Esso Highlands Limited

Papua New Guinea LNG Project

Environmental Standards

PGGP-EH-SSZZZ-000002

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1.0 OBJECTIVES & SCOPE

1.1 Objectives

It is Esso Highlands Limited (Company) policy to comply with all applicable environmental laws and regulations and apply responsible standards where laws and regulations do not exist.

Company's Operations Integrity Management System (OIMS) Standard System 6-1: Environmental Management requires environmental management processes to be compliant with applicable host-country environmental-, socioeconomic-, and health-related regulatory requirements and project-specific environmental, socioeconomic, and health related commitments and obligations (including but not limited to laws, regulations, decrees, permit/license/approval obligations, financing contracts/agreements).

The purpose of this document is to describe the numeric environmental criteria associated with pollution prevention which apply to the PNG LNG Project (the Project).

1.2 Scope

The standards put forth in this document have been adopted in order to meet requirements applicable to the Project, including:

- Numeric requirements prescribed in laws and regulations of Papua New Guinea
- Numeric requirements established in the Project's Environment Permit (WD-L3 (210)
- Requirements established in International Finance Corporation (IFC) Performance Standard 3 and its supporting guidelines, and
- Numeric requirements in Company design specifications.

For the purpose of this document the above requirements are referred to collectively as standards.

The requirements described herein apply to the construction execution, commissioning and operational phases of the Project.

The focus of this document is to describe applicable numeric standards only.

Non-numeric or qualitative standards are generally described in Company's Environmental and Social Management Plan (ESMP).

2.0 LAWS AND REGULATIONS OF PAPUA NEW GUINEA

Papua New Guinea laws and regulations containing numeric environmental criteria associated with pollution prevention are listed below.

Further details are provided in the ESMP and the Project Regulatory Compliance Plan.

- Environment Act 2000
- Environmental (Water Quality Criteria) Regulation 2002
- Environmental Code of Practice for Sanitary Landfill Sites PNG 2001
- Inflammable Liquid Act 1953 and Regulations
- Public Health (Sewerage) Regulation 1973
- Water Supply and Sewerage Act 1996

3.0 NUMERICAL STANDARDS

3.1 Emissions Standards: General

Source: Papua New Guinea LNG Project, Project Design Basis, PGHU-EH-BBPDB-000002, Revision 0, July 2009

All combustion sources (operating more than 500 hours per year with an annual capacity utilization factor of more than 30%) shall have stack sampling ports for isokinetic sampling, (testing volumetric flow rates and pollutant emission rates) at a location free of cyclonic flow during performance tests.

Stack sampling locations should adhere to US EPA 40 CRF 60 Method 1 “Sample and Velocity Traverses for Stationary Sources“. Appropriate platforms to carry out sampling, electrical supply connections, ladders and cranes and pullies must be provided.

Stack height on combustion sources shall be such that ambient air quality criteria are not exceeded.

Power generation and compressor turbines shall utilize low NO_X combustion technology.

MEG dehydration systems must provide for thermal destruction of BTEX.

3.2 Emission Standards: Incinerator Emissions

3.2.1 Permanent Incineration Units

Source: PNG LNG Project Design Specification, Waste Incinerator Packaged Units, PG-PDS-41-9904, Revision 0, December 2008

The primary combustion chamber shall be maintained so that the exit gas has a minimum temperature of 850°C.

The secondary combustion chamber shall operate so that the instantaneous temperature of the gas exiting the chamber is a minimum of 875°C. The secondary combustion chamber shall allow for a minimum two-second retention time at 875°C.

Stack emissions shall meet the intent of the applicable emissions limits in US EPA 40 CFR Part 60 (Standard of Performance for New Stationary Sources (NSS)) including subpart AAAA (Standards of Performance for small Municipal Waste Combustion Units) or Subpart CCCC (Standards of Performance for Commercial and Industrial Solid Waste Incineration Units) as applicable.

Guidance emissions limits as per the above Subparts are shown in Table 1. Emissions limits should be verified with the current version of US EPA 40 CFR Parts AAAA and/or CCCC.

Table 1: Permanent Incinerator Emissions Standards

Parameter	Limit	As determined by
Particulate Matter (PM10)	24 mg/m^3	CEMS
Nitrogen Oxides (NOx)	150 ppm (180ppm for first year)	Stack Test
Sulphur Oxides (SOx)	30 ppm	
Cadmium (Cd)	0.02 mg/m^3	
Dioxin (CDD) Furan (CDF)	13 ng/m^3	
Hydrogen Chloride (HCl)	25 mg/m^3	
Carbon Monoxide (CO)	150 ppm	CEMS
Fugitive Ash	Visible emissions of no more than 5% for hourly observation period	Visible Emissions

Note: All emissions except opacity measured at 7% O_2

The minimum stack extension beyond the roof of the building shall comply with NFPA 82. The stack design shall be based on the draft required to operate the incinerator and the dispersion characteristics of the plume necessary to meet required ground level emission concentration.

Sample ports shall be installed to permit entry to monitor the concentration level of exhaust Gases. The stack shall be designed with a continuous emissions monitoring system, record keeping and reporting requirements capable of monitoring carbon monoxide and particulates. The stack shall be designed with a permanent platform for stack sampling.

3.2.2 Temporary Incineration Units

Temporary incinerators utilized during construction shall be of dual combustion chamber design and shall provide for at least one second retention time at a minimum temperature of 850ºC in the secondary chamber.

Operational and monitoring/record keeping criteria applicable to the temporary incinerators are shown in Table 2.

Operating Procedures shall be established to address these requirements and incineration records shall be maintained.

Table 2: Temporary Incinerators: Operational and Monitoring Criteria

Parameter	Operating Criteria	Monitoring and Record Keeping
Temperature (at the exit of the secondary chamber)	850 - 1200 ºC	Continuous temperature monitor
Residence time (in the secondary chamber)	Equal to or more than 1 second	N/A
Waste Type	No restricted waste (see exceptions below)	Waste incineration records (waste type)
Waste Feed Rate	Per Vendor recommendation	Waste incineration records (feed rate)
Condition of Waste Bed	N/A	Waste incineration records (visual inspection at each burn cycle)
Stack Emissions	No black smoke or ash	Waste incineration records (visual inspection). Note: Emissions of black smoke or ash indicate corrective action required.
Fuel Consumption	N/A	Waste incineration records (fuel consumption)
Equipment Inspection & Maintenance	Per vendor recommendation	Waste incineration records (inspection and maintenance)

With the exception of health care waste and oily debris (oil filters, oily rags etc), no restricted waste (see Waste Management Plan PGGP-EH-SPENV-000018-006 for waste classifications), shall be incinerated in the temporary incinerators.

A temporary incinerator shall not be utilized for the incineration of health care waste or oily debris where the specification of the incinerator does not allow for a minimum temperature of 850ºC in the secondary chamber.

A temporary incinerator shall not be utilized for the incineration of health care waste or oily debris where the specification of the incinerator does not allow for a minimum retention time of one second in the secondary chamber, unless the temperature in the secondary chamber is equal to or greater than 850ºC.

Where health care waste is incinerated in the temporary incinerators, it shall be processed separately from other wastes. Ash from health care waste burn cycles shall, unless otherwise demonstrated through testing, be treated as a restricted waste and shall be stabilised and disposed of at the HWMA or LNG Plant landfill.

Incineration of restricted waste (with the exception of health care waste and oily debris as discussed above) in the temporary incinerators shall be on an exception basis and requires prior Company approval.

Incinerators burning restricted waste (other than medical waste or oily debris) shall be specified so as to meet the intent of the applicable emissions limits in US EPA 40 CFR Part 60 Subpart CCCC (Standards of Performance for Commercial and Industrial Solid Waste Incineration Units). Testing shall be undertaken during commissioning of the incinerator to demonstrate that stack emissions meet the required concentrations. Thereafter, monitoring of stack emissions for these parameters shall be undertaken periodically, but no less than annually.

In addition to the temporary incinerators to be utilized during construction, a high temperature incinerator is to be installed at the Hides Waste Management Area (HWMA).

The HWMA incinerator is of dual combustion chamber design and is specified to allow a minimum retention time in the secondary chamber of one second at 950ºC.

Stack emissions from the HWMA incinerator shall meet the intent of the emissions limits in US EPA 40 CFR Part 60 Subpart CCCC (Standards of Performance for Commercial and Industrial Solid Waste Incineration Units). Monitoring of emissions from the HWMA incinerator shall be conducted for carbon monoxide (CO) and particulate matter (PM_{10}) via Continuous Emissions Monitoring System (CEMS). For the other applicable parameters of US EPA 40 CFR Part 60 Subpart CCCC, performance tests (stack sampling) shall be undertaken during commissioning. The performance tests shall be extended as necessary to gain representative emissions data for all anticipated waste compositions. Thereafter, monitoring of stack emissions shall be undertaken as necessary to enable CEMS calibration.

Incinerators onboard offshore pipelay vessels shall be designed and built to an approved standard as described in regulation 16(2) of MARPOL Annex VI and shall have IMO approved certificates. Such certificates shall be made available to Company upon request.

3.3 Ambient Air Quality Standards

Source: World Health Organization Ambient Air Quality Guidelines (1987, 1999 and 2006) as referenced in Papua New Guinea LNG Project, Project Design Basis, PGHU-EH-BBPDB-000002, Revision 0, July 2009

Table 3: Ambient Air Quality Standards

	1 hour	**24-hr average**	**Annual average**	**Other**
SO_2		20 μg/m^3		10 minute: 500 μg/m^3
NO_2	200 μg/m^3		40 μg/m^3	
CO	30,000 μg/m^3			15 minute average: 100,000μg/m^3 30 minute average: 60,000μg/m^3 8-hr average: 10,000 μg/m^3
H_2S				No offensive odour at boundary, <5 mg/m^3
PM_{10}		150 μg/m^3	70 μg/m^3	
$PM_{2.5}$		75 μg/m^3	35 μg/m^3	
Total Suspended Particulates		150-230 μg/m^3	60-90 μg/m^3	
Ozone				8 hours, daily max: 100 μg/m3 (Not to be exceeded more than 24 times per year)

3.4 Water Discharge Standards

Source: PNG LNG Project Water Management Plan, PGGP-EH-SPENV-000018-007, Revision 1, August 2010

3.4.1 General

Wastewater quality criteria established in Table 4 shall apply end of pipe.

Should these criteria be exceeded, samples will immediately be taken upstream and downstream of the discharge point for the full suite of parameters shown in Table 5.

Compliance shall be determined by the samples taken in the receiving water body.

Table 4: Wastewater Discharge Standards

Location	Frequency	Criteria
All discharge locations	For treatment plants utilising biodigestion technology: weekly during plant stabilization (maximum 90 days)	pH (pH units) 6.5 – 9
		Residual Chlorine: As close as possible to 1 mg/L
		Volume (m3): Cumulative
All discharge locations	For treatment plants utilising biodigestion technology: once following plant stabilisation	Full suite of parameters detailed in Table 5.
All discharge locations	Twice monthly (following plant stabilization if applicable)	pH (pH units): 6.5 – 9
		BOD: 25 mg/L
		COD: 125 mg/L
		Ammonia Nitrogen (See Table 6)
		Total Suspended Solids: 50 mg/L
		Oil & Grease: No visible film
		Fecal Coliform: Not to exceed 200 colonies OR Residual Chlorine: As close as possible to 1 mg/L
		Volume (m3): Cumulative

Notes:

Wastewater treatment plants using biological digestion technology require a period of stabilisation in order to achieve steady operations.

The criteria and the monitoring thereof included in Table 4 do not apply to the discharge of wastewater to engineered soakaways/leach fields, or from marine vessels (which shall meet MARPOL requirements).

Table 5: Fresh Water (Surface) and Sea Water Quality Standards

Parameter*	Receiving Water Body	
	Freshwater	**Seawater**
pH (pH units)	6.5 – 9	No alteration to natural pH
Temperature	No alteration greater than 2°C	No alteration greater than 2°C
Turbidity NTU	No alteration greater than 25 NTU or <10% change from background levels at any particular time	No alteration greater than 25 NTU or <10% change from background levels at any particular time
Total Suspended Solids	50 mg/L or <10% change from background levels at any particular time	50 mg/L or <10% change from background levels at any particular time
Insoluble residues	No insoluble residues or sludge formation to occur	No insoluble residues or sludge formation to occur
Dissolved oxygen	Not less than 6.0 mg/L or <10% change from background levels at any particular time	Not less than 5.0 mg/L or <10% change from background levels at any particular time
Chemical Oxygen Demand (COD)	125 mg/L	125 mg/L
Biological Oxygen Demand (BOD)	25 mg/L	25 mg/L
Sulphate as SO42-	400.0 mg/L	---
Sulphide as HS-	0.002 mg/L	0.002 mg/L
Ammonia-nitrogen (NH3-N)	Dependent on pH and temperature (see Table 5)	---
Nitrate (NO3- + NO2-)	45 mg/L	45 mg/L
Potassium	5.0 mg/L	600 mg/L
Barium	1.0 mg/L	1.0 mg/L
Boron	1.0 mg/L	10 mg/L
Cadmium	0.01 mg/L	0.001 mg/L
Chromium (as hexavalent)	0.05 mg/L	0.01 mg/L
Cobalt	Limit of detection	
Copper	1.0 mg/L	0.03 mg/L
Iron	1.0 mg/L	1.0 mg/L
Lead	0.005 mg/L	0.004 mg/L
Manganese	0.5 mg/L	2.0 mg/L
Mercury	0.0002 mg/L	0.0002 mg/L
Nickel	1.0 mg/L	1.0 mg/L
Selenium	0.01 mg/L	0.01 mg/L
Silver	0.05 mg/L	0.05 mg/L
Tin	0.5 mg/L	0.5 mg/L
Zinc	5.0 mg/L	5.0 mg/L
Oil & Grease	No visible film (for construction discharges); and 10 mg/L (for operations discharges)	No visible film (for construction discharges); and 10 mg/L (for operations discharges)
Phenols	0.002 mg/L	0.002 mg/L
Fecal Coliform	Not to exceed 200 colonies or <10% change from background levels at any particular time	Not to exceed 200 colonies or <10% change from background levels at any particular time

Notes:

Units: mg/L unless stated otherwise

A dash ('—') denotes that no criteria or limit applies

Metal concentrations are for dissolved substances (passing through a nominal 0.45 um medium)

NTU = nephelometric turbidity unit

Cobalt (as 'limit of detectability') uses Graphite furnace atomic absorption spectrometry (GFAAS)

The criterion for fecal coliform bacteria (colonies per 100 mL) is based on not fewer than five water samples collected over not more than a 30 day period

Limits are subject to detection levels of the appropriate analytical procedure

Table 6: Maximum Ammonia-Nitrogen Concentrations for Freshwater (mg/L)

Temperature °C	pH		
	7.0	**8.0**	**9.0**
5	16.1	1.6	0.2
10	11.0	1.1	0.1
15	7.5	0.8	0.09
20	5.2	0.5	0.07
25	3.6	0.4	0.06
30	2.6	0.3	0.05
35	1.6	0.2	0.04

3.4.2 Groundwater

Groundwater in the vicinity of the LNG Facilities Site Landfill and Hides Landfill shall meet the criteria shown in Table 7.

Table 7: Groundwater

Criteria *
No alteration above natural background for: pH (pH Units) Dissolved Oxygen Sulphate as SO42— Ammonia-nitrogen (NH3-N) Nitrates (NO3-+ NO2-) Major Ions (Ca, Mg, Na, K) Electrical Conductivity Arsenic Barium Boron Cadmium dissolved Chromium (as hexavalent) Cobalt Copper Iron (dissolved) Lead Manganese (dissolved) Mercury Nickel Selenium Silver Tin Zinc Total Petroleum Hydrocarbons Fecal coliforms Phenols

* Dissolved metals

3.4.3 Leachate

Leachate discharged from Project landfills shall meet the criteria shown in Table 8.

Table 8: Leachate Monitoring

Location	Frequency	Criteria (Freshwater)
HGCP and LNG Plant Landfills only where discharged to surface or seawater	Upon discharge	Full suite of parameters detailed in Table 5.

3.4.4 Hydrotest

Hydrotest discharge water shall meet the criteria shown in Table 9.

Table 9: Hydrotest Water Monitoring

Parameter	Criteria (end of pipe for discharge to surface waters or land)*
pH	6-9
BOD	25 mg/L
COD	125 mg/L
TSS*	50 mg/L or <10% change from background levels at any particular time.
Phenols	0.5 mg/L
Sulfides	1 mg/L
Heavy metals (total)**	5 mg/l
Chlorides	600 mg/L (average); 1200 mg/L (maximum)

Notes:

* Measured at end of pipe

** Includes arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, vanadium, zinc

3.5 Noise

Source: PNG LNG Project Design Specification Facility Noise Design Criteria PGGP-EH-SSPDS-002102

Noise from permanent Project facilities shall meet the criteria detailed in Table 10.

These criteria are based on the International Finance Corporation General Environmental, Health and Safety Guidelines, April 2007 (Table 1.7.1 Noise Level Guidelines), however in the case of the Project the established criteria are applicable at the facility fence line and are exclusive of background noise.

Table 10: Noise

	One Hour LAeq (dBA)	
Receptor	**Day time: 07.00-22.00hrs**	**Night time: 22.00-07.00 hrs**
Perimeter Fence Line*	55 dB(A)	45 dB(A)

*exclusive of background.

3.6 Blasting Overpressure and Ground Vibration

Source: Australia and New Zealand Environment Council Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Vibration, 1999

The guideline levels presented in Table 11 below shall apply in the vicinity of noise or vibration sensitive receptors.

Table 11: Blasting Overpressure and Vibration

Airblast overpressure:	Recommended max: 115 dbL (in peak) for 95% of all blasts over 12 months; 120 dbL (in peak) not to be exceeded at any one time
Vibration:	Max level 5mm/s peak particle velocity (ppv); For 95% of all blasts over 12 months; 10mm/s not to be exceeded at any one time.
Timing:	0900 – 1700hrs, Mon-Sat 1 blast / day
Measurement:	At noise sensitive sites (houses, schools, hospitals etc, or within 30 m of any building)

3.7 Prohibited Substances

Source: Papua New Guinea LNG Project, Project Design Basis, PGHU-EH-BBPDB-000002, Revision 0, July 2009

Avoid the use of chemicals and hazardous materials subject to international bans or phase-outs due to their high toxicity to living organisms, environmental persistence, potential for bioaccumulation, or potential for depletion of the ozone layer, consistent with the objectives of the following:

- Stockholm Convention on Persistent Organic Pollutants
- Montreal Protocol on Substances that Deplete the Ozone Layer
- Rotterdam Convention of Prior Informed Consent for Certain Hazardous Chemicals and Pesticides in International Trade

In all such cases, utilize the use of less hazardous chemicals which are preferable from an environmental perspective.

In addition, avoid the following:

- Lead-based coatings, primers, and paints
- Lead naphthenate (lubricant)
- Leaded thread compound
- Fluorescent lights containing Mercury
- Asbestos
- Chlorinated solvents (e.g., carbon tetrachloride, 1,1,1-trichloroethane, trichloroethylene)
- Chromate corrosion inhibitors
- Heavy metals (e.g., in reverse emulsion breakers, and grit blast)

3.8 Pesticides

Source: Papua New Guinea LNG Project, Project Design Basis, PGHU-EH-BBPDB-000002, Revision 0, July 2009

Where pest management activities include the use of pesticides, the Project will select pesticides that are low in human toxicity, known to be effective against the target species, and have minimal effects on non-target species and the environment.

When the project selects pesticides, the selection will be based on whether the pesticides are packaged in safe containers, are clearly labelled for safe and proper use, and have been manufactured by an entity currently licensed by the relevant regulatory agency. The Project will design its pesticide application regime to minimize damage to natural enemies and prevent the development of resistance in pests. In addition, pesticides will be handled, stored, applied, and disposed of in accordance with the Food and Agriculture Organization's International Code of Conduct on the Distribution and Use of Pesticides or other good international industry practice.

The Project will not use products that fall in World Health Organization Recommended Classification of Pesticides by Hazard Classes 1a (extremely hazardous) and 1b (highly hazardous); or Class II (moderately hazardous), if the project host country lacks restrictions on distribution and use of these chemicals, or if such products are likely to be accessible to personnel without proper training, equipment, and facilities to handle, store, apply, and dispose of these products properly.

3.9 Hydrocarbon and Chemical Storage

Source: Papua New Guinea LNG Project, Project Design Basis, PGHU-EH-BBPDB-000002, Revision 0, July 2009

Hydrocarbon and chemical storage vessels will be of the double containment type or alternatively secondary containment will be provided in the form of impervious concrete bunds providing at least 110 percent of the largest tank capacity. In such cases filling points, vents and gauges will be located within the bunds.

Underground storage tanks for hydrocarbons and chemicals are not permitted.

All refuelling should occur within bunded areas.

3.10 Vehicle Wash Stations

Source: Papua New Guinea LNG Project, Project Design Basis, PGHU-EH-BBPDB-000002, Revision 0, July 2009

Permanent vehicle wash stations shall have a closed loop water system. All water collected at the wash station shall be filtered prior to release to the site rainwater drainage system.