed.

Sanitary Wastewater

Sewage and other wastewater generated from washrooms, etc. are similar to domestic wastewater. Impacts and management of sanitary wastewater is addressed in Section 1.3 of the **General EHS Guidelines.**

Solid Wastes

Coal-fired and biomass-fired thermal power plants generate the greatest amount of solid wastes due to the relatively high percentage of ash in the fuel.[24] The large-volume coal

[22] Suitable wastewater streams for reuse include gypsum wash water, which is a different wastewater stream than the FGD wastewater. In plants that produce marketable gypsum, the gypsum is rinsed to remove chloride and other undesirable trace elements.

[23] If coal pile runoff will be used as makeup to the FGD system, anionic detergents may increase or create foaming within the scrubber system. Therefore, use of anionic surfactants on coal piles should be evaluated on a case-by-case basis.

[24] For example, a 500 MWe plant using coal with 2.5% sulfur (S), 16% ash, and 30,000 kilojoules per kilogram (kJ/kg) heat content will generate about 500 tons of

combustion wastes (CCW) are fly ash, bottom ash, boiler slag, and FGD sludge. Biomass contains less sulfur; therefore FGD may not be necessary. Fluidized-bed combustion (FBC) boilers generate fly ash and bottom ash, which is called bed ash. Fly ash removed from exhaust gases makes up 60–85% of the coal ash residue in pulverized-coal boilers and 20% in stoker boilers. Bottom ash includes slag and particles that are coarser and heavier than fly ash. Due to the presence of sorbent material, FBC wastes have a higher content of calcium and sulfate and a lower content of silica and alumina than conventional coal combustion wastes. Low-volume solid wastes from coal-fired thermal power plants and other plants include coal mill rejects/pyrites, cooling tower sludge, wastewater treatment sludge, and water treatment sludge.

Oil combustion wastes include fly ash and bottom ash and are normally only generated in significant quantities when residual fuel oil is burned in oil-fired steam electric boilers. Other technologies (e.g., combustion turbines and diesel engines) and fuels (e.g., distillate oil) generate little or no solid wastes. Overall, oil combustion wastes are generated in much smaller quantities than the large-volume CCW discussed above. Gas-fired thermal power plants generate essentially no solid waste because of the negligible ash content, regardless of the combustion technology.

Metals are constituents of concern in both CCW and low-volume solid wastes. For example, ash residues and the dust removed from exhaust gases may contain significant levels of heavy metals and some organic compounds, in addition to inert materials.

Ash residues are not typically classified as a hazardous waste due to their inert nature.[25] However, where ash residues are expected to contain potentially significant levels of heavy metals, radioactivity, or other potentially hazardous materials, they should be tested at the start of plant operations to verify their classification as hazardous or non-hazardous according to local regulations or internationally recognized standards. Additional information about the classification and management of hazardous and non-hazardous wastes is presented in Section 1.6 of the **General EHS Guidelines.**

The high-volume CCWs wastes are typically managed in landfills or surface impoundments or, increasingly, may be applied to a variety of beneficial uses. Low-volume wastes are also managed in landfills or surface impoundments, but are more frequently managed in surface impoundments. Many coal-fired plants co-manage large-volume and low-volume wastes.

Recommended measures to prevent, minimize, and control the volume of solid wastes from thermal power plants include:

- Dry handling of the coal combustion wastes, in particular fly ash. Dry handling methods do not involve surface impoundments and, therefore, do not present the ecological risks identified for impoundments (e.g., metal uptake by wildlife);
- Recycling of CCWs in uses such as cement and other concrete products, construction fills (including structural fill, flowable fill, and road base), agricultural uses such as calcium fertilizers (provided trace metals or other potentially hazardous materials levels are within accepted thresholds), waste management applications, mining applications, construction materials (e.g., synthetic gypsum for plasterboard), and incorporation into other products provided the residues (such as trace metals and radioactivity) are not considered hazardous. Ensuring consistent quality of fuels and additives helps to ensure the CCWs can be recycled. If beneficial reuse is not feasible, disposal of CCW in permitted landfills with environmental controls such as run-on/run-off controls, liners, leachate collection systems, ground-water monitoring, closure controls, daily (or other operational) cover, and fugitive dust controls is recommended;

solid waste per day.

[25] Some countries may categorize fly ash as hazardous due to the presence of arsenic or radioactivity, precluding its use as a construction material.

- Dry collection of bottom ash and fly ash from power plants combusting heavy fuel oil if containing high levels of economically valuable metals such as vanadium and recycle for vanadium recovery (where economically viable) or disposal in a permitted landfill with environmental controls;
- Management of ash disposal and reclamation so as to minimize environmental impacts – especially the migration of toxic metals, if present, to nearby surface and groundwater bodies, in addition to the transport of suspended solids in surface runoff due to seasonal precipitation and flooding. In particular, construction, operation, and maintenance of surface impoundments should be conducted in accordance with internationally recognized standards.[26, 27]
- Reuse of sludge from treatment of waste waters from FGD plants. This sludge may be re-used in the FGD plant due to the calcium components. It can also be used as an additive in coal-fired plant combustion to improve the ash melting behavior

Hazardous Materials and Oil

Hazardous materials stored and used at combustion facilities include solid, liquid, and gaseous waste-based fuels; air, water, and wastewater treatment chemicals; and equipment and facility maintenance chemicals (e.g., paint certain types of lubricants, and cleaners). Spill prevention and response guidance is addressed in Sections 1.5 and 3.7 of the **General EHS Guidelines**.

In addition, recommended measures to prevent, minimize, and control hazards associated with hazardous materials storage and handling at thermal power plants include the use of double-walled, underground pressurized tanks for storage of pure liquefied ammonia (e.g., for use as reagent for SCR) in quantities over 100 m^3; tanks of lesser capacity should be manufactured using annealing processes (EC 2006).

Noise

Principal sources of noise in thermal power plants include the turbine generators and auxiliaries; boilers and auxiliaries, such as coal pulverizers; reciprocating engines; fans and ductwork; pumps; compressors; condensers; precipitators, including rappers and plate vibrators; piping and valves; motors; transformers; circuit breakers; and cooling towers. Thermal power plants used for base load operation may operate continually while smaller plants may operate less frequently but still pose a significant source of noise if located in urban areas.

Noise impacts, control measures, and recommended ambient noise levels are presented in Section 1.7 of the **General EHS Guidelines**. Additional recommended measures to prevent, minimize, and control noise from thermal power plants include:

- Siting new facilities with consideration of distances from the noise sources to the receptors (e.g., residential receptors, schools, hospitals, religious places) to the extent possible. If the local land use is not controlled through zoning or is not effectively enforced, examine whether residential receptors could come outside the acquired plant boundary. In some cases, it could be more cost effective to acquire additional land as buffer zone than relying on technical noise control measures, where possible;
- Use of noise control techniques such as: using acoustic machine enclosures; selecting structures according to their noise isolation effect to envelop the building; using mufflers or silencers in intake and exhaust channels; using sound-absorptive materials in walls and ceilings; using vibration isolators and flexible connections (e.g., helical steel springs and rubber elements); applying a carefully detailed design to prevent possible noise leakage through openings or to minimize pressure variations in piping;

[26] See, for example, U.S. Department of Labor, Mine Safety and Health Administration regulations at 30 CFR §§ 77.214 - 77.216.

[27] Additional detailed guidance applicable to the prevention and control of impacts to soil and water resources from non-hazardous and hazardous solid waste disposal is presented in the World Bank Group EHS Guidelines for Waste Management Facilities.

- Modification of the plant configuration or use of noise barriers such as berms and vegetation to limit ambient noise at plant property lines, especially where sensitive noise receptors may be present.

Noise propagation models may be effective tools to help evaluate noise management options such as alternative plant locations, general arrangement of the plant and auxiliary equipment, building enclosure design, and, together with the results of a baseline noise assessment, expected compliance with the applicable community noise requirements.

1.2 Occupational Health and Safety

Occupational health and safety risks and mitigation measures during construction, operation, and decommissioning of thermal power plants are similar to those at other large industrial facilities, and are addressed in Section 2.0 of the **General EHS Guidelines**. In addition, the following health and safety impacts are of particular concern during operation of thermal power plants:

- Non-ionizing radiation
- Heat
- Noise
- Confined spaces
- Electrical hazards
- Fire and explosion hazards
- Chemical hazards
- Dust

Non-ionizing radiation

Combustion facility workers may have a higher exposure to electric and magnetic fields (EMF) than the general public due to working in proximity to electric power generators, equipment, and connecting high-voltage transmission lines. Occupational EMF exposure should be prevented or minimized through the preparation and implementation of an EMF safety program including the following components:

- Identification of potential exposure levels in the workplace, including surveys of exposure levels in new projects and the use of personal monitors during working activities;
- Training of workers in the identification of occupational EMF levels and hazards;
- Establishment and identification of safety zones to differentiate between work areas with expected elevated EMF levels compared to those acceptable for public exposure, limiting access to properly trained workers;
- Implementation of action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations such as the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the Institute of Electrical and Electronics Engineers (IEEE).[28] Personal exposure monitoring equipment should be set to warn of exposure levels that are below occupational exposure reference levels (e.g., 50 percent). Action plans to address occupational exposure may include limiting exposure time through work rotation, increasing the distance between the source and the worker, when feasible, or the use of shielding materials.

Heat

Occupational exposure to heat occurs during operation and maintenance of combustion units, pipes, and related hot equipment. Recommended prevention and control measures to address heat exposure at thermal power plants include:

- Regular inspection and maintenance of pressure vessels and piping;
- Provision of adequate ventilation in work areas to reduce heat and humidity;

[28] The ICNIRP exposure guidelines for Occupational Exposure are listed in Section 2.2 of this Guideline.

- Reducing the time required for work in elevated temperature environments and ensuring access to drinking water;
- Shielding surfaces where workers come in close contact with hot equipment, including generating equipment, pipes etc;
- Use of warning signs near high temperature surfaces and personal protective equipment (PPE) as appropriate, including insulated gloves and shoes.

Noise

Noise sources in combustion facilities include the turbine generators and auxiliaries; boilers and auxiliaries, such as pulverizers; diesel engines; fans and ductwork; pumps; compressors; condensers; precipitators, including rappers and plate vibrators; piping and valves; motors; transformers; circuit breakers; and cooling towers. Recommendations for reducing noise and vibration are discussed in Section 1.1, above. In addition, recommendations to prevent, minimize, and control occupational noise exposures in thermal power plants include:

- Provision of sound-insulated control rooms with noise levels below 60 dBA[29];
- Design of generators to meet applicable occupational noise levels;
- Identify and mark high noise areas and require that personal noise protecting gear is used all the time when working in such high noise areas (typically areas with noise levels >85 dBA).

Confined Spaces

Specific areas for confined space entry may include coal ash containers, turbines, condensers, and cooling water towers (during maintenance activities). Recommend confined space entry procedures are discussed in Section 2.8 of the **General EHS Guidelines**.

Electrical Hazards

Energized equipment and power lines can pose electrical hazards for workers at thermal power plants. Recommended measures to prevent, minimize, and control electrical hazards at thermal power plants include:

- Consider installation of hazard warning lights inside electrical equipment enclosures to warn of inadvertent energization;
- Use of voltage sensors prior to and during workers' entrance into enclosures containing electrical components;
- Deactivation and proper grounding of live power equipment and distribution lines according to applicable legislation and guidelines whenever possible before work is performed on or proximal to them;
- Provision of specialized electrical safety training to those workers working with or around exposed components of electric circuits. This training should include, but not be limited to, training in basic electrical theory, proper safe work procedures, hazard awareness and identification, proper use of PPE, proper lockout/tagout procedures, first aid including CPR, and proper rescue procedures. Provisions should be made for periodic retraining as necessary.

Fire and Explosion Hazards

Thermal power plants store, transfer, and use large quantities of fuels; therefore, careful handling is necessary to mitigate fire and explosion risks. In particular, fire and explosion hazards increase as the particle size of coal is reduced. Particle sizes of coal that can fuel a propagating explosion occur within thermal dryers, cyclones, baghouses, pulverized-fuel systems, grinding mills, and other process or conveyance equipment. Fire and explosion prevention management guidance is provided in Section 2.1 and

[29] Depending on the type and size of the thermal power plants, distance between control room and the noise emitting sources differs. CSA Z107.58 provides design guidelines for control rooms as 60 dBA. Large thermal power plants using steam boilers or combustion turbines tend to be quieter than 60 dBA. Reciprocating engine manufacturers recommend 65 to 70 dBA instead of 60 dBA (Euromot Position as of 9 May 2008). This guideline recommends 60 dBA as GIIP, with an understanding that up to 65 dBA can be accepted for reciprocating engine power plants if 60 dBA is economically difficult to achieve.

2.4 of the **General EHS Guidelines**. Recommended measures to prevent, minimize, and control physical hazards at thermal power plants include:

- Use of automated combustion and safety controls;
- Proper maintenance of boiler safety controls;
- Implementation of startup and shutdown procedures to minimize the risk of suspending hot coal particles (e.g., in the pulverizer, mill, and cyclone) during startup;
- Regular cleaning of the facility to prevent accumulation of coal dust (e.g., on floors, ledges, beams, and equipment);
- Removal of hot spots from the coal stockpile (caused by spontaneous combustion) and spread until cooled, never loading hot coal into the pulverized fuel system;
- Use of automated systems such as temperature gauges or carbon monoxide sensors to survey solid fuel storage areas to detect fires caused by self-ignition and to identify risk points.

Chemical Hazards

Thermal power plants utilize hazardous materials, including ammonia for NO_X control systems, and chlorine gas for treatment of cooling tower and boiler water. Guidance on chemical hazards management is provided in Section 2.4 of the **General EHS Guidelines.** Additional, recommended measures to prevent, minimize, and control physical hazards at thermal power plants include:

- Consider generation of ammonia on site from urea or use of aqueous ammonia in place of pure liquefied ammonia;
- Consider use of sodium hypochlorite in place of gaseous chlorine.

Dust

Dust is generated in handing solid fuels, additives, and solid wastes (e.g., ash). Dust may contain silica (associated with silicosis), arsenic (skin and lung cancer), coal dust (black lung), and other potentially harmful substances. Dust management guidance is provided in the Section 2.1 and 2.4 of the **General EHS Guidelines.** Recommended measures to prevent, minimize, and control occupational exposure to dust in thermal power plants include:

- Use of dust controls (e.g., exhaust ventilation) to keep dust below applicable guidelines (see Section 2) or wherever free silica levels in airborne dust exceed 1 percent;
- Regular inspection and maintenance of asbestos containing materials (e.g., insulation in older plants may contain asbestos) to prevent airborne asbestos particles.

1.3 Community Health and Safety

Many community health and safety impacts during the construction, operation, and decommissioning of thermal power plant projects are common to those of most infrastructure and industrial facilities and are discussed in Section 3.0 the **General EHS Guidelines**. In addition to these and other aspects covered in Section 1.1, the following community health and safety impacts may be of particular concern for thermal power plant projects:

- Water Consumption;
- Traffic Safety.

Water Consumption

Boiler units require large amounts of cooling water for steam condensation and efficient thermal operation. The cooling water flow rate through the condenser is by far the largest process water flow, normally equating to about 98 percent of the total process water flow for the entire unit. In a once-through cooling water system, water is usually taken into the plant from surface waters, but sometimes ground waters or municipal supplies are used. The potential effects of water use should be assessed, as discussed in Section 3.1 of the **General EHS Guidelines**, to

ensure that the project does not compromise the availability of water for personal hygiene, agriculture, recreation, and other community needs.

Traffic Safety

Operation of a thermal power plant will increase traffic volume, in particular for facilities with fuels transported via land and sea, including heavy trucks carrying fuel, additives, etc. The increased traffic can be especially significant in sparsely populate areas where some thermal power plants are located. Prevention and control of traffic-related injuries are discussed in Section 3.4 of the **General EHS Guidelines**. Water transport safety is covered in the **EHS Guidelines for Shipping**.

2.0 Performance Indicators and Monitoring

2.1 Environment

Emissions and Effluent Guidelines

Effluent guidelines are described in Table 5. Emissions guidelines are described in Table 6. Effluent guidelines are applicable for direct discharges of treated effluents to surface waters for general use. Site-specific discharge levels may be established based on the availability and conditions in the use of publicly operated sewage collection and treatment systems or, if discharged directly to surface waters, on the receiving water use classification as described in the **General EHS Guideline.** Guideline values for process emissions and effluents in this sector are indicative of good international industry practice as reflected in standards of countries with recognized regulatory frameworks. These levels should be achieved, without dilution, at least 95 percent of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours. Deviation from these levels due to specific local project conditions should be justified in the environmental assessment.

Table 5 - Effluent Guidelines
(To be applicable at relevant wastewater stream: e.g., from FGD system, wet ash transport, washing boiler / air preheater and precipitator, boiler acid washing, regeneration of demineralizers and condensate polishers, oil-separated water, site drainage, coal pile runoff, and cooling water)

Parameter	mg/L, except pH and temp
pH	6 – 9
TSS	50
Oil and grease	10
Total residual chlorine	0.2
Chromium - Total (Cr)	0.5
Copper (Cu)	0.5
Iron (Fe)	1.0
Zinc (Zn)	1.0
Lead (Pb)	0.5
Cadmium (Cd)	0.1
Mercury (Hg)	0.005
Arsenic (As)	0.5
Temperature increase by thermal discharge from cooling system	• Site specific requirement to be established by the EA. • Elevated temperature areas due to discharge of once-through cooling water (e.g., 1 Celsius above, 2 Celsius above, 3 Celsius above ambient water temperature) should be minimized by adjusting intake and outfall design through the project specific EA depending on the sensitive aquatic ecosystems around the discharge point.

Note: Applicability of heavy metals should be determined in the EA. Guideline limits in the Table are from various references of effluent performance by thermal power plants.

Emissions levels for the design and operation of each project should be established through the EA process on the basis of country legislation and the recommendations provided in this guidance document, as applied to local conditions. The emissions levels selected should be justified in the EA.[30] The maximum emissions levels given here can be consistently achieved by well-designed, well-operated, and well-maintained pollution control systems. In contrast, poor operating or maintenance procedures affect actual pollutant removal efficiency and may reduce it to well

[30] For example, in cases where potential for acid deposition has been identified as a significant issue in the EA, plant design and operation should ensure that emissions mass loadings are effectively reduced to prevent or minimize such impacts.

below the design specification. Dilution of air emissions to achieve these guidelines is unacceptable. Compliance with ambient air quality guidelines should be assessed on the basis of good international industry practice (GIIP) recommendations.

As described in the General EHS Guidelines, emissions should not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards[31] by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines[32], or other internationally recognized sources[33]. Also, emissions from a single project should not contribute more than 25% of the applicable ambient air quality standards to allow additional, future sustainable development in the same airshed. [34]

As described in the General EHS Guidelines, facilities or projects located within poor quality airsheds[35], and within or next to areas established as ecologically sensitive (e.g., national parks), should ensure that any increase in pollution levels is as small as feasible, and amounts to a fraction of the applicable short-term and annual average air quality guidelines or standards as established in the project-specific environmental assessment.

Environmental Monitoring

Environmental monitoring programs for this sector are presented in Table 7. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Examples of emissions, stack testing, ambient air quality, and noise monitoring recommendations applicable to power plants are provided in Table 7. Additional guidance on applicable sampling and analytical methods for emissions and effluents is provided in the **General EHS Guidelines**.

[31] Ambient air quality standards are ambient air quality levels established and published through national legislative and regulatory processes, and ambient quality guidelines refer to ambient quality levels primarily developed through clinical, toxicological, and epidemiological evidence (such as those published by the World Health Organization).

[32] Available at World Health Organization (WHO). http://www.who.int/en

[33] For example the United States National Ambient Air Quality Standards (NAAQS) (http://www.epa.gov/air/criteria.html) and the relevant European Council Directives (Council Directive 1999/30/EC of 22 April 1999 / Council Directive 2002/3/EC of February 12 2002).

[34] US EPA Prevention of Significant Deterioration Increments Limits applicable to non-degraded airsheds.

[35] An airshed should be considered as having poor air quality if nationally legislated air quality standards or WHO Air Quality Guidelines are exceeded significantly.

Table 6 (A) - Emissions Guidelines (in mg/Nm³ or as indicated) for Reciprocating Engine

Note:

- Guidelines are applicable for new facilities.
- EA may justify more stringent or less stringent limits due to ambient environment, technical and economic considerations provided there is compliance with applicable ambient air quality standards and incremental impacts are minimized.
- For projects to rehabilitate existing facilities, case-by-case emission requirements should be established by the EA considering (i) the existing emission levels and impacts on the environment and community health, and (ii) cost and technical feasibility of bringing the existing emission levels to meet these new facilities limits.
- EA should demonstrate that emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards, and more stringent limits may be required.

Combustion Technology / Fuel	Particulate Matter (PM)		Sulfur Dioxide (SO_2)		Nitrogen Oxides (NOx)		Dry Gas, Excess O_2 Content (%)
Reciprocating Engine	NDA	DA	NDA	DA	NDA	DA	
Natural Gas	N/A	N/A	N/A	N/A	200 (Spark Ignition) 400 (Dual Fuel) (a)	200(SI) 400 (Dual Fuel / CI)	15%
Liquid Fuels (Plant >50 MWth to <300 MWth)	50	30	1,170 or use of 2% or less S fuel	0.5% S	1,460 (Compression Ignition, bore size diameter [mm] < 400) 1,850 (Compression Ignition, bore size diameter [mm] ≥ 400) 2,000 (Dual Fuel)	400	15%
Liquid Fuels (Plant >/=300 MWth)	50	30	585 or use of 1% or less S fuel	0.2% S	740 (contingent upon water availability for injection)	400	15%
Biofuels / Gaseous Fuels other than Natural Gas	50	30	N/A	N/A	30% higher limits than those provided above for Natural Gas and Liquid Fuels.	200 (SI, Natural Gas), 400 (other)	15%

General notes:

- MWth = Megawatt thermal input on HHV basis; N/A = not applicable; NDA = Non-degraded airshed; DA = Degraded airshed (poor air quality); Airshed should be considered as being degraded if nationally legislated air quality standards are exceeded or, in their absence, if WHO Air Quality Guidelines are exceeded significantly; S = sulfur content (expressed as a percent by mass); Nm^3 is at one atmospheric pressure, 0 degree Celsius; MWth category is to apply to the entire facility consisting of multiple units that are reasonably considered to be emitted from a common stack. Guideline limits apply to facilities operating more than 500 hours per year. Emission levels should be evaluated on a one hour average basis and be achieved 95% of annual operating hours.
- (a) Compression Ignition (CI) engines may require different emissions values which should be evaluated on a case-by-case basis through the EA process.

Comparison of the Guideline limits with standards of selected countries / region (as of August 2008):

- Natural Gas-fired Reciprocating Engine – NOx
  - Guideline limits: 200 (SI), 400 (DF)
  - UK: 100 (CI) , US: Reduce by 90% or more, or alternatively 1.6 g/kWh
- Liquid Fuels-fired Reciprocating Engine – NOx (Plant >50 MWth to <300 MWth)
  - Guideline limits: 1,460 (CI, bore size diameter < 400 mm), 1,850 (CI, bore size diameter ≥ 400 mm), 2,000 (DF)
  - UK: 300 (> 25 MWth), India: 1,460 (Urban area & ≤ 75 MWe (≈ 190 MWth), Rural area & ≤ 150 MWe (≈ 380 MWth))
- Liquid Fuels-fired Reciprocating Engine – NOx (Plant ≥300 MWth)
  - Guideline limits: 740 (contingent upon water availability for injection)
  - UK: 300 (> 25 MWth), India: 740 (Urban area & > 75MWe (≈ 190 MWth), Rural area & > 150 MWe (≈ 380 MWth))
- Liquid Fuels-fired Reciprocating Engine – SO2
  - Guideline limits: 1,170 or use of ≤ 2% S (Plant >50 MWth to <300 MWth), 585 or use of ≤ 1% S (Plant ≥300 MWth)
  - EU: Use of low S fuel oil or the secondary FGD (IPCC LCP BREF), HFO S content ≤ 1% (Liquid Fuel Quality Directive), US: Use of diesel fuel with max S of 500 ppm (0.05%); EU: Marine HFO S content ≤ 1.5% (Liquid Fuel Quality Directive) used in SOx Emission Control Areas; India: Urban (< 2% S), Rural (< 4%S), Only diesel fuels (HSD, LDO) should be used in Urban

Source: UK (S2 1.03 Combustion Processes: Compression Ignition Engines, 50 MWth and over), India (SOx/NOx Emission Standards for Diesel Engines ≥ 0.8 MW), EU (IPCC LCP BREF July 2006), EU (Liquid Fuel Quality Directive 1999/32/EC amended by 2005/33/EC), US (NSPS for Stationary Compression Ignition Internal Combustion Engine – Final Rule – July 11, 2006)

Table 6 (B) - Emissions Guidelines (in mg/Nm³ or as indicated) for Combustion Turbine

Note:

- **Guidelines are applicable for new facilities.**
- **EA may justify more stringent or less stringent limits due to ambient environment, technical and economic considerations provided there is compliance with applicable ambient air quality standards and incremental impacts are minimized.**
- **For projects to rehabilitate existing facilities, case-by-case emission requirements should be established by the EA considering (i) the existing emission levels and impacts on the environment and community health, and (ii) cost and technical feasibility of bringing the existing emission levels to meet these new facilities limits.**
- **EA should demonstrate that emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards, and more stringent limits may be required.**

Combustion Technology / Fuel	Particulate Matter (PM)		Sulfur Dioxide (SO_2)		Nitrogen Oxides (NOx)	Dry Gas, Excess O_2 Content (%)
Combustion Turbine			NDA/DA		NDA/DA	
Natural Gas (all turbine types of Unit > 50MWth)	N/A	N/A	N/A	N/A	51 (25 ppm)	15%
Fuels other than Natural Gas (Unit > > 50MWth)	50	30	Use of 1% or less S fuel	Use of 0.5% or less S fuel	152 (74 ppm)[a]	15%

General notes:

- MWth = Megawatt thermal input on HHV basis; N/A = not applicable; NDA = Non-degraded airshed; DA = Degraded airshed (poor air quality); Airshed should be considered as being degraded if nationally legislated air quality standards are exceeded or, in their absence, if WHO Air Quality Guidelines are exceeded significantly; S = sulfur content (expressed as a percent by mass); Nm^3 is at one atmospheric pressure, 0 degree Celsius; MWth category is to apply to single units; Guideline limits apply to facilities operating more than 500 hours per year. Emission levels should be evaluated on a one hour average basis and be achieved 95% of annual operating hours.
- If supplemental firing is used in a combined cycle gas turbine mode, the relevant guideline limits for combustion turbines should be achieved including emissions from those supplemental firing units (e.g., duct burners).
- (a) Technological differences (for example the use of Aeroderivatives) may require different emissions values which should be evaluated on a cases-by-case basis through the EA process but which should not exceed 200 mg/Nm3.

Comparison of the Guideline limits with standards of selected countries / region (as of August 2008):

- Natural Gas-fired Combustion Turbine – NOx
  - Guideline limits: 51 (25 ppm)
  - EU: 50 (24 ppm), 75 (37 ppm) (if combined cycle efficiency > 55%), 50*η / 35 (where η = simple cycle efficiency)
  - US: 25 ppm (> 50 MMBtu/h (≈ 14.6 MWth) and ≤ 850 MMBtu/h (≈ 249MWth)), 15 ppm (> 850 MMBtu/h (≈ 249 MWth))
  - (Note: further reduced NOx ppm in the range of 2 to 9 ppm is typically required through air permit)
- Liquid Fuel-fired Combustion Turbine – NOx
  - Guideline limits: 152 (74 ppm) – Heavy Duty Frame Turbines & LFO/HFO, 300 (146 ppm) – Aeroderivatives & HFO, 200 (97 ppm) – Aeroderivatives & LFO
  - EU: 120 (58 ppm), US: 74 ppm (> 50 MMBtu/h (≈ 14.6 MWth) and ≤ 850 MMBtu/h (≈ 249MWth)), 42 ppm (> 850 MMBtu/h (≈ 249 MWth))
- Liquid Fuel-fired Combustion Turbine – SOx
  - Guideline limits: Use of 1% or less S fuel
  - EU: S content of light fuel oil used in gas turbines below 0.1% / US: S content of about 0.05% (continental area) and 0.4% (non-continental area)

Source: EU (LCP Directive 2001/80/EC October 23 2001), EU (Liquid Fuel Quality Directive 1999/32/EC, 2005/33/EC), US (NSPS for Stationary Combustion Turbines, Final Rule – July 6, 2006)

Table 6 (C) - Emissions Guidelines (in mg/Nm^3 or as indicated) for Boiler

Note:

- **Guidelines are applicable for new facilities.**
- **EA may justify more stringent or less stringent limits due to ambient environment, technical and economic considerations provided there is compliance with applicable ambient air quality standards and incremental impacts are minimized.**
- **For projects to rehabilitate existing facilities, case-by-case emission requirements should be established by the EA considering (i) the existing emission levels and impacts on the environment and community health, and (ii) cost and technical feasibility of bringing the existing emission levels to meet these new facilities limits.**
- **EA should demonstrate that emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards, and more stringent limits may be required.**

Combustion Technology / Fuel	Particulate Matter (PM)		Sulfur Dioxide (SO_2)		Nitrogen Oxides (NOx)		Dry Gas, Excess O_2 Content (%)
Boiler	NDA	DA	NDA	DA	NDA	DA	
Natural Gas	N/A	N/A	N/A	N/A	240	240	3%
Other Gaseous Fuels	50	30	400	400	240	240	3%
Liquid Fuels (Plant >50 MWth to <600 MWth)	50	30	900 – 1,500[a]	400	400	200	3%
Liquid Fuels (Plant >/=600 MWth)	50	30	200 – 850[b]	200	400	200	3%
Solid Fuels (Plant >50 MWth to <600 MWth)	50	30	900 – 1,500[a]	400	510[c] Or up to 1,100 if volatile matter of fuel < 10%	200	6%
Solid Fuels (Plant >/=600 MWth)	50	30	200 – 850[b]	200			6%

General notes:

- MWth = Megawatt thermal input on HHV basis; N/A = not applicable; NDA = Non-degraded airshed; DA = Degraded airshed (poor air quality); Airshed should be considered as being degraded if nationally legislated air quality standards are exceeded or, in their absence, if WHO Air Quality Guidelines are exceeded significantly; CFB = circulating fluidized bed coal-fired; PC = pulverized coal-fired; Nm^3 is at one atmospheric pressure, 0 degree Celsius; MWth category is to apply to the entire facility consisting of multiple units that are reasonably considered to be emitted from a common stack. Guideline limits apply to facilities operating more than 500 hours per year. Emission levels should be evaluated on a one hour average basis and be achieved 95% of annual operating hours.
- a. Targeting the lower guidelines values and recognizing issues related to quality of available fuel, cost effectiveness of controls on smaller units, and the potential for higher energy conversion efficiencies (FGD may consume between 0.5% and 1.6% of electricity generated by the plant). b. Targeting the lower guidelines values and recognizing variability in approaches to the management of SO_2 emissions (fuel quality vs. use of secondary controls) and the potential for higher energy conversion efficiencies (FGD may consume between 0.5% and 1.6% of electricity generated by the plant). Larger plants are expected to have additional emission control measures. Selection of the emission level in the range is to be determined by EA considering the project's sustainability, development impact, and cost-benefit of the pollution control performance. c. Stoker boilers may require different emissions values which should be evaluated on a case-by-case basis through the EA process.

Comparison of the Guideline limits with standards of selected countries / region (as of August 2008):

- Natural Gas-fired Boiler – NOx
  - Guideline limits: 240
  - EU: 150 (50 to 300 MWth), 200 (> 300 MWth)
- Solid Fuels-fired Boiler - PM
  - Guideline limits: 50
  - EU: 50 (50 to 100 MWth), 30 (> 100 MWth), China: 50, India: 100 - 150
- Solid Fuels-fired Boiler – SO_2
  - Guideline limits: 900 – 1,500 (Plant > 50 MWth to < 600 MWth), 200 – 850 (Plant ≥ 600 MWth)
  - EU: 850 (50 – 100 MWth), 200 (> 100 MWth)
  - US: 180 ng/J gross energy output OR 95% reduction (≈ 200 mg/Nm3 at 6%O_2 assuming 38% HHV efficiency)
  - China: 400 (general), 800 (if using coal < 12,550 kJ/kg), 1,200 (if mine-mouth plant located in non-double control area of western region and burning low S coal (<0.5%))

Source: EU (LCP Directive 2001/80/EC October 23 2001), US (NSPS for Electric Utility Steam Generating Units (Subpart Da), Final Rule – June 13, 2007), China (GB 13223-2003)

Table 7 – Typical Air Emission Monitoring Parameters / Frequency for Thermal Power Plants
(Note: Detailed monitoring programs should be determined based on EA)

Combustion Technology / Fuel	Emission Monitoring			Stack Emission Testing				Ambient Air Quality	Noise
	Particulate Matter (PM)	Sulfur Dioxide (SO_2)	Nitrogen Oxides (NOx)	PM	SO_2	NOx	Heavy Metals		
Reciprocating Engine								If incremental impacts predicted by EA >/= 25 % of relevant short-term ambient air quality standards or if the plant >/= 1,200 MWth: - Monitor parameters (e.g., $PM_{10}/PM_{2.5}/SO_2$/NOx to be consistent with the relevant ambient air quality standards) by continuous ambient air quality monitoring system (typically a minimum of 2 systems to cover predicted maximum ground level concentration point / sensitive receptor / background point). If incremental impacts predicted by EA < 25% of relevant short term ambient air quality standards and if the facility < 1,200 MWth but >/= 100 MWth - Monitor parameters either by passive samplers (monthly average) or by seasonal manual sampling (e.g., 1 weeks/season) for parameters consistent with the relevant air quality standards. Effectiveness of the ambient air quality monitoring program should be reviewed regularly. It could be simplified or reduced if alternative program is developed (e.g., local government's monitoring network). Continuation of the program is recommended during the life of the project if there are sensitive receptors or if monitored levels are not far below the relevant ambient air quality standards.	If EA predicts noise levels at residential receptors or other sensitive receptors are close to the relevant ambient noise standards / guidelines, or if there are such receptors close to the plant boundary (e.g., within 100m) then, conduct ambient noise monitoring every year to three years depending on the project circumstances. Elimination of noise monitoring can be considered acceptable if a comprehensive survey showed that there are no receptors affected by the project or affected noise levels are far below the relevant ambient noise standards / guidelines.
Natural Gas (Plant >50 MWth to <300 MWth)	N/A	N/A	Continuous or indicative	N/A	N/A	Annual	N/A		
Natural Gas (Plant >/= 300 MWth)	N/A	N/A	Continuous	N/A	N/A	Annual	N/A		
Liquid (Plant >50 MWth to <300 MWth)	Continuous or indicative	Continuous if FGD is used or monitor by S content.	Continuous or indicative	Annual					
Liquid (Plant >/=300 MWth)	Continuous or indicative		Continuous						
Biomass	Continuous or indicative	N/A	Continuous or indicative	Annual	N/A	Annual	N/A		
Combustion Turbine									
Natural Gas (all turbine types of Unit > 50MWth)	N/A	N/A	Continuous or indicative	N/A	N/A	Annual	N/A		
Fuels other than Natural Gas (Unit > 50MWth)	Continuous or indicative	Continuous if FGD is used or monitor by S content.	Continuous or indicative	Annual					
Boiler									
Natural Gas	N/A	N/A	Continuous or indicative	N/A	N/A	Annual	N/A		
				Annual	Annual	Annual	N/A		
Other Gaseous fuels	Indicative	Indicative	Continuous or indicative	Annual					
Liquid (Plant >50 MWth to <600 MWth)	Continuous or indicative	Continuous if FGD is used or monitor by S content.	Continuous or indicative						
Liquid (Plant >=600 MWth)		Continuous							
Solid (Plant >50 MWth to <600 MWth)		Continuous if FGD is used or monitor by S Content.	Continuous or indicative						
Solid (Plant >/=600 MWth)		Continuous							

Note: Continuous or indicative means "Continuously monitor emissions or continuously monitor indicative parameters". Stack emission testing is to have direct measurement of emission levels to counter check the emission monitoring system.

2.2 Occupational Health and Safety

Occupational Health and Safety Guidelines

Occupational health and safety performance should be evaluated against internationally published exposure guidelines, of which examples include the Threshold Limit Value (TLV®) occupational exposure guidelines and Biological Exposure Indices (BEIs®) published by American Conference of Governmental Industrial Hygienists (ACGIH),[36] the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),[37] Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),[38] Indicative Occupational Exposure Limit Values published by European Union member states,[39] or other similar sources.

Additional indicators specifically applicable to electric power sector activities include the ICNIRP exposure limits for occupational exposure to electric and magnetic fields listed in Table 8. Additional applicable indicators such as noise, electrical hazards, air quality, etc. are presented in Section 2.0 of the **General EHS Guidelines**.

Table 8 - ICNIRP exposure limits for occupational exposure to electric and magnetic fields.

Frequency	Electric Field (V/m)	Magnetic Field (μT)
50 Hz	10,000	500
60 Hz	8300	415

Source: ICNIRP (1998) : "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)

Accident and Fatality Rates

Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. The accident and fatality rates of the specific facility may be benchmarked against the performance of facilities in this sector in developed countries through consultation with published sources (e.g., US Bureau of Labor Statistics and UK Health and Safety Executive)[40].

Occupational Health and Safety Monitoring

The working environment should be monitored for occupational hazards relevant to the specific project. Monitoring should be designed and implemented by accredited professionals[41] as part of an occupational health and safety monitoring program. Facilities should also maintain a record of occupational accidents and diseases and dangerous occurrences and accidents. Additional guidance on occupational health and safety monitoring programs is provided in the **General EHS Guidelines**.

[36] http://www.acgih.org/TLV/[36] Available at: http://www.acgih.org/TLV/ and http://www.acgih.org/store/

[37] Available at: http://www.cdc.gov/niosh/npg/

[38] Available at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992

[39] Available at: http://europe.osha.eu.int/good_practice/risks/ds/oel/

[40] Available at: http://www.bls.gov/iif/ and http://www.hse.gov.uk/statistics/index.htm

[41] Accredited professionals may include Certified Industrial Hygienists, Registered Occupational Hygienists, or Certified Safety Professionals or their equivalent.

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Annex A: General Description of Industry Activities

Thermal power plants burn fossil fuels or biomass to generate electrical energy and heat. Mechanical power is produced by a heat engine, which transforms thermal energy from combustion of a fossil fuel into rotational energy. A generator converts that mechanical energy into electrical energy by creating relative motion between a magnetic field and a conductor. Figure A-1 is a generalized flow diagram of a boiler-based thermal power plant and its associated operations.

Not all thermal energy can be transformed to mechanical power, according to the second law of thermodynamics. Therefore, thermal power plants also produce low-temperature heat. If no use is found for the heat, it is lost to the environment. If reject heat is employed as useful heat (e.g., for industrial processes or district heating), the power plant is referred to as a cogeneration power plant or CHP (combined heat-and-power) plant.

Types of Thermal power plants

Thermal power plants can be divided based on the type of combustion or gasification: boilers, internal reciprocating engines, and combustion turbines. In addition, combined-cycle and cogeneration systems increase efficiency by utilizing heat lost by conventional combustion systems. The type of system is chosen based on the loads, the availability of fuels, and the energy requirements of the electric power generation facility. Other ancillary processes, such as coal processing and pollution control, must also be performed to support the generation of electricity. The following subsections describe each system and then discuss ancillary processes at the facility (USEPA 1997).

Boilers (Steam Turbines)

Conventional steam-producing thermal power plants generate electricity through a series of energy conversion stages: fuel is burned in boilers to convert water to high-pressure steam, which is then used to drive a steam turbine to generate electricity. Heat for the system is usually provided by the combustion of coal, natural gas, oil, or biomass as well as other types of waste or recovered fuel. High-temperature, high-pressure steam is generated in the boiler and then enters the steam turbine. At the other end of the steam turbine is the condenser, which is maintained at a low temperature and pressure. Steam rushing from the high-pressure boiler to the low-pressure condenser drives the turbine blades, which powers the electric generator.

Low-pressure steam exiting the turbine enters the condenser shell and is condensed on the condenser tubes, which are maintained at a low temperature by the flow of cooling water. As the steam is cooled to condensate, the condensate is transported by the boiler feedwater system back to the boiler, where it is used again. A constant flow of low-temperature cooling water in the condenser tubes is required to keep the condenser shell (steam side) at proper pressure and to ensure efficient electricity generation. Through the condensing process, the cooling water is warmed. If the cooling system is an open or a once-through system, this warm water is released back to the source water body.[42] In a closed system, the warm water is cooled by recirculation through cooling towers, lakes, or ponds, where the heat is released into the air through evaporation and/or sensible heat transfer. If a recirculating cooling system is used, only a relatively small amount of make-up water is required to offset the evaporative losses and cooling tower blowdown that must be discharged periodically to control the build-up of solids. A recirculating system uses about one-twentieth the water of a once-through system.

Steam turbines typically have a thermal efficiency of about 35 percent, meaning that 35 percent of the heat of combustion is transformed into electricity. The remaining 65 percent of the heat either goes up the stack (typically 10 percent) or is

[42] If groundwater is used for cooling, the cooling water is usually discharged to a

discharged with the condenser cooling water (typically 55 percent).

Coal and lignite are the most common fuels in thermal power plants although heavy fuel oil is also used. Coal-fired steam generation systems are designed to use pulverized coal or crushed coal. Several types of coal-fired steam generators are in use, and are generally classified based on the characteristics of the coal fed to the burners and the mode of burning the coal. In fluidized-bed combustors, fuel materials are forced by gas into a state of buoyancy. The gas cushion between the solids allows the particles to move freely, thus flowing like a liquid. By using this technology, SO_2 and NO_X emissions are reduced because an SO_2 sorbent, such as limestone, can be used efficiently. Also, because the operating temperature is low, the amount of NO_X gases formed is lower than those produced using conventional technology.

Natural gas and liquid fuels are usually transported to thermal power plants via pipelines. Coal and biomass fuels can be transported by rail, barge, or truck. In some cases, coal is mixed with water to form slurry that can be pumped to the thermal power plant in a pipeline. Once coal arrives at the plant, it is unloaded to storage or directly to the stoker or hopper. In transporting coal during warmer months and in dry climates, dust suppression may be necessary.

Coal may be cleaned and prepared before being either crushed or pulverized. Impurities in coal such as ash, metals, silica, and sulfur can cause boiler fouling and slagging. Coal cleaning can be used to reduce sulfur in the coal to meet sulfur dioxide (SO_2) emissions regulations and also reduce ash content and the amount of heavy metals. Cleaning the coal is costly, but the cost can be at least partially offset by an increase in fuel efficiency, reduced emission control requirements, and lower waste management costs. Coal cleaning is typically performed at the mine by using gravity concentration, flotation, or dewatering methods.

Coal is transported from the coal bunker or silo to be crushed, ground, and dried further before it is fired in the burner or combustion system. Many mechanisms can be used to grind the coal and prepare it for firing. Pulverizers, cyclones, and stokers are all used to grind and dry the coal. Increasing the coal's particle surface area and decreasing its moisture content greatly boosting its heating capacity. Once prepared, the coal is transported within the plant to the combustion system. Devices at the bottom of the boilers catch ash and/or slag.

Reciprocating Engines

Internal combustion engines convert the chemical energy of fuels (typically diesel fuel or heavy fuel oil) into mechanical energy in a design similar to a truck engine, and the mechanical energy is used to turn a generator. Two types of engines normally used: the medium-speed, four-stroke trunk piston engine and the low-speed, two-stroke crosshead engine. Both types of engine operate on the air-standard diesel thermodynamic cycle. Air is drawn or forced into a cylinder and is compressed by a piston. Fuel is injected into the cylinder and is ignited by the heat of the compression of the air. The burning mixture of fuel and air expands, pushing the piston. The products of combustion are then removed from the cylinder, completing the cycle.

The exhaust gases from an engine are affected by the load profile of the prime mover; ambient conditions such as air humidity and temperature; fuel oil quality, such as sulfur content, nitrogen content, viscosity, ignition ability, density, and ash content; and site conditions and the auxiliary equipment associated with the prime mover, such as cooling properties and exhaust gas back pressure. The engine parameters that affect NO_X emissions are fuel injection in terms of timing, duration, and atomization; combustion air conditions, which are affected by

surface water body.

valve timing, the charge air system, and charge air cooling before cylinders; and the combustion process, which is affected by air and fuel mixing, combustion chamber design, and the compression ratio.[43] The particulate matter emissions are dependent on the general conditions of the engine, especially the fuel injection system and its maintenance, in addition to the ash content of the fuel, which is in the range 0.05–0.2%. SOx emissions are directly dependent on the sulfur content of the fuel. Fuel oil may contain as little as 0.3% sulfur and, in some cases, up to 5% sulfur.

Diesel engines are fuel flexible and can use fuels such as diesel oil, heavy fuel oil, natural gas, crude oil, bio-fuels (such as palm oil, etc.) and emulsified fuels (such as Orimulsion, etc.).

Typical electrical efficiencies in single mode are typically ranging from 40 % for the medium speed engines up to about 50 % for large engines and even higher efficiencies in combined cycle mode. Total efficiency in CHP (Combined Heat and Power) is typically in liquid operation up to 60 – 80 % and in gas mode even higher dependent on the application. The heat to power ratio is typically 0.5 to 1.3 in CHP applications, dependent on the application.

Lean Burn Gas Engines

Typical electrical efficiencies for bigger stationary medium speed engines in single mode are typically 40 – 47 % and up to close to 50 % in combined cycle mode. Total efficiency in CHP facilities is typically up to 90 % dependent on the application. The heat to power ratios are typically 0.5 to 1.3 in CHP-applications, dependent on the application.

Spark Ignition (SG)

Often a spark ignited gas-otto engine works according to the lean burn concept meaning that a lean mixture of combustion air and fuel is used in the cylinder (e.g., much more air than needed for the combustion). In order to stabilize the ignition and combustion of the lean mixture, in bigger engine types a prechamber with a richer air/fuel mixture is used. The ignition is initiated with a spark plug or some other device located in the prechamber, resulting in a high-energy ignition source for the main fuel charge in the cylinder. The most important parameter governing the rate of NOx formation in internal combustion engines is the combustion temperature; the higher the temperature the higher the NOx content of the exhaust gases. One method is to lower the fuel/air ratio, the same specific heat quantity released by the combustion of the fuel is then used to heat up a larger mass of exhaust gases, resulting in a lower maximum combustion temperature. This method low fuel/air ratio is called lean burn and it reduces NOx effectively. The spark-ignited lean-burn engine has therefore low NOx emissions. This is a pure gas engine; it operates only on gaseous fuels.

Dual fuel engines (DF)

Some DF engine types are fuel versatile, these can be run on low pressure natural gas or liquid fuels such as diesel oil (as back-up fuel, etc.), heavy fuel oil, etc. This engine type can operate at full load in both fuel modes. Dual Fuel (DF) engines can also be designed to work in gas mode only with a pilot liquid fuel used for ignition of the gas.

Combustion Turbines

Gas turbine systems operate in a manner similar to steam turbine systems except that combustion gases are used to turn the turbine blades instead of steam. In addition to the electric generator, the turbine also drives a rotating compressor to pressurize the air, which is then mixed with either gas or liquid

[43] If the fuel timing is too early, the cylinder pressure will increase, resulting in higher nitrogen oxide formation. If injection is timed too late, fuel consumption and turbocharger speed will increase. NO_X emissions can be reduced by later injection timing, but then particulate matter and the amount of unburned species will increase.

fuel in a combustion chamber. The greater the compression, the higher the temperature and the efficiency that can be achieved in a gas turbine. Higher temperatures, however, typically lead to increases in NO_X emissions. Exhaust gases are emitted to the atmosphere from the turbine. Unlike a steam turbine system, gas turbine systems do not have boilers or a steam supply, condensers, or a waste heat disposal system. Therefore, capital costs are much lower for a gas turbine system than for a steam system.

In electrical power applications, gas turbines are often used for peaking duty, where rapid startup and short runs are needed. Most installed simple gas turbines with no controls have only a 20- to 30-percent efficiency.

Combined Cycle

Combined-cycle generation is a configuration using both gas turbines and steam generators. In a combined-cycle gas turbine (CCGT), the hot exhaust gases of a gas turbine are used to provide all, or a portion of, the heat source for the boiler, which produces steam for the steam generator turbine. This combination increases the thermal efficiency to approximately 50 - 60 percent. Combined-cycle systems may have multiple gas turbines driving one steam turbine. Combined-cycle systems with diesel engines and steam generators are also sometimes used.

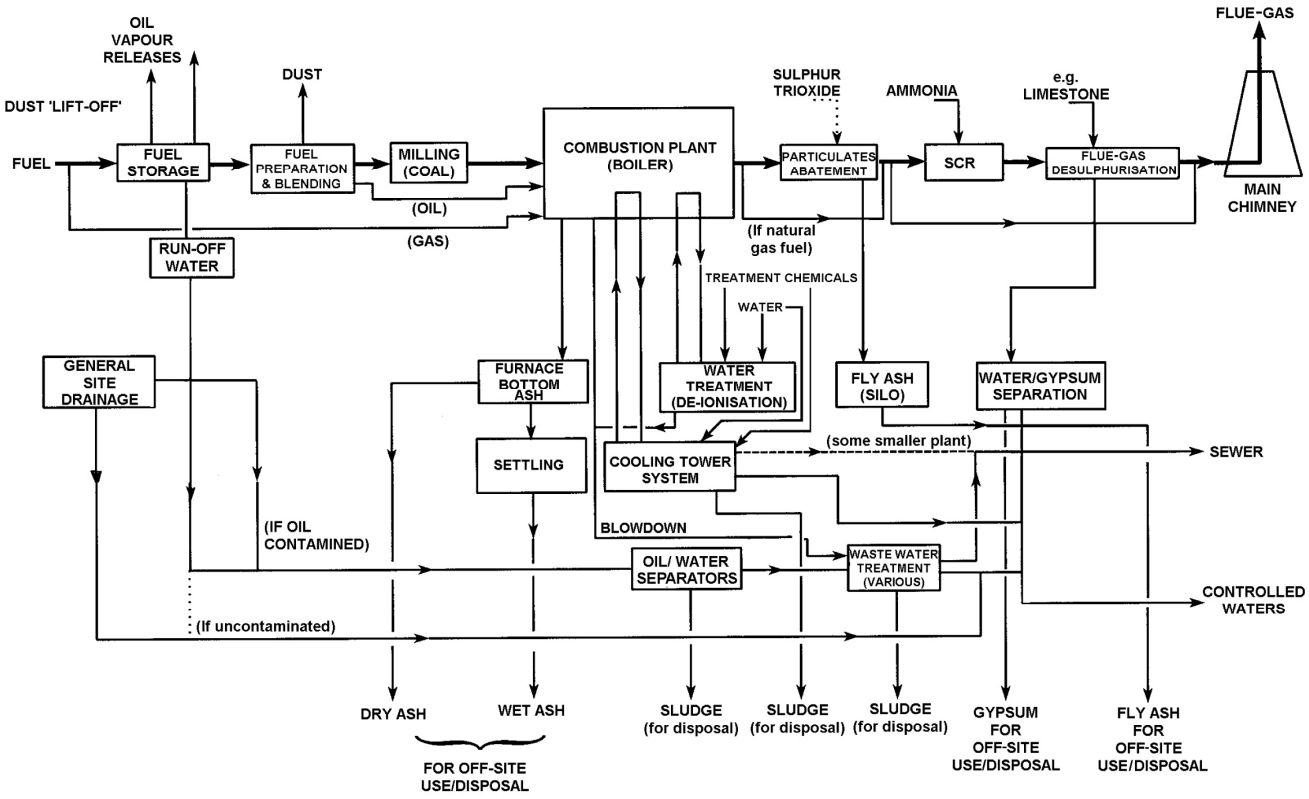
In addition, integrated coal gasification combined-cycle (IGCC) units are emerging technologies. In an IGCC system, coal gas is manufactured and cleaned in a "gasifier" under pressure, thereby reducing emissions and particulates.[44] The coal gas then is combusted in a CCGT generation system.

Cogeneration

Cogeneration is the merging of a system designed to produce electric power and a system used for producing industrial heat and steam and/or municipal heating. This system is a more efficient way of using energy inputs and allows the recovery of otherwise wasted thermal energy for use in an industrial process. Cogeneration technologies are classified as "topping cycle" and "bottoming cycle" systems, depending on whether electrical (topping cycle) or thermal (bottoming cycle) energy is derived first. Most cogeneration systems use a topping cycle.

[44] Gasification is a process in which coal is introduced to a reducing atmosphere with oxygen or air and steam.

Figure A-1
Generalized Flow Diagram of a Thermal power plant[45] and Associated Operations



Source: EC 2006

[45] Applicable to boiler plant with cooling tower only. Diagram does not apply to engines and turbines which have completely different configurations.

Annex B: Environmental Assessment Guidance for Thermal Power Projects

The development of an environmental assessment (EA) for a thermal power project should take into account any government energy and/or environmental policy or strategy including strategic aspects such as energy efficiency improvements in existing power generation, transmission, and distribution systems, demand side management, project siting, fuel choice, technology choice, and environmental performance.

New Facilities and Expansion of Existing Facilities

An (EA) for new facilities and a combined EA and environmental audit for existing facilities should be carried out early in the project cycle in order to establish site-specific emissions requirements and other measures for a new or expanded thermal power plant. Table B-1 provides suggested key elements of the EA, the scope of which will depend on project-specific circumstances.

Table B-1 Suggested Key EHS Elements for EA of New Thermal Power Project

Analysis of Alternatives	• Fuel selection including non-fossil fuel options (coal, oil, gas, biomass, other renewable options – wind, solar, geothermal, hydro), fuel supply sources
	• Power generation technology
	  ○ Thermal generating efficiency (HHV-gross, LHV-gross, HHV-net, LHV-net)
	  ○ Cost
	  ○ CO_2 emissions performance (gCO2/kWh)
	• GHG emissions reduction / offset options
	  ○ Energy conversion efficiency
	  ○ Offset arrangement
	  ○ Use of renewable energy sources, etc.
	• Baseline water quality of receiving water bodies
	• Water supply
	  ○ Surface water, underground water, desalination
	• Cooling system
	  ○ Once-through, wet closed circuit, dry closed circuit
	• Ash disposal system - wet disposal vs. dry disposal
	• Pollution control
	  ○ Air emission – primary vs. secondary flue gas treatment (cost, performance)
	  ○ Effluent (cost, performance)
	• Effluent discharge
	  ○ Surface water
	  ○ Evaporation
	  ○ Recycling – zero discharge
	• Siting
	  ○ Land acquisition consideration
	  ○ Access to fuel / electricity grid
	  ○ Existing and future land use zoning
	  ○ Existing and predicted environmental baseline (air, water, noise)

Impact Assessment	• Estimation of GHG emissions (tCO_2/year, gCO_2/kWh)
	• Air quality impact
	  ○ SO_2, NO_2, PM_{10}, $PM_{2.5}$, Heavy metals as appropriate, Acid deposition if relevant
	  ○ Incremental impacts to the attainment of relevant air quality standards
	  ○ Isopleth concentration lines (short-term, annual average, as appropriate) overlaid with land use and topographic map
	  ○ Cumulative impacts of existing sources / future projects if known
	  ○ Stack height determination
	  ○ Health impact consideration
	• Water quality / intake impact
	  ○ thermal discharge if once-through cooling system is used
	  ○ other key contaminants as appropriate
	  ○ water intake impact
	• Noise impact
	  ○ Noise contour lines overlaid with land use and locations of receptors
	• Determination of pollution prevention and abatement measures

Mitigation Measures /	• Air (Stack height, pollution control measures, cost)

Management Program	• Effluent (wastewater treatment measures, cost) • Noise (noise control measures, cost) • Waste utilization / disposal (e.g., ash, FGD by-product, used oil) ○ Ash management plan (quantitative balance of ash generation, disposal, utilization, size of ash disposal site, ash transportation arrangement) • Fuel supply arrangement • Emergency preparedness and response plan • Industrial risk assessment if relevant
Monitoring Program	• Parameters • Sampling Frequency • Evaluation Criteria • Sampling points overlaid with relevant site layout / surrounding maps • Cost

Tasks related to carrying out the quality impact analysis for the EA should include:

- Collection of baseline data ranging from relatively simple qualitative information (for smaller projects) to more comprehensive quantitative data (for larger projects) on ambient concentrations of parameters and averaging time consistent with relevant host country air quality standards (e.g., parameters such as PM_{10}, $PM_{2.5}$, SO_2 (for oil and coal-fired plants), NO_X, and ground-level ozone; and averaging time such as 1-hour maximum, 24-hour maximum, annual average), within a defined airshed encompassing the proposed project;[46]
- Evaluation of the baseline airshed quality (e.g., degraded or non-degraded);
- Evaluation of baseline water quality, where relevant;
- Use of appropriate mathematical or physical air quality dispersion models to estimate the impact of the project on the ambient concentrations of these pollutants;
- If acid deposition is considered a potentially significant impact, use of appropriate air quality models to evaluate long-range and trans-boundary acid deposition;
- The scope of baseline data collection and air quality impact assessment will depend on the project circumstances (e.g., project size, amount of air emissions and the potential impacts on the airshed). Examples of suggested practices are presented in Table B-2.

Table B-2 - Suggested Air Quality Impact Assessment Approach

Baseline air quality collection	• Qualitative information (for small projects e.g., < 100MWth) • Seasonal manual sampling (for mid-sized projects e.g., < 1,200MWth) • Continuous automatic sampling (for large projects e.g., >= 1,200MWth) • Modeling existing sources
Baseline meteorological data collection	• Continuous one-year data for dispersion modeling from nearby existing meteorological station (e.g., airport, meteorological station) or site-specific station, if installed, for mid-sized and large projects
Evaluation of airshed quality	• Determining if the airshed is degraded (i.e., ambient air quality standards are not attained) or non-degraded (i.e., ambient air quality standards are attained)
Air quality impact assessment	• Assess incremental and resultant levels by screening models (for small projects) • Assess incremental and resultant levels by refined models (for mid-sized and large projects, or for small projects if determined necessary after using screening models)[47] • Modify emission levels, if needed, to ensure that incremental impacts are small (e.g., 25% of relevant ambient air quality standard levels) and that the airshed will not become degraded.

[46] The term "airshed" refers to the local area around the plant whose ambient air quality is directly affected by emissions from the plant. The size of the relevant local airshed will depend on plant characteristics, such as stack height, as well as on local meteorological conditions and topography. In some cases, airsheds are defined in legislation or by the relevant environmental authorities. If not, the EA should clearly define the airshed on the basis of consultations with those responsible for local environmental management.

[47] For further guidance on refined / screening models, see Appendix W to Part 51 – Guidelines on Air Quality Models by US EPA (Final Rule, November 9, 2005)

When there is a reasonable likelihood that in the medium or long term the power plant will be expanded or other pollution sources will increase significantly, the analysis should take account of the impact of the proposed plant design both immediately and after any formally planned expansion in capacity or in other sources of pollution. Plant design should allow for future installation of additional pollution control equipment, should this prove desirable or necessary based upon predicted air quality impacts and/or anticipated changes in emission standards (i.e., impending membership into the EU). The EA should also address other project-specific environmental concerns, such as fuel and emissions from fuel impurities. In cases where fuel impurities lead to known hazardous emissions, the EA should estimate the emission amount, assess impacts and propose mitigations to reduce emissions.[48] Examples of compounds which may be present in certain types of coal, heavy fuel oil, petroleum coke, etc. include cadmium, mercury, and other heavy metals.

Rehabilitation of Existing Facilities

An environmental assessment of the proposed rehabilitation should be carried out early in the process of preparing the project in order to allow an opportunity to evaluate alternative rehabilitation options before key design decisions are finalized. The assessment should include an environmental audit that examines the impacts of the existing plant's operations on nearby populations and ecosystems, supplemented by an EA that examines the changes in these impacts that would result under alternative specifications for the rehabilitation, and the estimated capital and operating costs associated with each option. Depending on the scale and nature of the rehabilitation, the audit/environmental assessment may be relatively narrow in scope, focusing on only a small number of specific concerns that would be affected by the project, or it may be as extensive as would be appropriate for the construction of a new unit at the same site. Normally, it should cover the following points:

- Ambient environmental quality in the airshed or water basin affected by the plant, together with approximate estimates of the contribution of the plant to total emissions loads of the main pollutants of concern
- The impact of the plant, under existing operating conditions and under alternative scenarios for rehabilitation, on ambient air and water quality affecting neighboring populations and sensitive ecosystems
- The likely costs of achieving alternative emissions standards or other environmental targets for the plant as a whole or for specific aspects of its operations
- Recommendations concerning a range of cost effective measures for improving the environmental performance of the plant within the framework of the rehabilitation project and any associated emissions standards or other requirements implied by the adoption of specific measures.

These issues should be covered at a level of detail appropriate to the nature and scale of the proposed project. If the plant is located in an airshed or water basin that is polluted as a result of emissions from a range of sources, including the plant itself, comparisons should be made of the relative costs of improving ambient air or water quality by reducing emissions from the plant or by reducing emissions from other sources.

[48] Several U.S. states have adopted regulations that give coal-fired power plants the option to meet either a mercury emissions standard based on electricity output or a control-based standard. For instance, Illinois requires all coal-fired power plants of 25 MW electrical capacity or greater to meet either an emissions standard of 0.0080 lbs mercury per gigawatt hour (GWh) gross electrical output or an emissions control requirement of 90 percent relative to mercury input.

Appendix C: Equator Principle Requirements

Please see following pages.

C.1 Equator Principles

Criteria	*Detail/Requirement*	
EP1: Review and categorisation - Categorise the risk of a project based on the environmental and social screening criteria of the IFC	Category • A (potentially significant impacts that are diverse, irreversible or unprecedented), • B (potentially limited adverse impacts that are fewer in number, site specific, largely reversible and readily addressed through mitigation measures), or • C (minimal or no impacts) needs to be motivated and subsequent criteria addressed accordingly	
EP2: Social and environmental assessment - For Category A & B projects, complete a social and environmental assessment process to address the relevant impacts and risks of the project. Propose mitigation and management measures relevant and appropriate to the nature and scale of the project.	Social and Environmental Assessment (SEA) is a process that determines the impacts and risks (including environmental, social, labour, health and safety).	This document is prepared to meet the requirements of EP2.
EP 3: Applicable social and environmental standards - Project located in non-OECD countries and OECD countries not designated as High-Income in terms of the WB Development Indicators Database the assessment will refer to the: IFC Performance Standards (Exhibit II) and Industry Specific Guidelines (Exhibit IV).	The Assessment should address compliance with, or justify the deviation from, the: • PS and • EHS Guidelines, • relevant host country laws and regulations and permits.	Al three documents have been used as the basic criteria in the preparation of this ESIA.

Criteria	*Detail/Requirement*	
EP 4 Action plan and management system - For Category A and B projects an Action Plan (AP) must be prepared which addresses the relevant findings and draws on the conclusions of the assessment. AP describes and prioritises the actions needed to implement mitigation measures, corrective actions and monitoring measures to manage impacts and risks identified in the SEA. Establish, build-on and maintain a Social and Environmental Management System (SEMS) that addresses the management of the identified impacts and risks.	AP can range from brief description of routine mitigation measures to a series of documents (plans). Detail and complexity and priority of measures and actions will be commensurate with the impacts and risks. SEMS will incorporate (as per PS1): • Social and environmental assessment • Management programme • Organisational capacity • Training • Community engagement • Monitoring • Reporting	The EMP (Appendix E) is prepared to meet this requirement.
EP5: Consultation and Disclosure - For all Category A and B projects consultation with project affected communities has occurred in a structured and culturally appropriate manner. For projects with significant adverse impacts on affected communities the process ensures free, prior and informed consultation in all stages of the project. Free = free of external manipulation, interference or coercion and intimidation Prior = timely disclosure of information Informed = relevant, understandable and accessible information	• Affected communities are communities of the local population within the projects area of influence who are likely to be adversely affected. • Structured consultation requires the preparation of a Public Consultation and Disclosure Plan (PCDP). • Communication is tailored to the language preferences of the affected communities, their decision-making processes and the needs of disadvantage and vulnerable groups. • Consultation with indigenous people must conform to PS7. • The SEA and AP, or non-technical summary thereof, must be made available to the public for a reasonable minimum period in the relevant local language in a culturally appropriate manner. • The process and results (including actions agreed) of the consultation will be documented. • Disclosure should occur early in the assessment process and should be on-going.	Public Consultation was undertaken. The results are reported in Section 6 of the ESIA. Further public disclosure will take place after submission of the ESIA to the Sindh EPA for review.

Criteria	*Detail/Requirement*	
EP6: Grievance mechanism - For category A and B projects establish a grievance mechanism to ensure that consultation, disclosure and community engagement continues throughout construction and operation.	Inform the communities about the mechanism and ensure that mechanism addresses concerns promptly and transparently, is a culturally appropriate manner, is readily accessible to all.	A grievance mechanism has been proposed as part of the EMP.
EP 7: Independent Review - For all Category A projects and, as appropriate, for Category B projects, an independent social or environmental expert not directly associated with the borrower will review the SEA, AP and consultation process documentation to assist Lender's due diligence, and assess Equator Principles compliance.		This applies to the financing agency.
EP 8: Covenants - For Category A and B projects, the borrower will make covenants in financing documentation.	Covenants be made to: a) comply with all relevant host country social and environmental laws, regulations and permits in all material respects; b) comply with the AP (where applicable) during the construction and operation of the project in all material respects; c) provide periodic reports in a format agreed with EP Financial Institutions (EPFIs) (with the frequency of these reports proportionate to the severity of impacts, or as required by law, but not less than annually), prepared by in-house staff or third party experts, that i) document compliance with the AP (where applicable), and ii) provide representation of compliance with relevant local, state and host country social and environmental laws, regulations and permits; and d) decommission the facilities, where applicable and appropriate, in accordance with an agreed decommissioning plan.	This applies to the financing agency.

Criteria	*Detail/Requirement*	
EP 9: Independent Monitoring and Reporting	To ensure ongoing monitoring and reporting over the life of the loan, EPFIs will, for all Category A projects, and as appropriate, for Category B projects, require appointment of an independent environmental and/or social expert, or require that the borrower retain qualified and experienced external experts to verify its monitoring information which would be shared with EPFIs.	This applies to the financing agency.
EP 10: EPFI Reporting -	Each EPFI adopting the Equator Principles commits to report publicly at least annually about its Equator Principles implementation processes and experience, taking into account appropriate confidentiality considerations.	This applies to the financing agency.

C.2 IFC Performance Standards

Criteria	*Detail/Requirement*	
Social and Environmental Management System	Establish and maintain a Social and Environmental Management System (SEMS) incorporating the following elements: • Social and environmental assessment • Social and environmental management program & action plan • Organizational capacity • Training • Community engagement including disclosure, consultation, and a grievance mechanism • Monitoring • Reporting	The project proponent will develop and maintain a social and environmental management system which will be based upon internationally recognized standards such as the ISO 14000. The outline of the SEMS is presented in Section 8.
Social and Environmental Assessment	Conduct a Social and Environmental Assessment Process that considers the potential social and environmental (including labor, health and safety) risks and impacts. The assessment will include: • Current information	This ESIA report submitted contains all the required current baseline information, project description provided by the project proponent and considerations of all relevant social and

Criteria	*Detail/Requirement*	
	• Accurate project description • Appropriate baseline social and environmental baseline data • Consideration of all relevant social and environmental risks and impacts • Issues identified in PS2 to PS8 • Compliance with applicable laws and regulations	environmental risks and impacts
	Risks and impacts will be analyzed in the context of the project's area of influence encompassing: • Primary project site and related facilities that the client and its contractors develops or controls • Associated facilitates not funded as part of this project and whose viability and existence depend exclusively on the project and whose goods and services are essential for the successful operation of the project • Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments. • Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location	Risk and impact assessment was done after two rounds of detailed field visits to the plant site and the area that may be effected directly or that maybe affected in the long run by the cumulative effects of the proposed power plant project
	Risks and impacts will be analyzed for the key stages of the project cycle including: Pre-construction, Construction, Operations and Decommissioning or closure. Risks and impacts should consider: • The role and capacity of third parties (government, contractors and suppliers) to the extent that they pose a risk to the project, recognizing that the risks should be addressed commensurate to the client's control and influence over the third party actions. • Impacts associated with supply chains need to be considered where the resource utilized by the project is ecologically sensitive or where low labor cost is a factor in the competitiveness of the item supplied. • Consider transboundary effects and global effects. Transboundary	All four stages of the project are assessed. • No risk associated with third party in the context of environment • No resource utilized by the project is ecologically sensitive • No transboundary effect envisaged.

Criteria	*Detail/Requirement*	
	impacts are impacts that extend to multiple countries, beyond the host country of the project, but are not global in nature. Examples include air pollution extending to multiple countries, use or pollution of international waterways, and transboundary epidemic disease transmission.	
	The assessment should be an adequate, accurate and objective evaluation and presentation of the issues, prepared by qualified and experienced persons.	The ESIA report has been prepared by Hagler Bailly Pakistan Pvt. Limited, the company has conducted successful assessment studies for more than 200 projects
	The assessment should comprise a SEA depending on the type of project and nature and magnitude of risks and impacts. Where the project involves existing activities a social and/or environmental audit may be required to determine areas of concern.	As power plant project is not new to the country or the project and as the project is not based on new fuel or technology, SEA is not considered a requirement. As this is a new project, environmental audit is not necessary.
	Projects with potential significant adverse impacts that are diverse, irreversible or unprecedented will have comprehensive SEIAs. This will include an examination of technical and financially feasible alternatives and documentation of the rationale for selecting the particular course of action proposed. In exceptional cases a regional, sectorial or strategic assessment may be required. Narrower scopes of assessments may be conducted for projects with limited impacts that are fewer, site-specific, largely reversible and readily addressed through mitigation measures.	The project is based on typical technology and typical fuel. Project alternatives to the extent considered during project development have been described.
	Identify individuals or groups who may be differentially or disproportionately affected by the project because of their disadvantaged or vulnerable status. Implement differentiated measures so that adverse impacts do not fall disproportionately on them and they are not disadvantaged in sharing development benefits and opportunities. Consideration may need to be given to human rights issues, gender issues and those with disabilities.	No such group identified.

Criteria	*Detail/Requirement*	
Management program	Taking into account the findings of the SEIA and consultation establish and manage a program of mitigation and performance improvement measures and actions that address the risks and impacts.	All the required mitigation and performance improvement measures and actions that address the potential risks and impacts have been incorporated in the environmental management plan of attached with the ESIA report
	The management program will include operational policies, procedures and practices. Measures and actions to address impacts will favour avoidance and prevention over minimization, mitigation or compensation. Measures must comply with applicable laws and regulations and meet PS1 to PS8.	The proponents are committed to developing this as part of the overall environmental management plan.
	The management program will define desired outcomes as measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, with estimates of the resources and responsibilities for implementation. The program must be responsive to changes in circumstances, unforeseen events and results of monitoring.	The proponents are committed to developing this as part of the overall environmental management plan.
	Prepare an Action Plan of the mitigation measure and actions specific to comply with laws and regulations and PS1 to PS8 including: • Describe actions necessary to implement the various sets of mitigation measures or corrective actions • Prioritize these actions • Include a time-line for their implementation • Be disclosed to the affected communities • Describe the schedule and mechanism for external reporting on the implementation of the Action Plan	The EMP is designed in a manner that it can be used as the basis for Action Plan.
Organizational capacity	Establish, maintain and strengthen as appropriate an organizational structure that defines roles and responsibilities, authority to implement the management program/Action plan. • Specific personnel with clear lines of responsibility and authority should be designated. • Key social and environmental responsibilities should be well defined and communicated to relevant personnel and the rest of the	As part of the Environmental Management System (EMS) organizational capacity shall be built, developed and maintained that will include defining management responsibilities, and allocation of appropriate human and financial resources

Criteria	*Detail/Requirement*	
	organization • Management sponsorship and human and financial resources will be provided on an ongoing basis to achieve and continuous performance.	
Training	Train employees and contractors with direct responsibility for activities relevant to social and environmental performance including: • Host country laws and regulations • PS1 to PS8 • Knowledge and skills for their work • Measures and actions required under the management program/Action Plan • Methods required to perform the action items	Environmental trainings will be provided to the relevant staff as part of the EMP provided in the ESIA report
Community engagement	Ongoing process involving the client's disclosure of information. Build and maintain over time a constructive relationship with local affected communities. Engagement will be free of external manipulation, interference or coercion and intimidation and conducted on the basis of timely, relevant, understandable and accessible information.	A community relations manger will be appointed on a permanent basis.
Disclosure	Disclosure of relevant project information through public disclosure of the SEIA. Inform affected communities of the purpose, nature, scale of the project, duration of activities, risks and impacts on communities early in the assessment process and on an on-going basis.	The ESIA will be available to the public for review once it is submitted to the Sindh EPA.
Consultation	If affected communities may be subject to risks and impacts a consultation process will be undertaken providing communities with opportunities to express their views on project risks, impacts and mitigation measures. The client will consider and respond to these. Effective communication will be based on the following: • Prior disclosure of relevant and adequate information • Should begin early in the assessment process • Focus on risks and impacts and measures and actions to address these • Carried out on an ongoing basis as risks and impacts arise	Public consultation was an essential part of the ESIA process and included two rounds of consultations with the affected communities and other stakeholders whereby a brief description of the project and was given and their feedback was recorded and recommendations included in the ESIA report Most of the consultations were conducted in Urdu and Sindhi languages with the help of local social scientist

Criteria	*Detail/Requirement*	
	• Inclusive and culturally appropriate • Process tailored to the language preferences of affected communities, decision-making process and needs of the disadvantaged or vulnerable groups.	
	The consultation process will ensure free, prior and informed consultation and facilitate informed participation (organised and iterative consultation.) where affected parties views are incorporated into the project decision-making. The process should be documented.	The process was organized in this manner.
	A grievance mechanism will be established to receive and facilitate resolution of the affected communities concerns about the project's environmental and social performance. Concerns will be addressed promptly, using a transparent and understandable process that is culturally appropriate and readily accessible to all segments of the affected communities at no cost and without retribution. It will not impede access to judicial or administrative remedies. Communities will be informed of the mechanism as part of the community engagement process. Grievance mechanisms should: • Respond to community concerns around risks and potential adverse impacts of the project. • Established from the beginning of the Assessment process and be in place during construction and operations to the end of the project. • Establish and maintain an organizational structure with authority and responsibilities for the community liaison function. • Grievances should be handled by experienced and qualified personnel within the client organization. • Easily accessible and understandable to the members of the affected community. • It may be appropriate to enable complainants to have recourse to external experts or neutral parties. • Clients should be aware of judicial and administrative mechanisms available in the country for resolution of disputes.	A grievance mechanism has been proposed as part of the EMP.

Criteria	*Detail/Requirement*	
	• Grievances received and responses provided should be documented and report back given to the affected communities periodically.	
Monitoring	• As part of the SEMS establish procedures for monitoring and measuring effectiveness of the management programme. • Information should be recorded to track performance and establish operational controls. • Inspections and audits should be used to verify compliance and progress toward desired outcomes. • Qualified external experts will be retained to verify monitoring information. • Results will be documented and corrective and preventative actions implemented and followed up.	The project proponent will develop and maintain a social and environmental management system which will be based upon internationally recognized standards such as the ISO 14000. This aspect will be part of the SEMS
Reporting	Internal – senior management will receive periodic assessment of the effectiveness of the management program based on systematic data collection and analysis. External – the AP will be disclosed to affected communities. Periodic reports that describe progress with implementation of the AP regarding risks to communities, issues identified in the consultation process or grievance mechanism relevant to the communities. Reports will be in a format accessible to communities. Not less than annually.	The project proponent will develop and maintain a social and environmental management system which will be based upon internationally recognized standards such as the ISO 14000. This aspect will be part of the SEMS
Working conditions and management of worker relationship	Adopt a Human resources policy which sets out approach to managing employees consistent with PS2 (provide information on rights in terms of national labor and employment law, rights related to wages and benefits, clear, understandable and explained to each employee)	The policy will be developed.
	Working relationship – document and communicate to all employees their working conditions and terms of employment (including wages and benefits)	The project proponent will develop and maintain a social and environmental management system which will be based upon internationally recognized standards such as the ISO 14000. This aspect will be part of the SEMS
	Working conditions and terms of employment – Respect collective	The project proponent will develop and

Criteria	*Detail/Requirement*	
	bargaining agreements. In the absence thereof reasonable working conditions and terms of employment, which comply with national law, are required.	maintain a social and environmental management system which will be based upon internationally recognized standards such as the ISO 14000. This aspect will be part of the SEMS
	Workers organizations – Comply with national law, if it recognizes workers rights to form and join workers organizations and to bargain collectively. Where national law restricts workers organizations, client should enable alternative means for workers to express grievances and protect their rights. Engage with worker representatives.	The project proponent will develop and maintain a social and environmental management system which will be based upon internationally recognized standards such as the ISO 14000. This aspect will be part of the SEMS
	Non-discriminatory and equal opportunity – employment relationship based on principle of equal opportunity and fair treatment. Will not discriminate with respect to aspects of the employment relationship (recruiting, hiring, and compensation, working conditions, terms of employment, access of training, promotion, termination, retirement and discipline). Where national law supports this, compliance with the law is required. Where law does not support this, compliance with PS2 is required.	The project proponent will develop and maintain a social and environmental management system which will be based upon internationally recognized standards such as the ISO 14000. This aspect will be part of the SEMS
	Retrenchment – develop a plan to mitigate the adverse impacts of retrenchment on employees if elimination of a significant number of jobs/layoff employees is anticipated.	The project proponent will develop and maintain a social and environmental management system which will be based upon internationally recognized standards such as the ISO 14000. This aspect will be part of the SEMS
	Grievance mechanism – provide a grievance mechanism for worker to raise workplace concerns. Inform employees of the mechanism when hired and make it easily accessible. Concerns will be addressed promptly, using a transparent and understandable process that provides feedback, without retribution. It will not impede access to judicial or administrative remedies.	The project proponent will develop and maintain a social and environmental management system which will be based upon internationally recognized standards such as the ISO 14000. This aspect will be part of the SEMS

Criteria	*Detail/Requirement*	
Protecting the work force	Child labor – Children will not be employed in a manner that is economically exploitative, hazardous, interferes with their education, or harmful to their health or physical, mental, spiritual, moral or social development. Where national laws have provisions for employment of minors, clients will comply with national law. Under 18's cannot be employed in dangerous work.	The proponents are committed to this principle.
	Forced labor – Forced labor will not be employed. This includes involuntary or compulsory labor.	The proponents are committed to this principle.
Occupational health and safety	Workers will be provided with a safe and healthy work environment that takes account of risks and physical, chemical, biological and radiological hazards. Accident, injury and disease will be prevented. Areas to be addressed are: • Identification of potential hazards, particularly life threatening ones • Provision of preventative and protective measures, including modification, substitution or elimination of hazardous conditions or substances • Training of workers • Documentation and reporting of occupational accidents, diseases and incidents • Emergency prevention, preparedness and response arrangements.	The propone plan to develop an integrated management system that will be compliant with OHSAS 18000 for occupational safety.
Non-employee workers	• This covers workers who are not: i) Directly contracted by the client or contracted through other contractors or intermediaries; or ii) Performing work directly related to core functions essential to the clients products or services for a substantial duration. • When directly contracted by the client commercially reasonable efforts will be used to apply the PS2 requirements except for the HR policy, retrenchment and supply chain requirements. • When procured by contractors and intermediaries the client will ascertain that they are reputable and legitimate enterprises and require that PS2 is applied except for HR policy, retrenchment and supply chain requirements.	The propone plan to develop an integrated management system that will be compliant with OHSAS 18000 for occupational safety. This aspect will be part of the management system

Criteria	*Detail/Requirement*	
Supply chain	Adverse impacts associated with supply chains will be considered where low labor costs are a factor in the competitiveness of the item supplied. Client will enquire about child labor and forced labor.	The proponents are committed to this principle.
General requirements	General • During design, construction, operation and decommissioning consider ambient conditions and apply pollution prevention and control technologies and techniques best suited to avoid and thereafter minimize or reduce impacts on human health and the environment (technically and financially feasible and cost effective). • Techniques applied will be tailored to the hazards and risks associated with project emissions and consistent with good international industry practice and IFC EHS guidelines.	The proponents are committed to this principle.
	Pollution prevention, resource conservation and energy efficiency • Avoid the release of pollutants, or when not feasible, minimise or control the intensity or load o their release in routine, non-routine or accidental circumstances. • Incorporate resource conservation and energy efficiency measures (cleaner production principles).	The proponents are committed to this principle.
	Wastes • Avoid or minimize the generation of hazardous and non-hazardous waste materials. • Where generation cannot be avoided but has been minimized it will be recovered and reused. • Where waste cannot be recovered and reused, it will be treated, destroyed and disposed of in an environmentally sound manner. • If hazardous, commercially reasonable alternatives for environmentally sound disposal considering the limitations applicable to transboundary movement. • When third parties conduct disposal, client will use contractors that are reputable, legitimate and licensed by regulatory authorities.	The proponents are committed to this principle.

Criteria	*Detail/Requirement*	
	Hazardous materials • Avoid, or when not feasible, minimize or control the release of hazardous materials resulting from production, transportation, handling, storage and use. • Avoid the manufacture, trade and use of chemicals and hazardous materials subject to international bans and phase-outs and consider the use of less hazardous substitutes.	The proponents are committed to this principle.
	Emergency preparedness and response • Be prepared to respond to process upset, accidental and emergency situations in a manner appropriate to operational risks and the need to prevent their potential negative consequences. • Prepare a plan that addresses training, resources, responsibilities, communication, procedures and other aspects as required. (see also PS4)	An emergency response plan (ERS) will be prepared by the proponent to tackle any adverse situation that may arise
	Technical guidance • Refer to current version of EHS Guidelines when evaluating and selecting pollution prevention and control techniques and performance levels. • Where these differ from host country legislation the more stringent is to be achieved. • If less stringent levels or measures are appropriate, full and detailed justification of alternatives will be provided. • Alternate performance levels must be consistent with PS3.	The most recent version of the EHS Guideline has been used. The projects intends to achive the more stringent of the NEQS and IFC EHS Guidelines.
Ambient considerations	To address adverse impacts on existing ambient conditions, the client will: • Consider factors including the finite assimilative capacity of the environment, existing and future land use, existing ambient conditions, proximity to ecologically sensitive or protected areas and the potential for cumulative impacts with uncertain or irreversible consequences • Promote strategies that avoid, or where not feasible, minimize or reduce the release of pollutants, including strategies that contribute to	The proponents are committed to this principle.

Criteria	*Detail/Requirement*	
	the improvement of ambient conditions when contributing a significant source of emissions in an already degraded area. Strategies could include evaluation of project location alternatives and emissions offsets.	
Greenhouse gas emissions	Promote the reduction of project-related GHG emissions in a manner appropriate to the nature and scale of the project operations and impacts.	The proponents are committed to this principle.
	• For operations or projects that produce significant quantities of GHGs (i.e. greater than 100,000 metric tonnes CO_2 equivalent for the aggregate emissions of direct and indirect sources associated with purchased electricity for own consumption), quantify direct emissions (within project boundary) and indirect emissions (off-site production of power used by the project). • Quantification and monitoring of GHG emissions will be conducted annually in accordance with internationally recognized methodologies. • Evaluate technically and financially feasible and cost-effective options to reduce or offset project-related GHG emissions. Options could include carbon financing, energy efficiency improvement, use of renewable energy sources, and alterations of project design, emissions offsets, reduction of fugitive emissions and reduction of gas flaring.	The proponents are committed to this principle.
Pesticide use and management	Formulate and implement an integrated pest management (IPM) and/or integrated vector management approach for pest management. Such programmes will entail coordinated use of pest and environmental information along with pest control methods, including cultural practices, biological, genetic and, as a last resort, chemical means to prevent unacceptable levels of pest damage.	This is not directly applicable to the proposed project
	When management includes the use of pesticides, select those that are low in human toxicity, effective against target species, minimal affected on non-target species and the environment. Selection will be based on: • Packaging in safe containers • Clear labeling for safe and proper use • Manufactured by an entity licensed by a relevant authority.	This is not directly applicable to the proposed project

Criteria	*Detail/Requirement*	
	Design pesticide management regime to minimize damage to natural enemies and prevent the development of resistance in pests. Pesticides will be handled, stored, applied and disposed of in accordance with the Food and Agricultural Organizations International Code of Conduct for the Distribution and Use of Pesticides or other good international industry practice.	This is not directly applicable to the proposed project
	Pesticides that fall in the WHO Recommended Classification for Pesticides by Hazard Classes 1a and 1b or Class II will not be used if the host country lacks restrictions on distribution and use of these or if they are likely to be used by personnel without proper training, equipment, facilities to handle, store, apply and dispose of these products properly.	This is not directly applicable to the proposed project
Community health and safety requirements	General • Evaluate the risks and impacts to the health and safety of the affected community during the design, construction, operation and decommissioning of the project and establish preventative measures to address them. Measures will favor prevention or avoidance over minimization and reduction. When complex health or safety issues are involved, it may be appropriate for the client to engage experts for free-standing assessment, separate from the Assessment required under Performance Standard 1. • Where risks are posed the Action Plan and other relevant documentation will be disclosed to enable understanding. Affected communities and agencies will be engaged on an ongoing basis. Generally, community health monitoring is considered as a government function that is not within the technical obligation or expertise of a project. However, some projects may be located in environments that have extremely weak health and demographic surveillance systems. In these cases, a higher level of interaction with the host government may be needed for the project to accurately track health performance.	This is included in the ESIA/EMP
	Infrastructure and equipment safety • Design, construction, operation and decommission the structural elements of the project in accordance with good international industry	This is included in the ESIA/EMP

Criteria	*Detail/Requirement*	
	practice. • Give particular consideration to potential exposure to natural hazards. • Structural elements will be designed by qualified and experienced professionals and certified and approved by competent authorities or professionals. • In high-risk locations qualified experts with relevant and recognized experience in similar projects will review the project throughout design, construction and commissioning. • Prevent incidents and accidents associated with moving equipment on public roads and other infrastructure.	
	Hazardous materials safety • Prevent or minimize potential for community exposure to hazardous materials released by the project. The safe management of hazardous materials should extend into the decommissioning phase of the project where remaining wastes, including demolition wastes, must be safely managed according to the waste management requirements of PS 3. • Exercise care to avoid or minimize community exposure to hazards by modifying, substituting or eliminating the condition or substance causing hazards. • Where hazardous materials are part of the project, exercise care when conducting decommissioning activities to prevent exposure to community. • Exercise commercially reasonable efforts to control the safety of deliveries of raw materials and transportation and disposal of wastes. • Implement measures to avoid or control community exposure to pesticides (see also PS3)	This is included in the ESIA/EMP
	Environmental health and natural resource issues • Avoid or minimize the exacerbation of impacts caused by natural hazards that could arise from land use changes due to the project. • Avoid or minimize the adverse impacts due to project activities on soil, water and natural resources in use by affected communities.	This is included in the ESIA/EMP

Criteria	*Detail/Requirement*	
	Community exposure to disease • Prevent or minimize the potential for community exposure to water-borne, water-based, water-related, vector-borne disease and other communicable diseases that would result from project activities. Health impacts to potentially affected communities should be broadly considered and not just restricted to infectious diseases. • Where specific diseases are endemic to communities, explore opportunities to improve environmental conditions that could help reduce their incidence. • Prevent or minimize transmission of communicable diseases associated with the influx of temporary or permanent labour.	This is included in the ESIA/EMP
	Emergency preparedness and response • Assess the potential risks and impacts from project activities and inform affected communities of significant potential hazards in a culturally appropriate manner. • Assist and collaborate with the community and the local government in their preparations to respond effectively to emergency situations. • Where government lacks capacity, proponent will play an active role in preparing for and responding to emergencies associated with the project. • Document the emergency preparedness and response activities, resources and responsibilities and disclose appropriate information in the Action Plan or other relevant documentation to affected communities and government agencies.	This is included in the ESIA/EMP
Security personnel	When employees or contractors provide security to safeguard project personnel or property, proponent will assess risks to those within and outside the project site posed by its security arrangements. Client should: • Be guided by the principles of proportionality, good international practices in terms of hiring, rules of conduct, training equipping and monitoring of such personnel, and applicable law.	The proponents are committed to this principle.

Criteria	*Detail/Requirement*	
	• Make reasonable inquiries to ensure that those providing security are not implicated in past abuses, train them adequately in the use of force (firearms) and appropriate conduct toward workers and communities, require them to act within the law. • Not sanction the use of force, except when used for defensive or preventative purposes. • Provide a grievance mechanism to allow the affected community to express concerns about security arrangements.	
	When government security personnel provide security, the proponent will assess risks, communicate that they act as per the above and encourage relevant authorities to disclose security arrangements to the public.	The proponents are committed to this principle.
	Investigate credible allegations of unlawful or abusive acts of security personnel, take action to prevent recurrence and report unlawful and abusive acts to authorities.	The proponents are committed to this principle.
General requirements	Consider feasible alternative project designs to avoid or minimize physical or economic displacement	Not applicable
	• Compensation and benefits for displaced persons • Offer displaced persons and communities compensation for loss of assets at full replacement cost and other assistance to help them improve or restore their livelihoods/standard of living. • Standards for compensation will be transparent and consistent within the project. • Land-based compensation will be offered where livelihoods are land-based or land is collectively owned. • Provide opportunities to derive appropriate development benefits from the project.	Not applicable as there will be no resettlement required for this project
	Consultation • Disclose all information and then consult with and facilitate the informed participation of affected persons and communities, including host communities, in the resettlement decision-making processes.	Not applicable

Criteria	*Detail/Requirement*	
	• Continue consultation during the implementation, monitoring and evaluation of compensation payment and resettlement.	
	Grievance mechanism • Establish a grievance mechanism consistent with PS1 to receive and address concerns about compensation and relocation including a recourse mechanism to resolve disputes in an impartial manner.	Not applicable
Resettlement planning and implementation	Where resettlement is unavoidable, carry out a census with appropriate socio-economic baseline data to identify persons who will be displaced, determine who will be eligible for compensation and assistance and discourage inflow of people who are ineligible for these benefits. Establish a cut-off date for eligibility. Document and disseminate the cut-off date throughout the project area.	No resettlement is required as the plant site does not have any human settlement
	For Type 1 (acquisition of land rights through the exercise of eminent domain) and Type II (negotiated settlements) Transactions involving physical displacement of people the client will develop a resettlement action plan or resettlement framework base on the SEA that covers the PS requirements. The plan/framework will be designed to: • Mitigate negative impacts of displacement • Identify development opportunities • Establish entitlements of all categories of affected parties (also hosts, poor and vulnerable). Client should also document all transactions to acquire land rights, compensation measure and relocation activities, and establish procedures to monitor and evaluate the implementation of resettlement plans and corrective action.	The plant site was purchased by the proponents in early 2000s through negotiated settlement from the owners. No settlement existed on the site.
	For Type II Transactions involving economic displacement of people: the client will develop procedures to offer compensation and other assistance that meet PS. The procedures will establish entitlements and ensure that these are provided in a transparent, consistent and equitable manner. Where compensation offers are rejected and expropriation procedures are initiated, the sponsor will explore other opportunities to collaborate with	Not applicable

Criteria	*Detail/Requirement*	
	relevant government agency.	
Displacement	Displaced persons are classified as persons: i) Who have formal legal rights to the land they occupy ii) Who do not have formal legal rights to the land, but have a claim to land recognised under national (customary or traditional) law iii) Who have no legal right to the land they occupy. Land acquisition may result in physical displacement as well as economic displacement.	As the plant site consists of agricultural fields therefore this is not applicable
	Physical displacement When people are to move to another location the client will: • Offer choices among feasible options, including cash compensation or replacement housing • Provide relocation assistance suited to the needs of each group New resettlement sites will offer improved living conditions.	Not applicable
	For those covered by i) or ii) above, offer a choice of replacement property of equal or higher value, equivalent or better characteristics and advantages of location, or cash compensation at full replacement value where appropriate.	Not applicable
	For those covered by iii) above, offer adequate housing with security of tenure. Where the displaced persons own and occupy structures compensation must allow for the loss of assets other than land, such as dwellings and other improvements to the land, provided these people occupied the project area prior to the cut-off date for eligibility. Compensation in kind will be offered in lieu of cash compensation where feasible. The proponent is not required to compensate or assist those who encroach on the project are after the cut-off date.	Not applicable
	Where indigenous people are to be physically displaced from their communally held traditional or customary lands under use, PS 5 and PS7 will be met.	Not applicable

Criteria	*Detail/Requirement*	
	Economic Displacement If land acquisition causes loss of income or livelihood (regardless of whether or not the affected people are physically displaced) the following requirements need to be met: • Prompt compensation for loss of assets or access to assets at full replacement cost • Compensate business owners for cost of re-establishing commercial activities, for net loss income during the period of transition, and for the costs of transfer and reinstallation of the plant, machinery and equipment • Provide replacement property of equal or greater value, or cash compensation at full replacement cost to people with legal rights or claims to land under law • Compensate economically displaced people who are without legally recognizable claims to land for lost assets other than land at full replacement cost • Provide additional targeted assistance and opportunities to improve or at least restore income-earning capacity, production levels and standards of living to economically displaced persons who are adversely affected • Provide transitional support to economically displaced persons based on a reasonable estimate of time required to restore their income-earning capacity, production levels and standards of living.	Not applicable
	Where indigenous people are to be economically displaced, PS 5 and PS7 will be met.	Not applicable
Private sector responsibilities under government-managed resettlement	Where land acquisition and resettlement are the responsibility of government, the sponsor will collaborate with the responsible agency to achieve outcomes consistent with the objectives of the PS. It will play and active role in planning, implementation and monitoring where government capacity is limited.	The plant site will be located on a agricultural land therefore no resettlement is required for this project

Criteria	*Detail/Requirement*	
	For Type 1 involving physical or economic displacement and Type II Transactions involving physical displacement, prepare a plan or framework, which address the PS requirements and covers: • Description of entitlements of displaced persons under applicable law • Measure proposed to bridge any gaps between entitlements and the requirements of PS Financial and implementation responsibilities of government and/or client.	Not applicable
	For Type II transactions involving economic displacement of people, identify and describe the procedures that government plans to use to compensate affected persons/communities. If they do not meet the requirements of the PS then client will develop its own procedures to supplement government action.	Not applicable
	In collaboration with government, implement its plan or procedures and monitor resettlement activity until completed.	Not applicable
Protection and conservation of biodiversity	• Assess the significance of project impacts on all levels of biodiversity as an integral part of the SEA process. Take into account the differing values attached to biodiversity by specific stakeholders and well as identify impacts on ecosystems services. • SEA will focus on major threats to biodiversity, including habitat destruction and invasive alien species. • Retain qualified and experienced external experts to assist in the SEA	The study area does not support any rare or threatened species of flora or fauna therefore it will be not be required
Habitat	Habitats can be divided into natural and modified habitats. Both types can support important biodiversity at all levels including endemic or threatened species.	No threatened or vulnerable species are reported from the plant site r the Study Area, and majority of the species are found in diversified habitats
	Modified habitat Exercise care to minimize any conversion or degradation of such modified habitats, and identify opportunities to enhance habitat and protect and conserve biodiversity.	Not applicable

Criteria	*Detail/Requirement*	
	Natural habitat Do not significantly convert or degrade natural habitats unless the following conditions are met: • There are no technically or financially feasible alternatives • The overall benefits of the project outweigh the costs including those to the environment and biodiversity • Any conversion or degradation is appropriately mitigated. Mitigation measures will be designed to achieve no net loss of biodiversity and may include a combination of actions such as: • Post-operation restoration of habitats • Offset of losses through the creation of ecologically comparable areas that is managed for biodiversity • Compensation to direct users of biodiversity.	The proposed plant site and Study Area consists mainly of agricultural land and human settlements and there are no protected areas in the Study Area. Still disturbance to natural habitats will be avoided to the extent possible Mitigation measures and off sets from natural habitats have been provided in the ESIA report to further minimize the potential effect on the biodiversity of the Study Area
	Critical habitat Critical habitat includes: • Areas with high biodiversity value including habitat require for the survival of critically endangered or endangered species • Areas having special significance for endemic or restricted-range species • Sites that are critical for the survival of migratory species • Areas supporting globally significant concentrations or numbers of individuals of congregatory species • Areas with unique assemblages of species or which are associated with key evolutionary processes or provide ecosystem services • Areas having biodiversity of significant social, cultural or economic importance to local communities. Project activities will not be implemented in areas of critical habitat unless the following requirements are met:	No critical habitat in the Study Area

Criteria	*Detail/Requirement*	
	• No measurable adverse impacts on the ability of the critical habitat to support the established population of species or the functions of the critical habitat (as described above) • No reduction in the population of any recognised critically endangered or endangered species • Any lesser impacts are mitigated	
Legally protected areas	Projects in legally protected areas will meet the following requirements: • Act in a manner consistent with defined protected area management plans • Consult protected area sponsors and managers, local communities and other key stakeholders • Implement additional programmes to promote and enhance the conservation aims of the protected area	There are no legally protected areas in the Study Area
Alien invasive species	Alien species will not intentionally be introduced unless this is carried out in accordance with the existing regulatory framework for such introduction or is subject to a risk assessment (as part of SEA). This may include genetically modified organisms.	The project proponent does not intend to introduce any invasive species to the plant site or its vicinity
Management & use of renewable natural resources	Renewable natural resources will be managed in a sustainable manner. Demonstrate this through appropriate system of independent certification.	Not applicable
	Natural and plantation forests • Sponsors involved in natural forest harvesting or plantation development will not cause any conversion or degradation of critical habitat. • Locate plantations on unforested land or land already converted. • All natural forests and plantations are independently certified as meeting PS comparable with internationally accepted principles and criteria for sustainable forest management.	Not applicable
	Freshwater and marine systems Sponsors involved in production and harvesting of fish populations or other aquatic species must demonstrate that their activities are being undertaken	Not applicable

Criteria	*Detail/Requirement*	
	in a sustainable manner, through application of an internationally accepted system of independent certification.	
Definition	"Indigenous Peoples" is used in a generic sense to refer to a distinct social and cultural group possessing the following characteristics in varying degrees: • Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others • Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories • Customary cultural, economic, social, or political institutions that are separate from those of the dominant society or culture • An indigenous language, often different from the official language of the country or region Ascertaining whether a particular group is considered as Indigenous Peoples for the purpose of this Performance Standard may require technical judgment.	There are no indigenous people present at the plant site or its vicinity as the proposed plant site is devoid of an human settlement
Avoidance of adverse impacts	Identify through the SEA all communities of Indigenous Peoples who may be affected by the project within the project's area of influence, as well as the nature and degree of expected social, cultural (including cultural heritage[1]), and environmental impacts on them, and avoid adverse impacts whenever feasible.	Not applicable
	When avoidance is not feasible, minimize, mitigate or compensate for impacts in a culturally appropriate manner. The proposed action will be developed with the informed participation of affected Indigenous Peoples and contained in a time-bound plan, such as an Indigenous Peoples Development Plan, or a broader community development plan with separate components for Indigenous Peoples.	Not applicable
Information disclosure, consultation and informed participation	Establish an ongoing relationship with the Indigenous Peoples as early as possible in the project planning and throughout the life of the project. In projects with adverse impacts on Indigenous communities, the consultation process will ensure free, prior, and informed consultation and facilitate	Not applicable

Criteria	*Detail/Requirement*	
	informed participation on matters that affect them directly, such as proposed mitigation measures, the sharing of development benefits and opportunities, and implementation issues. The process of community engagement will be culturally appropriate and commensurate with the risks and potential impacts to the Indigenous Peoples. In particular, the process will include the following steps: • Involve Indigenous Peoples' representative bodies (for example, councils of elders or village councils, among others) • Be inclusive of both women and men and of various age groups in a culturally appropriate manner • Provide sufficient time for Indigenous Peoples' collective decision-making processes • Facilitate the Indigenous Peoples' expression of their views, concerns, and proposals in the language of their choice, without external manipulation, interference, or coercion, and without intimidation • Ensure that the grievance mechanism established for the project, as described in PS 1 is culturally appropriate and accessible for Indigenous Peoples	
Development benefits	Seek to identify, through the process of consultation with and the informed participation of the affected communities of, opportunities for culturally appropriate development benefits. Such opportunities should be commensurate with the degree of project impacts, with the aim of improving their standard of living and livelihoods in a culturally appropriate manner, and to fostering the long-term sustainability of the natural resource on which they depend. Document identified development benefits and provide them in a timely and equitable manner.	-
Special requirements	Because Indigenous Peoples may be particularly vulnerable to the project circumstances described below, the following requirements will also apply, in the circumstances indicated, in addition to the General Requirements above. When any of these Special Requirements apply, the proponent will retain qualified and experienced external experts to assist in conducting the Assessment.	Not applicable

Criteria	*Detail/Requirement*	
	Indigenous Peoples are often closely tied to their traditional or customary lands and natural resources on these lands. While these lands may not be under legal ownership pursuant to national law, use of these lands, including seasonal or cyclical use, by communities of Indigenous Peoples for their livelihoods, or cultural, ceremonial, or spiritual purposes that define their identity and community, can often be substantiated and documented.	Not applicable
	If the client proposes to locate the project on, or commercially develop natural resources located within, traditional or customary lands under use, and adverse impacts can be expected on the livelihoods, or cultural, ceremonial, or spiritual use that define the identity and community of the Indigenous Peoples, the following steps must be taken: • Document its efforts to avoid or at least minimize the size of land proposed for the project • Get experts to document the Indigenous Peoples' land use in collaboration with the affected communities without prejudicing any Indigenous Peoples' land claim4 • Inform affected communities of their rights with respect to these lands under national laws, including any national law recognizing customary rights or use • Offer affected communities at least compensation and due process available to those with full legal title to land in the case of commercial development of their land under national laws, together with culturally appropriate development opportunities; land-based compensation or compensation-in-kind will be offered in lieu of cash compensation where feasible • Enter into good faith negotiation with the affected communities and document their informed participation and the successful outcome of the negotiation	Not applicable
Relocation of Indigenous Peoples from Traditional or Customary Lands	• Consider feasible alternative project designs to avoid the relocation of Indigenous Peoples from their communally held[5] traditional or customary lands under use. If such relocation is unavoidable, do not proceed with the project unless good faith negotiations with the	There are no indigenous people on the plant site r its vicinity according to the definition of indigenous people provided in the IFC Performance Standards

Criteria	*Detail/Requirement*	
	affected communities are entered into, documented and successfully negotiated. • Ensure relocation of Indigenous Peoples is consistent with the Resettlement Planning and Implementation requirements of PS 5. • Where feasible, relocated Indigenous Peoples should be able to return to their traditional or customary lands, should the reason for their relocation cease to exist.	
Cultural resources	Where a project proposes to use the cultural resources, knowledge, innovations, or practices of Indigenous Peoples for commercial purposes, inform the Indigenous Peoples of: • their rights under national law; • the scope and nature of the proposed commercial development; and • the potential consequences of such development. Only proceed with such commercialization after : • entering into a good faith negotiation with the affected communities • documenting their informed participation and the successful outcome of the negotiation • providing for fair and equitable sharing of benefits from commercialization of such knowledge, innovation, or practice, consistent with their customs and traditions	Not applicable
Internationally recognised practices	• Comply with national law and host countries obligations under the Convention Concerning the Protection of the World Cultural and Natural Heritage. • Protect and support cultural heritage by undertaking internationally recognised practices for the protection, field based study and documentation of cultural heritage. • Where necessary (see below), retain qualified and experience experts to assist in any assessments.	There are no declared national or international cultural and heritage sites at the plant site or the Study Area
Chance find procedures	Project should be designed and sited to avoid significant damage to cultural heritage. If the proposed location is in areas where cultural heritage is	Not applicable

Criteria	*Detail/Requirement*	
	expected to be found, either during construction or operations, chance find procedures must be established as part of the SEA. Chance finds must not be disturbed until assessment by a competent specialist is made and actions consistent with the requirements of this PS are identified.	
Consultation	• Where a project may affect cultural heritage, consult with affected communities within the host country who use, or have used within living memory, the cultural heritage for long-standing cultural purposes to identify cultural heritage of importance. • Incorporate the results of consultation into the proponent's decision-making process. • Consultation to involve the relevant national or local regulatory agencies entrusted with the protection of cultural heritage.	Not applicable
Removal of cultural heritage	Preference given to preserving cultural heritage in its place, since removal may result in irreparable damage or destruction. Cultural heritage will not be removed unless the following conditions are met: • No technically or financially feasible alternatives exist • Overall benefits to the project outweigh the anticipated cultural heritage loss from removal • Removal is conducted by the best available technique	No removal of an cultural heritage is required of the proposed project
Critical cultural heritage	Critical cultural heritage consists of: • Internationally recognized heritage of communities who use, or have used within living memory the cultural heritage for long standing cultural purposes • Legally protected cultural heritage areas, including hose proposed by host governments for such designation	The plant site is located on agricultural land and therefore there is no potential of damaging any critical heritage due to installation of the power plant
	Do not significantly alter, damage or remove any critical cultural heritage. If in exceptional circumstances, damage cannot be avoided, and its damage or loss may endanger the cultural or economic survival of communities within the host country who use the cultural heritage, the proponent will: (i) consult with affected communities; and (ii) conduct a good faith negotiation with and document the informed participation of the affected communities	Not applicable

Criteria	*Detail/Requirement*	
	and the successful outcome of the negotiation. In addition, any other impacts on critical cultural heritage must be appropriately mitigated with the informed participation of the affected communities.	
	For legally protected cultural heritage, the proponent will: • Comply with defined national or local cultural heritage regulations or protected area management plans; • Consult the protected area sponsors and manager, local communities and other key stakeholders • Implement additional programs, as appropriate, to promote and enhance the conservation aims of the protected area	There is no declared cultural heritage site at the plant site or its vicinity
Projects use of cultural heritage	Where a project proposes to use the cultural resources, knowledge, innovations, or practices of local communities embodying traditional lifestyles for commercial purposes, the proponent will inform these communities of: (i) their rights under national law; (ii) the scope and nature of the proposed commercial development; and (iii) the potential consequences of such development. The client will not proceed with such commercialization unless it: (i) enters into a good faith negotiation with the affected local communities embodying traditional lifestyles; (ii) documents their informed participation and the successful outcome of the negotiation; and (iii) provides for fair and equitable sharing of benefits from commercialization of such knowledge, innovation, or practice, consistent with their customs and traditions.	No cultural resources will be used for this project

Appendix D: Reference Data

See following Pages.

Exhibit D.1: Water Quality Analysis Results

Parameter	*Analytical Method*	*Unit*	*Minimum Detection Limit*	*WSTR15*	*WSTR17*	*WSTR21*	*WSTR31*
			Coordinates	*N 28 03 15.0 E 69 49 72.8*	*N 28 01 9.57 E 69 47 8.57*	*N 28 03 13.1 E 69 47 59.9*	*N 28 03 66.6 E 69 47 78.4*
DO	US EPA 360.1	mg/l	1	4.66	4.41	3.31	2.93
Temperature	US EPA 170.1	°C	1	27.1	30.5	30.2	27.9
Nitrate	US EPA 352.1	mg/l	0.1	8.93	6.82	1.15	0.86
Ammonia	SMEW 4500-NH^3	mg/l	0.5	BDL	BDL	BDL	BDL
pH	EPA 150.1		0.1	6.8	6.7	6.9	7.3
EC	EPA 120.1	µS/cm	1	1,378	1,425	1,114	1,375
Magnesium	US EPA 6010 B	mg/l	0.1	59.8	48.53	41.55	75.65
Calcium	US EPA 6010 B	mg/l	0.1	93.55	174.93	88.79	110.64
Potassium	US EPA 6010 B	mg/l	0.1	13.71	27.54	11.24	30.85
Sulfate	EPA 9056 A	mg/l	0.1	343.19	348.13	270.77	381.05
Chloride	EPA 9056 A	mg/l	0.1	209.15	212.7	85.08	124.07
Fluoride	EPA 9056 A	mg/l	0.1	0.98	0.75	0.9	0.7
Bicarbonate Alkalinity	EPA 310.1	mg/l	1	282	283	439	385
T. Hardness	EPA 130.2	mg/l	0.1	500	432	436	568
Silicate as SiO_2	US EPA 6010 B	mg/l	0.1	25.81	20.04	22.27	25.83
TDS		mg/l	1	920	940	776	932
Sulfide S^{2-}	EPA 376.1	mg/l	1	BDL	BDL	BDL	BDL
Iron	US EPA 6020 A	mg/l	0.01	BDL	BDL	BDL	BDL
Aluminum	US EPA 6020 A	mg/l	0.01	BDL	BDL	BDL	BDL

Parameter	*Analytical Method*	*Unit*	*Minimum Detection Limit*	*WSTR15*	*WSTR17*	*WSTR21*	*WSTR31*
			Coordinates	*N 28 03 15.0 E 69 49 72.8*	*N 28 01 9.57 E 69 47 8.57*	*N 28 03 13.1 E 69 47 59.9*	*N 28 03 66.6 E 69 47 78.4*
Arsenic	US EPA 6020 A	mg/l	0.005	BDL	BDL	BDL	0.026
Cadmium	US EPA 6020 A	mg/l	0.001	0.001	0.001	0.001	0.001
Chromium	US EPA 6020 A	mg/l	0.001	0.011	0.012	0.011	0.097
Cobalt	US EPA 6020 A	mg/l	0.01	BDL	BDL	BDL	BDL
Copper	US EPA 6020 A	mg/l	0.001	BDL	BDL	BDL	BDL
Lead	US EPA 6020 A	mg/l	0.001	0.019	0.016	0.021	0.024
Manganese	US EPA 6020 A	mg/l	0.001	0.011	0.016	0.18	0.085
Mercury	US EPA 6020 A	mg/l	0.0005	0.0041	0.0012	0.0025	0.0014
Nickel	US EPA 6020 A	mg/l	0.001	BDL	BDL	BDL	BDL
Selenium	US EPA 6020 A	mg/l	0.01	BDL	BDL	BDL	BDL
Zinc	US EPA 6020 A	mg/l	0.005	BDL	BDL	0.209	BDL

Exhibit D.2: Ambient Air Quality Monitoring Results

Parameter	*PM10 (24-Hour Sampling)*	*CO*	*NOX*	*SOX*
Analytical Methods	US EPA 40 CFR App B Part 50	Electro Chemical	ISO 6768	US EPA App A Part 50 Pararosaniline
N 28^{o} 02' 54.10" E 69^{o} 46' 41.20"	187.49 µg/Nm^3	0 mg/Nm^3	43.20 µg/Nm^3	22.8 ug/Nm^3
N 28^{o} 02' 42.68" E 69^{o} 47' 13.3"	239.90 µg/Nm^3	0 mg/Nm^3	45.60 µg/Nm^3	37.2 µg/Nm^3
N 28^{o} 03' 42.96" E 69^{o} 47' 50.78"	328.68 µg/Nm^3	0 mg/Nm^3	40.95 µg/Nm^3	37.2 µg/Nm^3
N 28^{o} 04' 4.04" E 69^{o} 47' 3.59"	236.75 µg/Nm^3	0 mg/Nm^3	43.29 µg/Nm^3	31.2 µg/Nm^3
WHO Ambient Air Quality Guidelines (Interim Target-1)	150 µg/m^3		200 µg/m^3	125 µg/m^3
NEQS Draft 2008	250 µg/m^3	10 mg/m^3	141[a] µg/m^3	120 µg/m^3

mg/Nm3: Milligram per normal cubic meter

µg/Nm3: Microgram per normal cubic meter.

a The limit for NO and NO_2 is 40 and 80 ug/m^3, respectively. NO_x limit is calculated by assuming that all NO converts to NO_2.

Exhibit D.3: Soil Analysis Results

Parameter	*Analytical Method*	*Minimum Detection Limit*	*Unit*	*SSTR1*	*SSTR2*	*SSTR4*	*SSTR9*
		Coordinates		*N 28o 02.998' E 69o 47.141'*	*N 28o 01.729' E 69o 48.380'*	*N 28o 04.435' E 69o 49.450'*	*N 28o 04.212' E 69o 47.415'*
pH	CSSS	0.0		7	7.3	7.7	7.3
Conductivity	CSSS	1.0	µS/cm	3,240	1,405	823	4,200
TDS		0.5	mg/kg	1,662	696	402	2,180
Salinity		0.001	%	0.17	0.07	0.04	0.22
Organic Matter	CSSS	0.1	%	1.26	0.31	1.56	1.23
Organic Carbon	CSSS	0.05	%	0.72	0.18	0.89	0.71
Sodium	ICP-OES	1.0	mg/kg	1,083	316	442	1,108
Potassium	ICP-OES	1.0	mg/kg	5,134	1,457	3,718	5,481
Calcium	ICP-OES	1.0	mg/kg	35,612	24,157	34,815	42,418
Magnesium	ICP-OES	1.0	mg/kg	11,358	4,217	9,736	14,396
Sulfate	ICP-OES	1.0	mg/kg	14,184	439	1,324	6,748
Carbonate	Titration	1.0	mg/kg	BDL	BDL	BDL	BDL
Bicarbonate	Titration	1.0	mg/kg	680	1,072	928	736
Chloride	ISE	1.0	mg/kg	851	166	122	506
Barium	ICP-OES	0.6	mg/kg	92	29	79	103
Lead	ICP-OES	0.15	mg/kg	12	6	10	16
Chromium	ICP-OES	0.06	mg/kg	45	19	35	49
Cadmium	ICP-OES	0.03	mg/kg	5	7	15	1
Arsenic	HGAAS	0.01	mg/kg	1.83	0.29	1.12	2.13
Mercury	AFS-CV	0.01	mg/kg	BDL	BDL	BDL	BDL

Appendix E: Ambient Air Quality

Engro Fertilizers Limited, Engro Power Gen Limited, Mari Gas Company, Fauji Fertilizers Limited, and Liberty Power are the major significant stationary sources of gaseous emission in the Study Area. Another source that is likely to commission before the proposed Star Power Project is Foundation Power. Emissions from these sources mostly consist of ammonia, methane, nitrogen, and carbon dioxide. The main non-stationary sources of emissions are the road traffic on the National Highway N-5 and trains travelling on the main Karachi-Peshawar railway track of Pakistan Railway. Both of these corridors pass through the Study Area.

To assess the ambient air quality for the Study Area, ambient air quality was recorded at four separate locations around the plant site from August 27 to August 30, 2010 (See **Exhibit E.1**). These locations were selected on their proximity to the plant site as well as the location of sensitive receptors nearby, such as human settlements. Results of the ambient air quality monitoring are presented in **Exhibit E.2**. The 24-hour concentrations of SO_x, NO_x, PM_{10} and CO were monitored in the Study Area.

Recognizing that the ambient air samples are limited as these cover only two days in one season, an investigation was carried out to develop the annual average concentration of the various pollutants in the ambient air using secondary sources.

Exhibit E.3 shows the locations of major point sources of NO_x, SO_x, CO and PM_{10} within approximately 30 km of the proposed plant Site. Ambient air quality has been monitored at these locations intermittently between 2003 and 2010. Although ambient measurements have been made at these plants in various season no continuous monitoring station exists in the area. The available data from these plants is shown in **Exhibit E.4**.

The results of measurements of concentration of pollutants in ambient air depend on many factors. These include, for example, sensor type, the height of sensor from the ground level, climatic conditions (season, humidity, temperature, wind speed and direction), presence of physical barriers, and distance from any local source of pollution such as kitchen exhaust. For these reasons, the results of measurements reported in various sources may not always be comparable. Therefore, before using the available data to calculate annual average of the pollutants in the air shed, the data is critically evaluated to determine its validity.

All ambient air quality data reported in Pakistan refer to urban areas. No measurement from the rural areas is reported. Two recent studies that are of particular importance are:

1. Institutional Analysis of Air Quality Measurement in Urban Pakistan, June 2009, Pakistan Environmental Protection Agency (Pak-EPA) (www.environment.gov.pk/NEW.../AQM%20Draft%20Final%20Report.pdf)
2. Country Synthesis Report on Urban Air Quality Management: Pakistan, December 2006, Asian Development Bank (ADB) and Clean Air Initiative for

Asian Cities Center (www.adb.org/Documents/Reports/Urban-Air-Quality-Management/pakistan.pdf)

The results are concentration of pollutant of interest reported in five urban centers of Pakistan in the Pak-EPA report are shown in **Exhibit E.5**. These are the most recent results. Another importance of this data is that this is the only source that reports both nitric oxide and nitrogen dioxide concentration.

In **Exhibit E.6**, plots from ADB report are reproduced. This data clearly demonstrates dependence of the pollutant concentrations on season. It is, therefore, essential that instead of taking simple average of pollutant concentration, each season shall be averaged separately and than a time-weighted average be calculated. The data reported in **Exhibit E.4**, can thus be categorized as follows:

- Summer (April-June) – Engro Fertilizer, Foundation Power
- Monsoon (July-September) – Star Power, Liberty Power
- Post-Monsoon and Winter (October-March) – Engro PowerGen

Based on the reference data, the comments on the validity of the data are as follows:

1. PM_{10} as reported for various sources (**Exhibit E.4**) is consistent with the ADB data (**Exhibit E.6**) and is considered acceptable
2. CO as reported for various sources (**Exhibit E.4**) is consistent with the data Pak-EPA data (**Exhibit E.6**) and is considered acceptable
3. SO_2 data from all sources except that from the Foundation Power (FP) is consistent with the reported Pak-EPA and ADB data. The average SO_2 value of FP data is 107.1 $\mu g/m^3$, whereas for the remaining sources it is 23.7 $\mu g/m^3$. In comparison, the average SO_2 values of Pak-EPA data is 18.7 $\mu g/m^3$ and ADB SO_2 data is in the range 35–85 $\mu g/m^3$. As no information is available on the method used for FP survey, it is difficult to explain the discrepancy. An error often made in such measurements is that the generator used to power the samplers is placed very close to the sensors. Thus the emissions from the generators are captured by the sensors affecting the data quality. It is estimated that FP has overestimated SO_2 by 30-70 $\mu g/m^3$. It is therefore recommended that for a conservative estimate, 30 $\mu g/m^3$ shall be subtracted from the FP values.
4. The average NO_2 value in the Pak-EPA data is 37.8 $\mu g/m^3$ whereas the same in the ADB data is about 32 $\mu g/m^3$. In comparison, the average value of FP data is 80.1 $\mu g/m^3$ and for the remaining sites it is 37.5 $\mu g/m^3$. Apart from interference from the generator used for powering the samplers, another possible source of discrepancy is possible the confusion between NO_2 and NO_X. The present ambient air quality standards apply to NO_2 only. However, in some earlier reports NOX was reported where NO_X could mean a) total concentration of NO_2 and NO ($NO_X = NO + NO_2$); or b) concentration of NO_2 ($NO_X = NO_2$); or c) total concentration of NO_2 and NO, if it is converted to NO_2 ($NO_X = NO_2 + 46/30 \times NO$). The conversion method is rarely clarified in the survey reports. It is possible that FP is either reporting total nitrogen oxide (option b above) or NO_2 assuming all nitrogen oxide got converted to NO_2 (option c above). Assuming

that Pak-EPA data (**Exhibit E.5**) represents typical concentration of NO_2 and NO in Pakistan, NO concentration is about 39% of the total NO_X concentration. If NO is to oxidize to NO_2, the resulting NO_2 will constitute about 50% of the total NO_X. If FP data suffers from the former type of error, the reported values are to be multiplied by 0.61 to obtain correct values and if it suffers from the latter type of error, the values must be multiplied by 0.50 to obtain corrected values. In the absence of any information, it is not possible to determine the cause of discrepancy in the FP data. Other than discarding the data, the only option is to use a conservative approach which in this case is to multiply the FP data by 0.61 for correction and not make any correction due to errors introduced by possible wrong placement of the power generators.

The corrected values thus obtained are shown in **Exhibit E.7**. These values are then used to calculate the annual average as follows:

Annual Concentration in Vicinity of Star Power	=	[Average of concentration in summer monsoon × 3 months + Average of concentration winter dry season × 6 months + Average of concentration summer dry season × 3 months] /12months

The average concentration calculated for the 24 hours in each season was assumed to represent the entire season. All values, with one exception, are well within guideline values set by NEQS and IFC. PM_{10} values exceeded IFC's annual ambient air quality guidelines but is within the 24-hour limits (150 $\mu g/m^3$). Due to dry conditions, the PM concentration in Pakistan is naturally high which explains why the national standard for PM is relatively high.

Exhibit E.1: Ambient Air Quality Sampling Locations

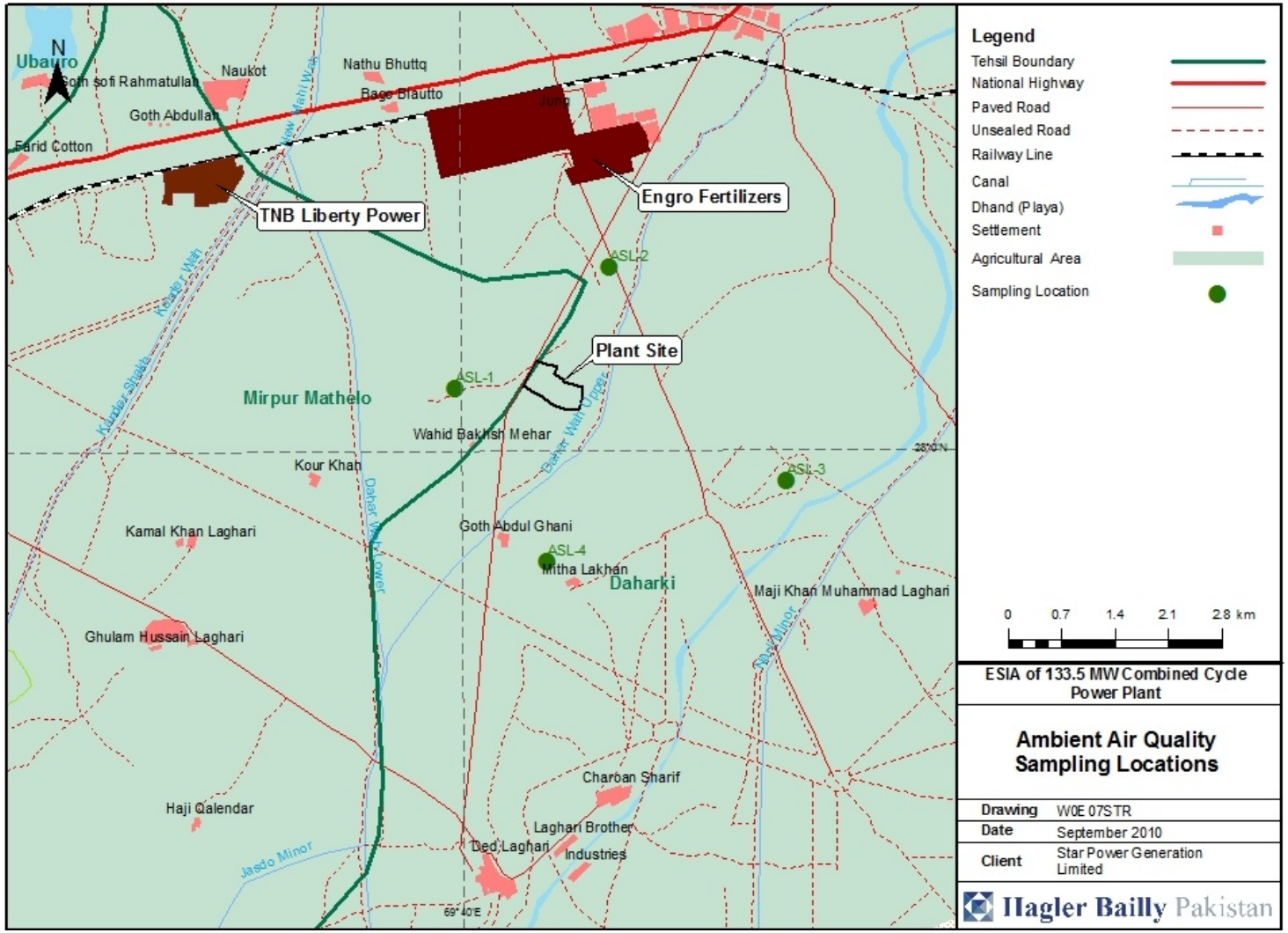


Exhibit E.2: Ambient Air Quality Monitoring Results

Parameter	*Field ID*	*PM_{10} µg/Nm^3 (24 Hour Sampling)*	*CO mg/Nm^3*	*NOX µg/Nm^3*	*SOX µg/Nm^3*
Analytical Methods		US EPA 40 CFR App B Part 50	Electro Chemical	ISO 6768	US EPA App A Part 50 Pararosaniline
Coordinates N 28 00 26.9 E 069 39 57.4	ASL-1	171.4	0	52.0	13.5
N 28 01 18.3 E 069 41 11.6	ASL-2	132.0	0	57.5	9.5
N 27 59 46.7 E 069 42 36.2	ASL-3	166.4	0	43.0	10.0
N 27 59 12.6 E 069 40 41.1	ASL-4	150.4	0	44.4	12.0

mg/Nm^3: Milligram per normal cubic meter

µg/Nm^3: Microgram per normal cubic meter.

Exhibit E.3: Locations of the Reference Ambient Air Monitored Sites

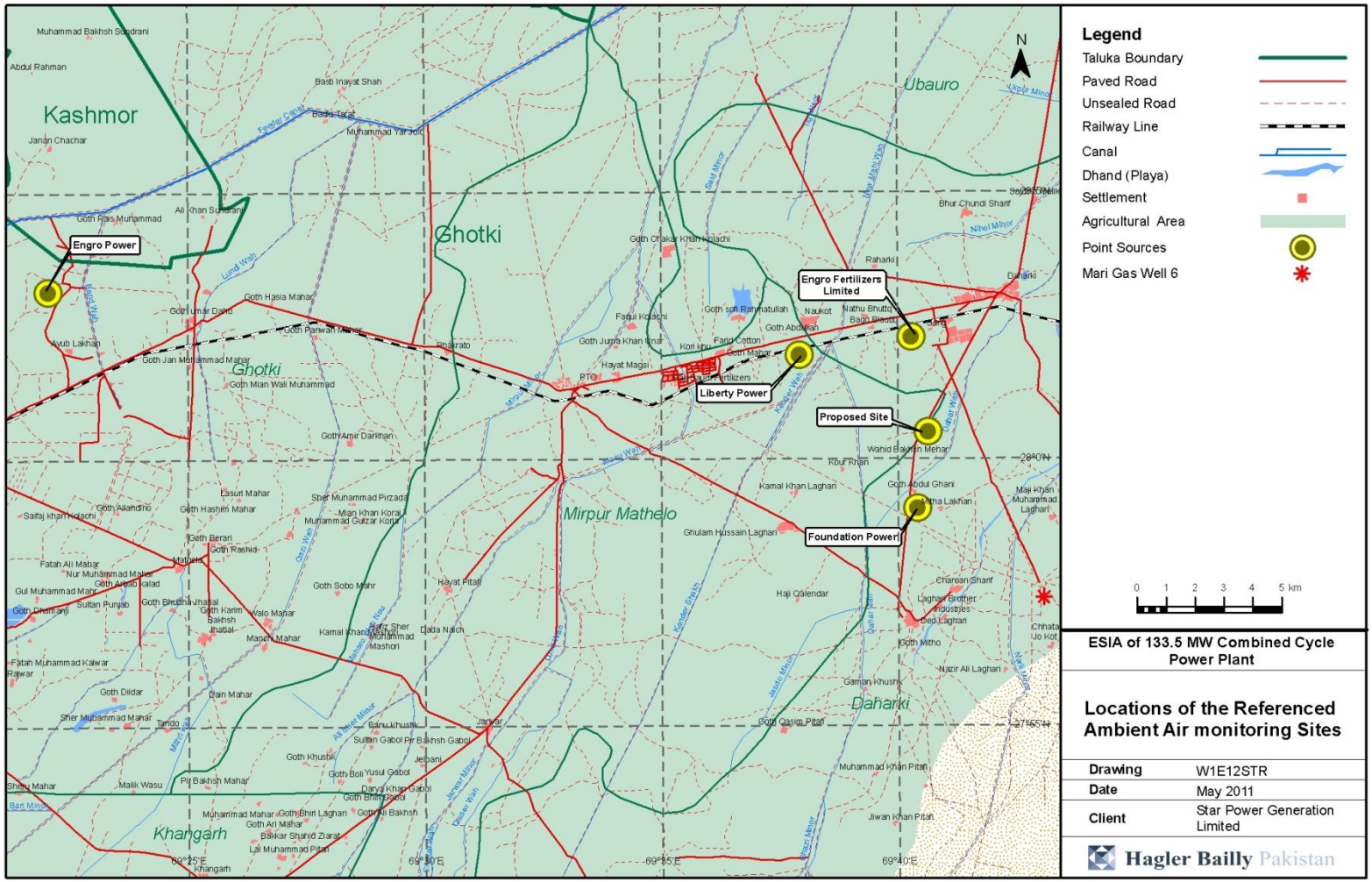


Exhibit E.4: Reference Sites Ambient Air Quality Monitoring Results

Date	*Project*	*Site*	*SO_2 (ug/m^3)*	*NO_2 (ug/m^3)*	*CO (ug/m^3)*	*PM_{10} (ug/m^3)*
7/20/2010	Star Power Daharki	N 28 02 54.1, E 69 46 41.2	22.8	43.2	< 500	188
7/21/2010		N 28 02 42.7, E 69 47 13.3"	37.2	45.6	< 500	240
7/22/2010		N 28 03 43.0, E 69 47 50.8	37.2	41.0	< 500	329
7/23/2010		N 28 04 04.0, E 69 47 03.6	31.2	43.3	< 500	237
8/27/2010		N 28 00 26.9, E 69 39 57.4	13.5	52.0	< 500	171
8/28/2010		N 28 01 18.3, E 69 41 11.6	9.5	57.5	< 500	132
8/29/2010		N 27 59 46.7, E 69 42 36.2	10.0	43.0	< 500	166
8/30/2010		N 27 59 12.6, E 69 40 41.1	12.0	44.4	< 500	150
9/2/2003	Liberty Power Daharki	Site 1	38.9	37.6	2,001	–
9/2/2003		Site 2	23.2	26.6	1,511	–
9/3/2003		Site 3	25.2	22.6	1,235	–
3/9/2007	Engro Fertilizer Daharki	Site 1	28.2	29.7	1,040	77
3/10/2007		Site 2	19.6	23.2	1,435	95
4/16/2006	Engro Power Gen Qadirpur	Site 1	21.9	28.6	1,112	–
4/15/2006		Site 2	22.4	28.9	946	–
4/16/2006		Site 3	26.8	32.5	1,249	–
5/29/2007	Foundation Power Daharki	Point 1	104.1	76.9	559	169
5/29/2007		Point 5	104.9	80.3	568	173
5/29/2007		Point 3	102.6	76.0	552	178
5/29/2007		Point 4	100.2	74.6	559	180
5/29/2007		Point 6	111.7	83.1	581	175
5/29/2007		Point 11	106.2	77.6	575	182
5/29/2007		Point 12	105.4	76.7	567	184
5/29/2007		Point 7	112.5	86.9	593	190
5/29/2007		Point 8	114.1	88.2	602	187
5/29/2007		Point 10	108.8	80.8	581	170

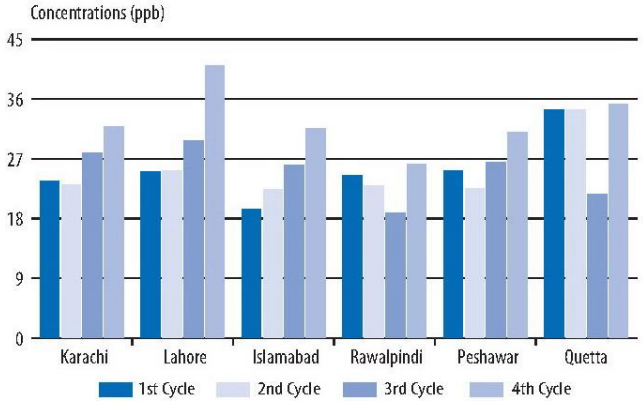
'–' indicates that no measurement were made

Exhibit E.5: Ambient Air Quality in Urban Areas of Pakistan (Source: Pak-EPA)

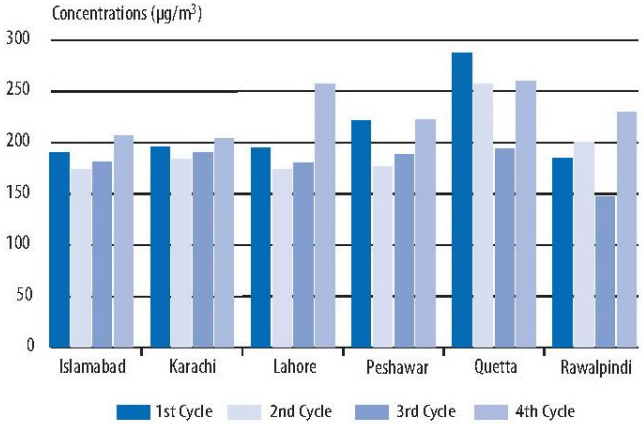
Station	*NO (ug/m^3)*		*NO_2 (ug/m^3)*		*CO (ppm)*		*SO_2 (ug/m^3)*		*$PM_{2.5}$ (ug/m^3)*	
	May '07	Sep '07	May '07	Sep '07	May '07	Sep '07	May '07	Sep '07	May '07	Sep '07
Islamabad Fixed	54.5	29.2	46.0	34.5	1.07	0.79	17.5	2.0	47.2	30.6
Islamabad Mobile	15.9	8.2	32.2	26.8	0.69	0.55	10.3	0.1	43.7	29.6
Karachi Fixed 1	10.1	12.6	20.8	21.8	0.43	0.38	21.9	7.9	77.9	105.0
Karachi Fixed 2	17.5	19.4	43.7	28.9	0.56	0.28	18.0	10.9	65.6	90.0
Lahore Fixed 1	48.8	6.8	83.6	50.4	1.91	0.87	41.6	16.6	91.8	85.5
Lahore Fixed 2	6.9	5.0	33.7	35.3	0.63	1.05	21.5	46.5	57.5	99.6
Quetta Fixed	3.2	20.5	18.8	42.2	0.44	1.28	6.6	21.4	206.4	106.4
Peshawar Fixed	29.8	15.1	53.3	33.1	1.21	1.03	22.0	34.9	185.5	79.4

Exhibit E.6: Ambient Air Quality in Urban Areas of Pakistan by Seasons (Source: ADB)

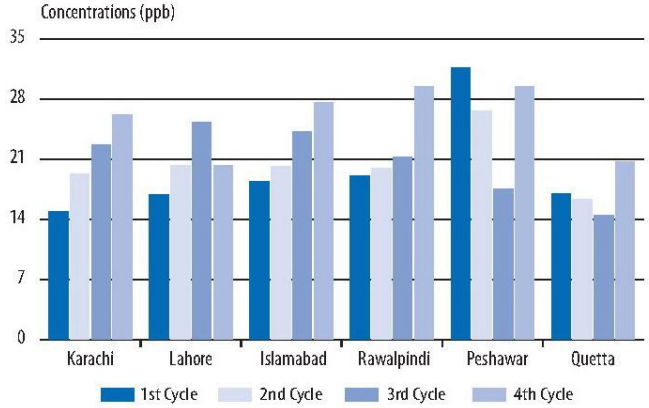
NO_x Levels in Major Pakistani Cities



48-hour Mean of PM_{10} in Major Pakistani Cities



48-hour Mean of SO_2 in Major Pakistani Cities



Climatic Conditions for the Four Cycles

	2003		2004	
City	1st Cycle	2nd Cycle	3rd Cycle	4th Cycle
Islamabad	Monsoon	Winter	Spring	Summer
Karachi	Postmonsoon	Winter	Spring	Summer
Lahore	Monsoon	Postmonsoon	Spring	Summer
Peshawar	Monsoon	Winter	Spring	Summer
Quetta	Summer	Postmonsoon	Winter	Spring
Rawalpindi	Monsoon	Postmonsoon	Winter	Summer

Exhibit E.7: Calculation of Annual Average Concentration

Date	*Season* [a]	*Project*	SO_2 *(ug/m^3)*	NO_2 *(ug/m^3)*	*CO (ug/m^3)*	PM_{10} *(ug/m^3)*
7/20/2010	Summer, Monsoon	Star Power Daharki	22.8	43.2	500	188
7/21/2010	Summer, Monsoon		37.2	45.6	500	240
7/22/2010	Summer, Monsoon		37.2	41.0	500	329
7/23/2010	Summer, Monsoon		31.2	43.3	500	237
8/27/2010	Summer, Monsoon		13.5	52.0	500	171
8/28/2010	Summer, Monsoon		9.5	57.5	500	132
8/29/2010	Summer, Monsoon		10.0	43.0	500	166
8/30/2010	Summer, Monsoon		12.0	44.4	500	150
9/2/2003	Summer, Monsoon	Liberty Power Daharki	38.9	37.6	2,001	–[b]
9/2/2003	Summer, Monsoon		23.2	26.6	1,511	–
9/3/2003	Summer, Monsoon		25.2	22.6	1,235	–
3/9/2007	Winter, Dry	Engro Fertilizer Daharki	28.2	29.7	1,040	77
3/10/2007	Winter, Dry		19.6	23.2	1,435	95
4/16/2006	Summer, Dry	Engro Power Gen Qadirpur	21.9	28.6	1,112	–
4/15/2006	Summer, Dry		22.4	28.9	946	–
4/16/2006	Summer, Dry		26.8	32.5	1,249	–
5/29/2007	Summer, Dry	Foundation Power Daharki	74.1	46.9	559	169
5/29/2007	Summer, Dry		74.9	49.0	568	173
5/29/2007	Summer, Dry		72.6	46.4	552	178
5/29/2007	Summer, Dry		70.2	45.5	559	180
5/29/2007	Summer, Dry		81.7	50.7	581	175
5/29/2007	Summer, Dry		76.2	47.3	575	182
5/29/2007	Summer, Dry		75.4	46.8	567	184
5/29/2007	Summer, Dry		82.5	53.0	593	190
5/29/2007	Summer, Dry		84.1	53.8	602	187
5/29/2007	Summer, Dry		78.8	49.3	581	170
Averages	Summer, Monsoon	3 months	23.7	41.5	795	202
	Winter, Dry	6 months	23.9	26.5	1,238	86
	Summer, Dry	3 months	64.7	44.5	696	179
	Annual	**12 months**	**34.1**	**34.7**	**991**	**138**
Maximum			84.1	57.5	2,001	329
Criteria	Annual, IFC Guidelines		[c]	40.0		70[d]
	Annual, NEQS		80.0	40.0		200
	24-hour, IFC Guidelines		125.0[d]	200.0		150[d]
	24-hour, NEQS		120.0	80.0		250

[a] Summer monsoon season: July – September; Winter dry season: October – March; Summer dry season: April – June

[b] '–' indicates that no measurement were made

[c] Blank cells indicate that no limit are set

[d] Interim target-1

Appendix F: Introductory Leaflet

Please see following page.

خام گیس سے بجلی بنانے والا 133.5 میگاواٹ بجلی گھر بنانے کا منصوبہ

سٹار پاور جینریشن لمیٹیڈ، ضلع گھوٹکی، تحصیل ڈھارکی میں خام گیس سے بجلی بنانے والا 133.5 میگاواٹ کا بجلی گھر لگا رہی ہے۔ مجوزہ بجلی گھر کیلئے خام گیس ماڑی گیس (Mari Gas) کے کنوے نمبر ۶ (Well No. 6) سے مہیا کی جائیگی۔ ماڑی گیس کا یہ کنواں نمبر ۶ مجوزہ بجلی گھر سے تقریباً 10 کلومیٹر کی دوری پر جنوب کی طرف واقع ہے۔ اس منصوبے کے اثرات ماحول اور سماج پر مرتب ہو سکتے ہیں۔ ان ماحولیاتی اور سماجی اثرات کا جائزہ (ESIA) لینے کے لئے سٹار پاور جینریشن لمیٹیڈ نے ہیگلر بیلی پاکستان پرائیویٹ لمیٹیڈ کی خدمات حاصل کی ہیں۔

ہمارا مقصد آپ کو اس منصوبے سے متعلق آگاہی دینا اور آپ کی رائے حاصل کرنا ہے جو کہ ماحولیاتی اور سماجی اثرات کے جائزے (ESIA) کا ایک اہم جزو ہے۔ آپ کی رائے ماحولیاتی اور سماجی اثرات کے جائزے کی رپورٹ میں شامل کی جائیگی۔ یہ ماحولیاتی اور سماجی اثرات کا جائزہ آپ کے صوبائی ماحولیاتی ادارے (سندھ EPA) کے قوانین کے مطابق کیا جا رہا ہے تاکہ قانونی تقاضوں کو پورا کیا جا سکے۔

یہ ماحولیاتی اور سماجی جائزہ بین الاقوامی معیار کے بھی مطابق کیا جا رہا ہے، جو مندرجہ ذیل ہیں۔

1۔ ایکویٹر پرنسپل **(Equator Principles)**

2۔ آئی ایف سی پرفارمرنس سٹینڈرڈز **(IFC Performance Standards)**

3۔ ڈبلیو بی جی، ای ایچ ایس گائیڈ لائینز **(WBG, EHS Guidelines)**

یہ ماحولیاتی اور سماجی اثرات کا جائزہ اس منصوبے کے ماحول اور سماج پر اثرات کے جائزے کے علاوہ ان اثرات کو کم کرنے کی تجاویز (Mitigation Measures) بھی پیش کریگا۔ منصوبہ سے متعلق مزید معلومات اور تجاویز کے لئے نیچے دئے گئے پتہ پر رابطہ کریں۔

فرخ احمد
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Appendix G: Environmental Management Plan

CONTENTS

Exhibits

Abbreviations

EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
HBP	Hagler Bailly Pakistan (Pvt.) Limited
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IUCN	World Conservation Union
SIDA	Sindh Irrigation and Drainage Authority
MMscfd	Million standard cubic feet per day
NEQS	National Environmental Quality Standards
NGO	Non-Governmental Organizations
Nm^3/h	Normal cubic meter (m^3) per hour
NSC	Pakistan National Conservation Strategy
Pak-EPA	Pakistan Environmental Protection Agency
PEPC	Pakistan Environmental Protection Council
PPS	[IFC's] Policy and Performance Standards
RoW	Right of Way
SEPA	Sindh Environmental Protection Agency
tpy	tons per year
WWF	World Wide Fund for Nature

1. Introduction

This document provides the environmental management plan (EMP) of the proposed project. The EMP for the construction phase is provided in **Sections 2** whereas the operation phase EMP is provided in **Section 3**.

2. Construction Phase EMP

2.1 Purpose and Objectives of the EMP

The primary objectives of the EMP are to:

- Facilitate the implementation of the mitigation measures identified for construction phase in the environmental assessment;
- Define the responsibilities of the project proponent and contractor and provide a means of effective communication of environmental issues between them;
- Identify monitoring parameters in order to ensure the effectiveness of the mitigation measures;
- Provide a mechanism for taking timely action in the face of unanticipated environmental situations; and
- Identify training requirements at various levels.

The EMP is prepared on the basis of the details currently available on the construction phase of the project. As construction contractor is appointed and further information is available, the EMP will be amended to reflect the change. However, no mitigation measures committed in the EMP can be changed.

2.2 Management Approach

The organizational roles and responsibilities of the key players are summarized below:

Star Power Generation Limited (SPGL): The project proponent will undertake overall responsibility for compliance with the EMP. SPGL will carry out verification checks to ensure that the contractors are effectively implementing their environmental and social requirements.

Contractors: The contractors will implement the majority of environmental and social mitigations as required by their contract with SPGL. The contractors will carry out field activities as part of the proposed project. The contractors are subject to certain liabilities under the environmental laws of the country, and under its contract with SPGL.

2.3 Management Responsibilities

The responsibilities of the client and contractor are briefly described below:

- Primary responsibilities:
  - As regards environmental performance during the project, the respective highest-ranking officers in the country will assume the primary responsibilities on behalf of both the project proponent and contractor.
  - SPGL's Project Manager will be responsible for environmental assessment and EMP compliance throughout the project on behalf of the company itself.
  - SPGL will coordinate with the concerned government departments.

- Project management and quality control:
  - Carrying out construction activities in an environmentally sound manner during the project will be the responsibility of the contractor's site manager.
  - SPGL's Construction representative will be responsible for the overall environmental soundness of all field operations.

Specific roles and responsibilities for environmental monitoring are provided in **Exhibit 2.1**.

2.4 Components of the EMP

The EMP consists of the following:

- Mitigation plan
- Monitoring Plan
- Communication and documentation
- Change management
- Environmental training

2.5 Mitigation Plan

The mitigation plan is a key component of the EMP. It lists all the mitigation measures identified in the environmental assessment and the associated environmental or social aspect. The mitigation measures for plant construction are presented in **Exhibit 2.2**. The measures are organized under the following environmental aspects of the project activities:

- Construction noise control plan
- Dust emission
- Vehicle and equipment exhaust
- Water conservation plan
- Community safety plan
- Soil contamination
- Hazardous and non-hazardous waste management plan

2.6 Monitoring Plan

Environmental monitoring is a vital component of the environmental management plan. It is the mechanism through which the effectiveness of the environmental management plan in protecting the environment is measured. The feedback provided by environmental monitoring is instrumental in identifying any problems and planning corrective actions.

2.6.1 Objectives of Monitoring

The main objectives of the environmental monitoring during the construction phase of the proposed project will be:

- To provide a mechanism to determine whether the project construction contractors are carrying out the project in conformity with the EMP
- To identify areas where the impacts of the projects are exceeding the criteria of significance and, therefore, require corrective actions
- To document the actual project impacts on physical, biological, and socioeconomic receptors, quantitatively where possible, in order to design better and more effective mitigation measures
- To provide data for preparing the monitoring report to be submitted to the SEPA after the completion of the construction phase

2.6.2 Environmental Monitoring Plan

The detailed monitoring plan will be finalized prior to commencement of the construction. The environmental monitoring requirements identified in the environmental assessment are presented in **Exhibit 2.3.**

2.6.3 Environmental Record

Following environmental record will be maintained:

- Periodic inspection reports of Contractor's Environmental Officer and SPGL Environmental Manager or his designate
- Audit reports
- Incident record of all moderate and major spills. The record will include:
  - Location of spill
  - Estimated quantity
  - Spilled material
  - Restoration measures
  - Photographs
  - Description of any damage to vegetation, water resource, or community asset
  - Corrective measures taken, if any
- Waste Tracking Register that will records of all waste generated during the construction period. This will include quantities of waste disposed, recycled, or reused
- Records of water consumption with use wise breakdown
- Survey reports, in particular, the following:
  - Soil erosion: Baseline survey, including photographs (or video), will be conducted to document pre-construction condition of the construction corridor

- Vehicle and equipment noise
- Ambient noise survey reports

- Public infrastructure: Record of all damages and repair work undertaken
- Employment
  - Total number of unskilled, semi-skilled, and skilled jobs offered during construction
  - Name and domicile of the employed staff
  - Archeological resources—Record of any finds with photographs
- Project and Community Interface
  - Record of community complains and the measures taken to address them.
  - Number of meeting held in various communities and persons who attended
- Environmental and social training records

2.7 Communication and Documentation

An effective mechanism to store and communicate environmental information during the project is an essential requirement of an EMP.

2.7.1 Meetings

Two kinds of environmental meetings will take place during the project:

- Kick-off meetings
- Fortnightly meetings

The purpose of the kick-off meeting will be to present the EMP to project staff and discuss its implementation.

A weekly meeting will be held during construction phase at site. The purpose of this meeting will be to discuss the environmental issues and their management. The proceedings of the meeting will be recorded in the form of a weekly environmental report.

2.7.2 Reports

Environmental reports will be prepared on a monthly basis.

2.7.3 Change-Record Register

A change-record register will be maintained at the site, in order to document any changes in project design. These changes will be handled through the change management mechanism discussed later in this document, and reported to the SEPA.

2.8 Change Management

An environmental assessment of the proposed project has been made on the basis of the project description available at the time the environmental assessment report was

prepared. However, it is possible that changes in project design may be required at the time of project implementation. This section describes the mechanism that will be put into place to manage changes that might affect the project's environmental impacts.

2.8.1 Changes to the Operation

Potential changes in project design have been categorized as first-order, second-order, and third-order changes. These are defined below.

2.8.2 First-Order Change

A first-order change is one that leads to a significant departure from the project described in the environmental assessment report and consequently requires a reassessment of the environmental impacts associated with the change.

In such an instance, the environmental impacts of the proposed change will be reassessed, and the results sent to the SEPA for approval.

2.8.3 Second-Order Change

A second-order change is one that entails project activities not significantly different from those described in the environmental assessment report, and which may result in project impacts whose overall magnitude would be similar to the assessment made in this report.

In case of such changes, the environmental impact of the activity will be reassessed, additional mitigation measures specified if necessary, and the changes reported to the SEPA.

2.8.4 Third-Order Change

A third-order change is one that is of little consequence to the environmental assessment reports' findings. This type of change does not result in impact levels exceeding those already discussed in the environmental assessment; rather these may be made onsite to minimize the impact of an activity. The only action required in this case will be to record the change in the change record register.

2.8.5 Changes to the EMP

Changes in project design may necessitate changes in the EMP. In this case, the following actions will be taken:

- A meeting will be held between SPGL and the contractor representatives, to discuss and agree upon the proposed addition to the EMP
- Based on the discussion during the meeting, a change report will be produced collectively, which will include the additional EMP clause and the reasons for its addition
- A copy of the report will be sent to the head offices of SPGL and the contractor
- All relevant project personnel will be informed of the addition.

2.9 Environmental Training

Environmental training will help to ensure that the requirements of the environmental assessment and EMP are clearly understood and followed by all project personnel in the course of the project. The contractor will be primarily responsibility for providing training to all project personnel. An indicative environmental and social training program is provided in **Exhibit 2.4**, which will be finalized before the commencement of the project.

Exhibit 2.1: Roles and Responsibilities for Environmental Monitoring

Aspect	SPGL *Responsibilities*	*Contractor's Responsibilities*	*Relevant Documentation*
Contracting	Ensure that the monitoring requirements are included in the contract between SPGL and the construction contractor(s)	Understand the requirements and estimating the required resources	Contract between SPGL and the construction contractor(s)
Monitoring plan	Finalize the monitoring plan prior to commencement of construction		Revised monitoring plan
Resources	Ensure the availability of resources required for environmental monitoring	Ensure the availability of resources required for environmental monitoring	Project budgets
Environmental staff	Designate an Environmental Manager for the project	Appoint an officer dedicated to environment (may be combined with health and safety)	Job descriptions
Monitoring surveys and inspections	Undertake periodic inspections and carry out field measurements, where needed	Systematically observe and collect data on the environmental performance, undertake inspections, and carry out surveys	Inspection and survey reports
Environmental audit	Conduct periodic audits of the construction sites and commissioning third party audits	Conducting periodic internal audits	Audit reports
Reporting	Ensuring that periodic environmental monitoring reports are received from the contractor(s) and review the reports	Generate periodic environmental monitoring reports and disseminating these among the management and appropriate staff members	Periodic reports
Corrective actions	Verify that the activities are carried out comply with the environmental assessment /EMP and identify corrective actions, if needed	Carry-out the required corrective actions	Corrective action record
Maintenance of record	Maintain monitoring data and record of all incidents of environmental significance and related corrective measures	Maintain monitoring data and record of all incidents of environmental significance and related corrective measures	Environmental databases

Exhibit 2.2: Mitigation Plan for Construction Phase

	Environmental or Social Aspects	*ID*	*Measure*	*Responsibility*
1	Construction Noise Control Plan\	1.1	Periodic surveys and trainings will be conducted for noise levels from construction equipments, operational machinery and vehicles	Construction Contractor
		1.2	Noise control measures will be implemented if the results of surveys indicate non-compliance to the acceptable limits. If needed, restricted activity zones, will be identified. Construction work within the restricted zone(s) will be managed	Construction Contractor
2	Dust Emission Control Plan	2.1	Water will be sprinkled on all exposed surfaces to suppress emission of dust Frequency of sprinkling will be kept such that the dust remains under control	Construction Contractor Construction Contractor
		2.2	Dust emission from soil piles and aggregate storage stockpiles will be reduced by keeping the material moist by sprinkling of water at appropriate frequency or erecting windshield walls on three sides of the piles such that the wall project 0.5 m above the pile, or covering the pile, for example with tarpaulin or thick plastic sheets, to prevent emission	Construction Contractor
3	Vehicle and Equipment Exhaust Control Plan	3.1	All vehicles, generators and other equipment used during the construction will be tuned and maintained in good working condition in order to minimize emission of pollutants	Construction Contractor
		3.2	The stack height of the generators will be at least 3 m above the ground	Construction Contractor, SPGL
4	Water Conservation Plan	4.1	Groundwater being extracted for construction activities would be recorded	Construction Contractor, SPGL
		4.2	Where possible, water would be recycled	Construction Contractor, SPGL
		4.3	Water usage for each activity i.e., dust suppression sprinkling, washing, and domestic use would be calculated, opportunities for reduction in water usage would be identified, and the appropriate measures would be undertaken	Construction Contractor, SPGL
5	Community Safety Plan	5.1	The fence surrounding the site will be put in on during the construction to prevent access to the construction site	Construction Contractor
		5.2	All entry points into the construction area will be staffed 24 hours a day	Construction Contractor

	Environmental or Social Aspects	*ID*	*Measure*	*Responsibility*
		5.3	Flagmen and traffic controllers employed by SPGL will be put on the access road to direct the project related traffic	Construction Contractor, SPGL
		5.4	Speed limit of 10 km/h will be maintained on the section of the access road that is adjacent to the village	Construction Contractor
		5.5	Nighttime driving of project vehicles will be limited where possible	Construction Contractor
		5.6	Work areas outside the proposed plant site, especially where machinery is involved will be roped off	Construction Contractor
		5.7	No machinery will be left unattended, particularly in running condition	Construction Contractor
6	Soil Contamination	6.1	Spill prevention trays will be provided and used at refueling locations	Construction Contractor
		6.2	On-site maintenance of construction vehicles and equipment will be avoided as far as possible	Construction Contractor
		6.3	In case on-site maintenance is unavoidable, tarpaulin or other impermeable material will be spread on the ground to prevent contamination of soil	Construction Contractor
		6.4	Regular inspections will be carried out to detect leakages in construction vehicles and equipment	Construction Contractor
		6.5	All vehicles will be washed in external commercial facilities	Construction Contractor
		6.6	Fuels, lubricants, and chemicals will be stored in covered bounded areas, underlain with impervious lining	Construction Contractor
		6.7	Appropriate arrangements, including shovels, plastic bags and absorbent materials, will be available near fuel and oil storage areas	Construction Contractor
		6.8	Contaminated soil will be removed from the site stored temporarily on an on-site storage facility and disposed off in an approved disposal facility	Construction Contractor
		6.9	Emergency plan for spill management will be developed and inducted to the staff for any incident of spill	Construction Contractor, SPGL

	Environmental or Social Aspects	*ID*	*Measure*	*Responsibility*
7	Hazardous and Non-Hazardous Waste Management Plan	7.1	Recyclable material will be separated at source and delivered to a designated waste recycler	Construction Contractor, SPGL
		7.2	Waste bins for the construction waste will be constructed inside the plant boundary. No waste will be dumped at any location outside the boundary	Construction Contractor, SPGL
		7.3	All hazardous waste will be separated from other wastes; hazardous waste such as oily waste will be disposed of through waste contractors approved by SEPA	Construction Contractor, SPGL
		7.4	On-site storage facility for hazardous waste will be developed to hold hazardous waste until an off-site hazardous waste disposal facility is available	Construction Contractor, SPGL
		7.5	Records of all waste generated during the construction period will be maintained	Construction Contractor, SPGL
		7.6	Quantities of waste disposed, recycled, or reused will be logged on a Waste Tracking Register	Construction Contractor, SPGL
		7.7	All non-hazardous waste material that cannot be recycled or reused will be disposed of at municipal waste facility in Ghotki or dispoded of through waste contractors approved by SEPA	Construction Contractor, SPGL
		7.8	The possibility of returning the packaging to the manufacturers for reuse will be explored	Construction Contractor, SPGL
		7.9	Chemical containers (including partially full containers) will be returned to vendors	Construction Contractor, SPGL
		7.10	An emergency response plan will be developed for the hazardous waste (and substances)	Construction Contractor, SPGL
		7.11	Training will be provided to personnel for identification, segregation, and management of waste	Construction Contractor, SPGL
		7.12	All containers of hazardous waste will be appropriately labeled	Construction Contractor, SPGL
		7.13	Equipment and material containing asbestos, poly-chlorinated biphenyls (PCBs), and ozone depleting substances (ODSs) will not be used	Construction Contractor, SPGL

	Environmental or Social Aspects	*ID*	*Measure*	*Responsibility*
8	Hazazrds in HSD and natural gas handling	8.1	Spill prevention and control measures should be implemented	Construction Contractor, SPGL
		8.2	HSD should be stored in a fenced area with impermeable floor	Construction Contractor, SPGL
		8.3	HSD containers should be of high quality leak resistant material	Construction Contractor, SPGL
		8.4	Emergency shut off valves should be installed at suitable intervals so that in case of emergency release can be stopped at once	Construction Contractor, SPGL
		8.5	Fire detection and alarm systems should be in place near the HSD storage tanks and the supply pipelines of HSD and natural gas	Construction Contractor, SPGL
		8.6	Emergency response and firefighting back up plan should be in place	Construction Contractor, SPGL
		8.7	Spill prevention and control measures should be implemented	Construction Contractor, SPGL
		8.8	HSD should be stored in a fenced area with impermeable floor	Construction Contractor, SPGL
		8.9	HSD containers should be of high quality leak resistant material	Construction Contractor, SPGL
		8.10	Emergency shut off valves should be installed at suitable intervals so that in case of emergency release can be stopped at once	Construction Contractor, SPGL
		8.11	Fire detection and alarm systems should be in place near the HSD storage tanks and the supply pipelines of HSD and natural gas	Construction Contractor, SPGL
9	Occupational Health and safety	9.1	Implement project-specific health and safety-related plans, which would include appropriate training and supervision of employees and enforcement of workplace safety policies.	Construction Contractor, SPGL
		9.2	All processes and equipment would be designed and constructed for safe operation.	Construction Contractor, SPGL

Environmental or Social Aspects	*ID*	*Measure*	*Responsibility*
	9.3	Develop and implement a process safety management program to identify hazards associated with each applicable chemical.	Construction Contractor, SPGL
	9.4	All project related staff would be provided the required personal protection equipment (PPE) and shall be trained to make sure that they are aware of the usefulness and correct use.	Construction Contractor, SPGL
	9.5	Working at heights and in confined spaces should be done after obtaining approvals from the safety supervisors and should regularly be monitored.	Construction Contractor, SPGL
	9.6	Emergency escape routes should be identified and all the workers should be made aware of them.	Construction Contractor, SPGL
	9.7	Use of correct signage for better understanding of all the health safety instructions and precautions for the workers.	Construction Contractor, SPGL
	9.8	Implement project-specific health and safety-related plans, which would include appropriate training and supervision of employees and enforcement of workplace safety policies.	Construction Contractor, SPGL

Exhibit 2.3: Monitoring Requirements

Project Activity and Potential Impact	*Objective of Monitoring*	*Parameters to be Monitored*	*Measurements*	*Location*	*Frequency*	*Responsibility*
Noise Disturbance due to noise from construction activity	To determine the effectiveness of noise abatement measures on sound pressure levels	Ambient noise level near receptors	A-weighted noise levels – 24 hours, readings taken at 15 s intervals over 15 min. every hour, and then averaged	At three locations on the plant boundary and three location at the receptor level. At two point along the RoW	**Baseline before start of construction:** On three typical working days and one weekend **During construction:** Once every three months on a typical working day	Contractor's Environmental officer, SPGL
	To determine the effectiveness of noise control measures on the sound pressure level of the noise sources	Source noise level of generators, major equipment and large vehicles	A-weighted noise levels measured at 15 m from the source in four directions. Measurement should be taken at full throttle, typical operating and idling conditions	15 m from the source in four direction	Once in 3 month	Contractor's Environmental officer, SPGL
Air Quality Dust emissions from construction equipment working on construction sites	To determine the effectiveness of dust control program on dust at receptor level	PM10 (particulate matter smaller than 10 microns) concentration at receptor level	1-hr and 24-hr concentration levels	At three representative locations	**During construction:** Once every three months on a typical working day	Contractor's Environmental officer, SPGL
		Visible dust	Visual observation of size of dust clouds, their dispersion and the direction of dispersion	construction sites	Once daily during peak construction period	Contractor's Environmental officer, SPGL

Project Activity and Potential Impact	*Objective of Monitoring*	*Parameters to be Monitored*	*Measurements*	*Location*	*Frequency*	*Responsibility*
Air Quality Exhaust emissions from generators and construction equipment	To determine the effectiveness of gaseous emission control measures on source emission	Gaseous emission rates from generators and other key equipment	CO, NO_X, SO_2 and PM. Measurement should be taken at full throttle, typical operating and idling conditions	Exhaust	Baseline when the equipment is inducted in pool and once a day week subsequently	Contractor's Environmental officer, SPGL
Soil Erosion Soil erosion due to wind from exposed surfaces	To determine the effectiveness of erosion control measures	Inspection for signs or erosion during and after the construction and post-reinstatement	Visual inspections	Dust	On weekly basis	Contractor's Environmental officer, SPGL
Soil Contamination Contamination due to leakages of oil and chemicals on ground	To determine the effectiveness of control measures taken to minimize the risk of spillages of oil and chemicals	Procedures in place to handle liquids and availability of procedures and equipments for emergency response incidents	Visual inspections and availability checks	Plant and pipeline construction sites	Weekly inspections	Contractor's Environmental officer, SPGL
Wastewater quality Soil and water contamination from discharge in to the environment	To determine the effectiveness of the wastewater treatment facilities and control measures	Sanitary wastewater effluent and liquid waste and thermal discharges	Parameters as described in NEQS and IFC guidelines	Influent and discharge points of wastewater treatment	Daily basis	Contractor's Environmental Officer, SGPL

Project Activity and Potential Impact	*Objective of Monitoring*	*Parameters to be Monitored*	*Measurements*	*Location*	*Frequency*	*Responsibility*
Waste Disposal Insufficient procedures for waste collection, storage, transportation and disposal	To check the availability of waste management system and implementation	Inspection of waste genaration, collection, segregation, storage, recycling and disposal will be undertaken at each site of the project activity	Visual inspections	Plant and pipeline construction sites and camp sites	Once daily	Contractor's Environmental officer, SPGL

Exhibit 2.4: Training Program

Target Audience	*Trainers*	*Contents*	*Schedule*
Selected management staff from contractor	Contractor	Key findings of environmental assessment report Mitigation measures EMP	Prior to the start of project activities
All site personnel	Contractor	Mitigation measures Camp Rules	Prior to the start of project activities
Construction crew	Contractor	EMP Waste disposal procedures	Prior to the start of construction activities
Drivers	Contractor	Road safety Road access restrictions Vehicle movement restrictions Dust reduction Waste disposal	Before and during field operations
Mechanics	Contractor	Waste disposal Vehicle movement restrictions	Before and during field operations
Camp staff	Contractor	Camp operation Waste disposal Natural resource conservation Housekeeping Camp Rules	Before and during field operations

3. Operation Phase EMP

The purpose of an EMP is not only to address the expected environmental impacts of a project, but also to enhance project benefits, and to introduce standards of good practice to be adopted for all projects works. The operation phase EMP is outlined here. This is a preliminary document that will be refined before commencement of operation. The final EMP for the operation will also be submitted to SEPA as a regulatory requirement.

3.1 Environmental Mangement System

SPGL will develop an environmental management system that is compliant with the internationally acceptable standards such as the ISO 14001. The outline of the EMS is presented in detail in **Section 8** of the main report.

3.2 Purpose and Objectives of the EMP

The primary objectives of the EMP will be to:

- Facilitate the implementation of the mitigation measures identified for operation phase in the environmental assessment;
- Define the responsibilities of the plant management and provide a means of effective communication of environmental issues between various departments and line management;
- Identify monitoring parameters in order to ensure the effectiveness of the mitigation measures;
- Provide a mechanism for taking timely action in the face of unanticipated environmental situations; and
- Identify training requirements at various levels.

3.3 Mitigation Plan

The mitigation plan is a key component of the EMP. It lists all the mitigation measures identified in the environmental assessment and the associated environmental or social aspect. The mitigation measures for plant construction are presented in **Exhibit 3.1**.

3.4 Monitoring Plan

Environmental monitoring is a vital component of the environmental management plan. It is the mechanism through which the effectiveness of the environmental management plan in protecting the environment is measured. The feedback provided by environmental monitoring is instrumental in identifying any problems and planning corrective actions.

3.4.1 Objectives of Monitoring

The main objectives of the environmental monitoring during the operation phase of the proposed project will be:

- To provide a mechanism to determine whether the conformity of the project with the environmental conditions
- To identify areas where the impacts of the projects are exceeding the criteria of significance and, therefore, require corrective actions
- To document the actual project impacts on physical, biological, and socioeconomic receptors, quantitatively where possible, in order to design better and more effective mitigation measures
- To provide data for preparing the monitoring report to be submitted to the SEPA

3.4.2 Environmental Monitoring Plan

The detailed monitoring plan will be finalized prior to commencement of the construction. The environmental monitoring requirements identified in the environmental assessment are presented in **Exhibit 3.2.**

3.4.3 Environmental Record

Following environmental record will be maintained:

- Periodic inspection reports of SPGL Environmental Manager or his designate
- Audit reports
- Incident record of all moderate and major spills.
- Waste Tracking Register that will records of all waste generated. This will include quantities of waste disposed, recycled, or reused
- Records of water consumption with use wise breakdown
- Survey reports.
- Public infrastructure: Record of all damages and repair work undertaken
- Employment records
- Project and Community Interface
  - Record of community complains and the measures taken to address them.
  - Number of meeting held in various communities and persons who attended
- Environmental and social training records

3.4.4 Environmental Reports

Environmental reports will be prepared on an annual basis.

Exhibit 3.1: Mitigation Plan for the Operation Phase

Aspect	*ID*	*Mitigation Measure*	*Achievement Indicators*
Cultural awareness	1.01	Provide employees and visitors to the site with cultural awareness training.	Induction material and presentations containing cultural awareness material along with records of attendance
Emissions	2.01	Limit vehicle idling for reduction of tail gas emissions.	Visual inspection
	2.02	Limit vehicle speed on the access road and within the plant site to minimise dust.	Visual inspection
	2.03	Maintain vehicles and equipment (including abatement equipment) in accordance with manufacturer's instructions.	Maintenance log
Employment	3.01	Develop and implement a Local Employment Policy and Recruitment Plan.	Completed policy
	3.02	Focus recruitment of semi-skilled and unskilled labour to residents of local communities	Local content targets met
	3.03	Define areas 'local' to the Project in consultation with the community	Definition of local; Records of community agreement
	3.04	Publish the local employment policy and create awareness of the policy. Explain the recruitment process to local communities.	Evidence of publication; Records of engagement
	3.05	Collect and store data on 'local' candidates	Database in place and maintained
	3.06	Set long term (10 to 15 year) targets for local content at the managerial level.	Long-term targets set; Recruitment records showing the number and %age of positions filled by locals
Energy Management	4.01	Implement an energy management plan that includes: • energy usage targets for different mine site activities; and • suggestions on how energy can be conserved.	Plan in place with evidence of implementation and review

Aspect	*ID*	*Mitigation Measure*	*Achievement Indicators*
Hazardous Materials	5.01	Develop and implement a Hazardous Material Management Plan including procedures for transport, handling and storage of hazardous substances to minimise risk of accidental exposure. Include clear instructions on what to do should exposure occur. Hazardous materials include explosives, fuel, lubricants, laboratory chemicals, hazardous waste etc.	Procedures for transport, handling and storage of hazardous substances with evidence of implementation
	5.02	Require vehicle maintenance be performed in designated workshops where appropriate pollution control measures are provided.	Visual inspection
	5.03	Record and report information on spills including: • location of spill; • material type (hazard potential) and quantity released; • quantity of material recovered; • media affected (soils, water, air); • actions taken to contain, recover and remove material released; • methods and location of disposal of recovered material or affected media; • cause of the spill; and • how future spills could be avoided.	Records of spills showing lessons learnt
	5.04	Provide spill prevention and response training to staff , contractors and visitors, including: • an explanation of good house-keeping practices; • identification and use of equipment and engineering controls designed to prevent spills; • description of proper spill response procedures; and • indication of possible health, safety and environmental risks potentially occurring as a result of a spill.	Training/induction logs
	5.05	Provide and maintain diesel tanks with secondary containment equal to 110% of the tank's capacity.	Built according to design
	5.06	Where fuel is being transported, provide clean-up/remediation equipment sufficient to contain small spills (defined as at least 5% of fuel being transported at any one time).	Visual inspection
	5.07	Develop and implement Spill Prevention and Mitigation Plan for the plant site and road transportation	Plan document, training provided as documented in training logs

Aspect	*ID*	*Mitigation Measure*	*Achievement Indicators*
Health	6.01	Undertake health screening of employees.	Health screening reports
	6.02	Consider providing health and hygiene education awareness programmes to local educational establishments and employees.	Awareness campaign material
Local Economy	7.01	Locally award contracts that are within the capability of local contractors.	Records of procurement contracts awarded to local companies
	7.02	Develop and maintain a supplier and contractor database, along with a process to review, monitor and strengthen capabilities of local suppliers and contractors on an ongoing basis.	Database established and being used
Noise control	8.01	Provide hearing protection for operators.	Protective equipment available and staff know how to use
	8.02	Maintain vehicles and equipment in accordance with manufacturer's instructions.	Maintenance log
	8.03	Undertake standardised noise measurements on major items of equipment upon delivery to provide a noise baseline.	Log of measurements
	8.04	Require visitors to the site to wear ear protectors if working or visiting areas where appropriate occupational health and safety sound levels are exceeded.	Protective equipment available for use
Occupational health and safety	9.01	Develop health and safety management plan to cover identified health and safety risks likely to occur during construction, start up, operation, closure and rehabilitation phases of the project.	Plan in place with evidence of review
	9.02	Systematically and continuously identify, assess and respond to health and safety risks throughout the Project life cycle.	Record of risk identification and management
	9.03	Restrict the noise levels emitted from equipment or provide suitable personal protection devices if this limit cannot be achieved.	Noise levels known and equipment provided where necessary
	9.04	Provide fire protection systems to comply with United States of America's National Fire Protection Association regulations.	Systems in place and tested

Aspect	*ID*	*Mitigation Measure*	*Achievement Indicators*
	9.05	Provide personnel with appropriate personal protection equipment (PPE) if they are obliged to work in areas where occupation health and safety standards are exceeded. Provide staff with training on how and when to use the PPE.	PPE available and staff know how to use it
	9.06	Prevent access to areas with high hazard potential and clearly mark such areas with suitable warning signs showing written and visual representation of the hazard.	High hazard areas identified on a plan and barriers in place with suitable warning signs
	9.07	Encourage personnel to report near misses where Project activities or infrastructure could have potentially resulted in harm to staff, visitors, local communities or ecological systems.	Near miss register established and used
Pipeline crossing	10.01	Provide and maintain drainage infrastructure to minimise soil erosion and sediment transport during rainfall events.	Visual inspection
	10.02	Construct and maintain erosion control measures at water course crossing points.	Visual inspection
Plant Light	11.01	Use and maintain directional lighting around the plant fence to minimize light intrusion.	Visual inspection
Road traffic	12.01	Provide driver training, assessment and monitoring including what to do in the event of an emergency.	Training reports
	12.02	Maintain vehicles in accordance with manufacturer's instructions.	Maintenance logs
	12.03	Use the non-conformance and incident report system to record and evaluate the cause of traffic accidents and update traffic procedures accordingly.	Accidents are recorded and investigated
	12.04	Encourage staff to minimize night driving on the access road	Visual inspection
	12.05	Prohibit unnecessary off road driving.	No visual evidence of Project related off road driving.

Aspect	*ID*	*Mitigation Measure*	*Achievement Indicators*
Stakeholder engagement	13.01	Develop and implement Stakeholder Engagement Plan that includes: • maintaining regular communication with local communities and other stakeholders to minimise tensions arising from Project activities; • maintaining a grievance procedure, and encourage and facilitate stakeholders to use the mechanism to express concerns; and • provides sufficient resources to the community relations team to enable them to monitor negative perceptions and associated tensions, and to address them in a timely fashion.	Plan in place with records of implementation including records of communication/ information sharing
Waste Management	14.01	Prepare operation waste management plans and implement these consistent with Pakistan regulations and international standards to the extent practicable.	Plan in place with evidence of review
	14.02	Include in the waste management plans the following: • a commitment to a waste hierarchy comprising a) waste avoidance, source reduction, prevention or minimisation; b) waste recovery for materials that can be re-used; c) waste treatment to avoid potential impacts to human health and the environment or to reduce the waste to a manageable volume; and d) safe and responsible waste disposal; • inventory of wastes identifying the source/s, characteristics and expected volumes; • waste segregation requirements; • location and type of waste collection points, which are conveniently located, have adequate capacity, are frequently serviced and clearly labelled; • storage requirements; • opportunities for source reduction, re-use or recycling; • targets for waste re-use, recycling and incineration; • opportunities to minimise bulk or render waste non-hazardous; • procedures for operating waste storage, treatment and disposal facilities; • labelling requirements for waste disposed of offsite; • method of tracking waste recovered, incinerated or disposed of to the site's landfill; • method of tracking quantity, date, transporter and fate of waste disposed of offsite; • a contingency plan should waste disposal facilities be unavailable for a time; and • training requirements for waste management staff and other employees and contractors.	Waste management plan in place with evidence of implementation

Aspect	*ID*	*Mitigation Measure*	*Achievement Indicators*
	14.03	Recycle, compost or incinerate non-hazardous waste to the extent practicable.	Records of waste recycled, composed or incinerated
	14.04	Preferably return hazardous waste to the associated supplier or transport to other appropriately licensed facilities off-site to the extent practicable and permitted.	Records of waste returned to supplier
	14.05	Provisionally store hazardous waste not transported off site in appropriate storage facilities on-site until their final disposal is determined. Include a roofed enclosure over a concrete pad with a low concrete wall to provide containment to hold 110% of the volume of stored hazardous liquids. Also include a fenced open area of storage of empty containers. Restrict access to this area to qualified personnel only.	Visual inspection
	14.06	Develop and implement supporting procedures to the waste management plans as needed, for the transport, storage, handling and disposal of waste materials (including hazardous waste)	Procedures in place with evidence of implementation
	14.07	Maintain sewage treatment facilities according to manufacturers' specifications and Pakistan requirements.	Maintenance logs
	14.08	Fit cooking areas with grease traps, and maintain these, to prevent excess oils and fats reporting to the sanitation facilities.	Visual inspection
Wastewater	15.01	Minimise release of storm water from the plant site by maintaining	Construction signed off by appropriately qualified engineer
	15.02	Treat sewage effluent.	Sewage treatment facilities in place and operating according to instructions
	15.03	Deploy erosion control and sediment management measures around areas disturbed during construction.	Construction signed off by appropriately qualified engineer
Water conservation	16.01	Recycle wastewater after treatment for horticulture and road sprinkle	Maintenance of water balance to track water usage
	16.02	Use water efficiency technologies, as far as practicable, to minimise raw water consumption.	Maintenance of water balance to track water usage

Aspect	*ID*	*Mitigation Measure*	*Achievement Indicators*
	16.03	Train staff and keep them aware of good water conservation practices.	Training material and records
	16.04	Develop a water management plan for the Project that includes monitoring of water use, development of water balance, and periodic review of use predictions, impacts and mitigation.	Plan in place with evidence of implementation and review
Wildlife	17.01	Develop and implement a wildlife and habitat management plan that: • provides awareness training to staff and contractors on: prevention of injury of animals; identification of likely species found on site; identifications of animal hazards (such as venomous snakes); and what to do if dangerous animals are encountered; • requires personnel to report large animal kills to the management; and • encourages personnel to report sightings of wildlife of conservation importance or incidents of poaching to the management.	Plan in place with evidence of implementation and review
	17.02	Prohibit hunting or trading in wildlife or their products by employees and contractors.	No reports of such incidents
	17.03	Limit and enforce speed limits along access road to minimise the risk of animal road kills.	Random speed checks

Exhibit 3.2: Monitoring Requirements

Aspect	*Type of monitoring*	*Frequency*	*Location/s*
Land disturbance	Soil quality (major metals, nutrients, organic contents, and TPH)	Every two years	4 monitoring points around the plant
	Visual inspection of road condition	Quarterly or on receipt of grievance	Access road
Water	Rate and volume of water abstracted from groundwater bores	Continuous	Boreholes
	Rate and volume of water used and recycled	Continuous	Usage points
	Groundwater levels	Monthly	Boreholes
	Groundwater quality (pH, EC, TDS, temperature, dissolved oxygen, nitrate, chloride, fluoride, sulfate, phosphate, Na, K, Ca, Mg, Al, Fe, Mn, B, Cu, Zn, As, and Hg).	Annually	• Water source • Three (3) community wells nearest to the boreholes • Four (4) community wells nearest to the plant site
Air	PM_{10} and TSP for 24 hour filter-based low-volume sampler	Annually	4 monitoring points around the plant
	Ambient 24 hr NO_2 and SO_2 concentrations (using active sampler)	Once every year	4 monitoring points around the plant
	Ambient monthly NO_2 and SO_2 concentrations (using passive sampler)	Monthly	4 monitoring points around the plant
	Stack testing	Annual and as per the regulations	All stacks
	Times and duration of upset conditions	When upset conditions occur	All plant stacks

Aspect	*Type of monitoring*	*Frequency*	*Location/s*
Vehicles and equipment	Random speed checks	At different locations and different time	Access road and plant road
	Records of vehicle and equipment maintenance	As per manufacturers instructions	Transport office and workshop
	Baseline noise emissions of new equipment	On commissioning of new equipment	Within 100m of equipment
Noise	Ambient noise levels	Annually or upon receipt of complaint	4 monitoring points around the plant and two points along the access road near the villages
Ecological	Records of animal kills	On occurrence	Access road and surrounding areas
	Records of major wildlife sightings	On occurrence	Access road and surrounding areas
Employment	Details of job applicants and actual employees categorised by: • skill level; • whether they are local, provincial, national and/or international; • ethnicity • gender; • from a vulnerable group (for example disabled).	Ongoing throughout the life of the Project	Plant site
	Employees trained, categorised by: • skill level; • type of training received; • whether they are local, provincial, national and/or international; • ethnicity; • gender; • from a vulnerable group (for example disabled).	Quarterly (during DD and C phases)	Project training facilities

Aspect	*Type of monitoring*	*Frequency*	*Location/s*
Contractors	Origin of contractors and suppliers (Local, provincial, national and/or international)	Yearly	Plant site
Community	Community grievances or complaints, categorised by type (for example: access to opportunities; community health and safety; compensation; presence of non-locals, etc.	Monthly	Grievance register maintained at plant site
Hazardous material	Records of hazardous materials used	On arrival at site	Warehouse or storage facility
	Inspections of hazardous substances containment facilities, instrumentation and detection systems.	Evert three months	Hazardous material containment facilities
Waste	Volume of different wastes types disposed of to landfill or incineration	Continuous	Waste disposal sites
	Volume of different waste types recycled or reused	Continuous	Waste disposal sites
	Volume of soil bio-remediated	Continuous	Waste management site at mine