APPENDIX 4

Air Emissions Standards Comparison

Purpose

This document reviews the Company's compliance against adopted international standards and guidelines.

The Table below:

- summarises key requirements of adopted international and EC standards,
- compares these with the current requirements applied to the Project,
- provides an overview of monitoring programmes, considering the adopted international and EC Standards, TEO-C and EMP, and
- provides a Comment stating the extent of compliance with the adopted international and EC Standards.

Who is this for?

This document supports the Asset/Activity HSE Managers and Environmental Specialists to determine compliance, maintain internal standards and specifications, and advise Asset/Activity Managers on relevant requirements.

Ref	Component	IFC EHS Guidelines April 2007	Project Specification	Monitoring Overview	Compliance/ Comments
GENERAL REQUIREMENTS					
1.	VOC (and benzene)	**IFC EHS General Guidelines April 2007** Implementing a leak detection and repair (LDAR) program that controls fugitive emissions by regularly monitoring to detect leaks, and implementing repairs within a predefined time period At facility level, impacts should be estimated through qualitative or quantitative assessments by the use of baseline air quality assessments and atmospheric dispersion models to assess potential ground level concentrations. Local atmospheric, climatic, and air quality data should be applied when modeling dispersion, protection against atmospheric downwash, wakes, or eddy effects of the source, nearby structures, and terrain features.	Sakhalin Energy Air Emissions and Energy Management Standard (requirement #10) requires LDAR programs to be implemented for Assets with total VOC emissions greater than 100 tons per year. Atmospheric dispersion models are developed and maintained as part of MPE applications).	Hydrocarbons (Benzene, fractions such as C1-C5 etc) in ambient air are included in Sanitary Monitoring Programs. Emissions of VOCs, Benzene and other chemicals are calculated and variously reported (as hydrocarbon fractions and specific substances) from: • fugitive leakage • tank loading • refueling stations (PMDs) • tanker loading (all tankers without vapour recovery units).	Comply

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2.	H_2S	**IFC EHS Industry Sector Guidelines April 2007 (onshore and offshore)** Limit 7 mg/m3 at ambient air. Installation of monitors set to activate warning signals. The number and location of monitors should be determined based on an assessment of plant locations prone to H2S emission and occupational exposure;	Both the Piltun-Astokhskoye (PA-A, PA-B) and Lunskoye (Lun-A) fields are "sweet" (i.e. no inherent H_2S). Notwithstanding this fact, measures to manage and detect potential souring of reservoir are implemented.	• Drilling - H_2S detector located in the shaker room in the header box signaling 7 mg/m^3 (5 ppm). No H_2S detected to date; • Production - no permanent detectors located in or around the production modules because there is currently no H_2S. In the potential event that monitoring shows that H_2S concentrations might conceivably rise to hazardous levels, portable or fixed toxic gas detectors will be provided as appropriate. Two alarm levels will be specified at 5 ppm and 10 ppm H_2S gas in air, having regard to the short term and long term exposure limits. • Trained staff shall measure H_2S (along with other gases), prior to any activities in areas where H_2S could accumulate. H_2S may also be measured in other locations such as at the bell nipple or the gas of individual wells when routed via the test separator, as appropriate to the level of risk at the time. No H2S detected to date.	Comply
3.	CFCs/Halons	"The Montreal Protocol on Substances that Deplete the Ozone Layer" as adjusted and/or amended in London 1990: Copenhagen 1992: Vienna 1995: Montreal 1997: Beijing 1999.	Sakhalin Energy Air Emissions and Energy Management Standard (requirement #11) includes the identification and inventory of Ozone Depleting Substances until they are eliminated. Sakhalin Energy is committed to eliminate HCFCs by end-of-year 2020 in accordance with the Montreal Protocol.	N/A	Comply
4.	Flaring/venting	**IFC EHS Industry Sector Guidelines April 2007 (onshore, offshore)** Continuous venting of associated gas is not considered	The Air Emissions and Energy Management Standard Appendix 1 (0000-S-90-04-O-0257-00-E) details	Flow meters are installed for all flares and BS2 vent. Totalized flow to flare tips / vent stack and totalised flare / venting emissions to air is	Comply

Ref	Component	IFC EHS Guidelines April 2007	Project Specification	Monitoring Overview	Compliance/ Comments
		current good practice and should be avoided. The associated gas stream should be routed to an efficient flare system, although continuous flaring of gas should be avoided if feasible alternatives are available. If flaring is necessary, continuous improvement of flaring through implementation of best practices and new technologies should be demonstrated. The following pollution prevention and control measures should be considered for gas flaring: • Implementation of source gas reduction measures to the maximum extent possible; • Use of efficient flare tips, and optimization of the size and number of burning nozzles; • Maximizing flare combustion efficiency by controlling and optimizing flare fuel / air stream flow rates to ensure the correct ratio of assist stream to flare stream; • Minimizing flaring from purges and pilots, without compromising safety, through measures including installation of purge gas reduction devices, flare gas recovery units, inert purge gas, soft seat valve technology where appropriate, and installation of conservation pilots; • Minimizing risk of pilot blow-out by ensuring sufficient exit velocity and providing wind guards; • Use of a reliable pilot ignition system; • Installation of high integrity instrument pressure protection systems, where appropriate, to reduce over pressure events and avoid or reduce flaring situations; • Minimizing liquid carry-over and entrainment in the gas flare stream with a suitable liquid separation system; • Minimizing flame lift off and / or flame lick; • Operating flare to control odor and visible smoke emissions (no visible black smoke); • Locating flare at a safe distance from local communities	Sakhalin Energy's commitment to no continuous flaring or venting (Requirement #6), and the Company maintains a Greenhouse Gas and Energy Management Plan (Requirement #5). Sakhalin Energy applies good industry practice and technologies in line with the IFC guidelines. For example, installation of knock out drums to remove condensate, flare metering on all facilities, and flares designed to achieve smokeless flaring during normal operations. Venting is provided only for emergency situations (e.g. from relief valves on atmospheric pressure storage tanks) or on Booster Station 2 during abnormal conditions.	reported. This data is used to calculate monthly emissions of NOx CO, CH4, Soot, and quarterly emissions of greenhouse gases.	

Ref	Component	IFC EHS Guidelines April 2007	Project Specification	Monitoring Overview	Compliance/ Comments
		and the workforce including workforce accommodation units; • Implementation of burner maintenance and replacement programs to ensure continuous maximum flare efficiency; • Metering flare gas. Emergency venting may be necessary under specific field conditions where flaring of the gas stream is not possible, or where a flare gas system is not available, such as a lack of sufficient hydrocarbon content in the gas stream to support combustion or a lack of sufficient gas pressure to allow it to enter the flare system. To minimize flaring events as a result of equipment breakdowns and plant upsets, plant reliability should be high (>95 percent) and provision should be made for equipment sparing and plant turn down protocols. Flaring volumes for new facilities should be estimated during the initial commissioning period so that fixed volume flaring targets can be developed. The volumes of gas flared for all flaring events should be recorded and reported.			
5.	Greenhouse Gases	**IFC EHS Industry Sector Guidelines April 2007 (onshore and offshore)** Significant (>100,000 tons CO2 equivalent per year) greenhouse gas (GHG) emissions from all facilities and offshore support activities should be quantified annually as aggregate emissions in accordance with internationally recognized methodologies and reporting procedures. All reasonable attempts should be made to maximize energy efficiency and design facilities for lowest energy use. The overall objective should be to reduce air emissions and evaluate costeffective options for reducing emissions that are technically feasible. Additional recommendations on the management of greenhouse gases and energy conservation are addressed in the General EHS Guidelines.	In accordance with the Sakhalin Energy Air Emissions and Energy Management Standard Appendix 1 (0000-S-90-04-O-0257-00-E), the Company maintains and implements a Greenhouse Gas and Energy Management Plan (Requirement #5) that sets targets and tracks improvement options. Greenhouse gas emissions are reported for all assets/facilities. In addition, a considerable improvement in the air quality of Sakhalin and the surrounding region should be achieved as a result of the shift from coal to dual-	Based on equipment runtime, fuel and gas consumption, and equipment specifications, quarterly greenhouse gas (GHG) emissions are calculated from equipment including combustion (power generators, gas compressors, water pumps, etc.), flares, vents, and fugitive emissions.	Comply

Ref	Component	IFC EHS Guidelines April 2007	Project Specification	Monitoring Overview	Compliance/ Comments
			fired power generation at State Power Station #1 With Sakhalin Energy's commissioning of gas transfer terminal near Yuzhno-Sakhalinsk in 2011; natural gas is now supplied to the power station.		
6.	Sulfur Dioxide	**IFC EHS Guidelines April 2007:** Combustion Facilities Emissions Guidelines, turbines (3MWth to <50 MWth), **SO2** = 0.5% S or lower % S (0.2%S) if commercially available without significant excess fuel cost Engine (3MWth to <50 MWth) liquid fuel **SO2** = 1.5 % S or up to 3.0 % S if justified by project specific considerations Boiler (3MWth to <50 MWth) liquid fuel **SO2** = 2000 mg/m3	Diesel Fuel maximum S content 0.2% (in accordance with applicable RF GOST)	Turbines and Engines: annual Stack Emission Testing if turbine works on liquid fuel. Boilers: annual Stack Emission Testing if turbine works on liquid fuel. SO2 is calculated based on fuel quality certification.	Comply
PLATFORMS					
7.	PA-B main power generators: two x 24MW Rolls Royce dual fuel (gas/diesel) turbines A-4001A/B	**Standard applicable at time of Design:** IFC Oil & Gas Development (Offshore), 2000: For offshore drilling and recovery operations the following air emission levels should be achieved: NOx = 1,000 mg/Nm3 SO2 = 400 mg/Nm3 **IFC EHS Guidelines April 2007:** Small Combustion Facilities Emissions Guidelines, turbines (15MWth to <50 MWth), Natural gas fuel (O2@15%) **NOx** = 25 ppm/ 51,3 mg/m3 Fuels other than Natural Gas (O2@15%) **NOx** = 74 ppm / 152 mg/m3	Project Specification: NO_x = 700 mg/m^3 SO_2 = 300 mg/m^3 (SO_2 based on diesel fuel containing 0.2% w/w) Equipment Technical passport (3000-T-90-29-R-2104-00-01-E02-001-00): natural gas fuel (O2@15%) NO_x = 586 mg/m^3 Diesel fuel (O2@15%) NO_x = 838 mg/m^3	Minimum Annual Stack Emission Testing: NOx and for liquid fuel SO2 Equipment runtime and fuel consumption is monitored daily and emissions are calculated in accordance with RF calculation rules, and these emissions are reported.	Complies with IFC requirements applicable at time of design and construction. Note that Deviation #2 is in place in relation to Low NOx burners.
8.	PA-B 18 MW compressor driver turbine KT-0401		Project Specification: NO_x = 700 mg/Nm^3 SO_2 = 300 mg/Nm^3		Complies with IFC requirements applicable at time of design and

Ref	Component	IFC EHS Guidelines April 2007	Project Specification	Monitoring Overview	Compliance/ Comments
			Equipment Technical passport (3000-T-04-27-R-2109-00-01-M02-001-00): Natural gas fuel (O2@15%) NO_x = 171.3 (100% load) -78.6 (25% load) ppm / 351.78– 161.4 mg/Nm^3		construction. Note that Deviation #2 is in place in relation to Low NOx burners.
9.	PA-A H.P. gas and Injection Gas compressor package Gas Turbine driven Tornado Twin Shaft 06MV7A 2 x 6.6 MW shaft power CT-0203/4X		Based on Actual Measurement results 2011: NOx 12.6 ppm / 25.8 mg/m3		Comply
10.	PA-A Turbine engine water injection pump package PT-0601A/B Dual fuel Typhoon Twin Shaft 4.9 MW		Based on Actual Measurement results 2011: PT-0601A NOx 100 ppm / 206 mg/m3 PT-0601B NOx 83 ppm / 170 mg/m3		Comply
11.	PA-A Single Shaft Typhoon DLE 4.9MW Duel fuel electric turbine generator GX-5501X	**Standard applicable at time of Design:** IFC Oil & Gas Development (Offshore), 2000: For offshore drilling and recovery operations the following air emission levels should be achieved: NOx = 1,000 mg/Nm3 SO2 = 400 mg/Nm3 **IFC EHS Guidelines April 2007:** Small Combustion Facilities Emissions Guidelines, turbines (3MWth to <15 MWth), Natural gas fuel (O2@15%) NOx = 42 ppm (Electric generation) / 86.25 mg/m3 Fuels other than Natural Gas (O2@15%) NOx = 96 ppm (Electric generation) / 197 mg/m3	Based on Actual Measurement results 2011: GX-5501X NOx 16.4 ppm / 33.68 mg/m3	Minimum Annual Stack Emission Testing: NOx and for liquid fuel SO2 Equipment runtime and fuel consumption is monitored daily and emissions are calculated in accordance with RF calculation rules, and these emissions are reported.	Comply
12.	PA-A Typhoon 5.25 MW (ISO) Turbine generator package Duel fuel GX-5511X		Based on Actual Measurement results 2011 operating on diesel: GX-5511X NOx 77.46 ppm / 159.06 mg/m3		Comply
13.	Two PA-B and two LUN-A 1.492 MW diesel fire water pump (Caterpillar 3516 TA)	IFC 2007 requirements for Small Combustion processes (systems designed to deliver electrical or mechanical power, steam, heat, or any combination of these, regardless of the	The listed equipment (left) is not included in this definition (each item is tested for 1 hour per week).Technical	Equipment runtime and fuel consumption is monitored daily and emissions are calculated in accordance with RF calculation rules, and	No applicable requirements (Historical Note: in relation to the

Ref	Component	IFC EHS Guidelines April 2007	Project Specification	Monitoring Overview	Compliance/ Comments
	with the same specification Two PA-B and one LUN-A 1.675 MW standby generator with the same specification. Model MTU 16V 396 Two PA-B and one LUN-A 0.129 MW start up diesel generator with the same specification. Model MTU 16V 396. Model MTU 6R 183 AA32 PA-B one 1.6 MW auxiliary DE model Caterpillar 3500 B PA-A: Main engine generators EG-70-001 A/B/C/D and one stand by engine generators EG-70-001 E Model Caterpillar D399 CPTAJWAC 1.67 MW	fuel type, with a total, rated heat input capacity of between 3 Megawatt thermal (MWth) and 50 MWth) are applicable only to equipment operating more than 500 hours per year, and with an annual capacity utilization of more than 30 percent.	passport: NO_x = 4.507 g/Nm^3 PM = 0.055 g/Nm^3	these emissions are reported.	IFC Offshore 2000 requirements, Deviation 2 was approved for this equipment)
14.	PA-A: PD-7502X Cuttings Injection Pump 8083-7433/8V92TA 336 kW PA-A: RG-15-023/4 2 x Cement Pump drive 235.4 kW PA-A: "Frost" Fan Heater 5pcs. x 123 kW PA-A: RE-39-001 Auxiliary Air Compressor 150 kW PA-A: RC-39-002 Green	IFC 2007 requirements for Small Combustion processes (systems designed to deliver electrical or mechanical power, steam, heat, or any combination of these, regardless of the fuel type, with a total, rated heat input capacity of between 3 Megawatt thermal (MWth) and 50 MWth) are applicable only to equipment operating more than 500 hours per year, and with an annual capacity utilization of more than 30 percent.	Equipment <3MW not included in IFC Requirements	Equipment runtime and fuel consumption is monitored daily and emissions are calculated in accordance with RF calculation rules, and these emissions are reported	No applicable requirements.

Ref	Component	IFC EHS Guidelines April 2007	Project Specification	Monitoring Overview	Compliance/ Comments
	Compressor 224 kW PA-A: RC-39-003 Yellow Compressor 53 kW PA-A: HF-87-001 Mechanical Repair Shop Heater 41 kW PA-A: GX-7350X Emergency generator 600 kW Caterpillar 3412 PA-A: LC-81-003B/C Deck Crane #2,3 294 kW PA-A: RC-63-026 Cold Start Compressor 26.5 kW PA-A: Lifeboats 5 pcs. x 26.5 kW PD-4201X Fire Pump drive 172 kW Caterpillar 3406 DITA Liebherr OM-404 PA-A: LC-81-003A Deck Crane #1 400 kW				
15.	PAA Boilers (diesel fuel): HX3760-90X HVAC System Heaters (4 p.) Capacity 1250000 kcal/hour; Dual fuel burner Model Mark IV, 1.465 MW each PAA Boilers (diesel fuel): HB-61-015A/B/C Water Glycol Heating System Boiler (3 psc.) Bryan Steam Corporation CL-300-W-FDO, 0.615 each	IFC 2007 requirements for Small Combustion processes (systems designed to deliver electrical or mechanical power, steam, heat, or any combination of these, regardless of the fuel type, with a total, rated heat input capacity of between 3 Megawatt thermal (MWth) and 50 MWth) are applicable only to equipment operating more than 500 hours per year, and with an annual capacity utilization of more than 30 percent.	Various	Equipment runtime and fuel consumption is monitored daily and emissions are calculated in accordance with RF calculation rules, and these emissions are reported	No applicable requirements.

Ref	Component	IFC EHS Guidelines April 2007	Project Specification	Monitoring Overview	Compliance/ Comments
	PAA Boilers (diesel fuel): HB-62-001A/B/C Upper Deck Steam Boiler (3 pcs.) Volcano Inc. Model 5B-100HP Capacity 1560 kg of steam/h; 981 kW PAA Boilers (diesel fuel): B-47-002 Lower Deck Boiler (2 pcs.) Capacity 1.098 MW PAA Boilers (diesel fuel): F-47-001-5 Lower Deck Heaters (5 pcs.) Capacity 212500 kcal/hour Dravo Hastings I-33404H, F-47-001-4 0.25 MW each, F-47-005 0.365 MW PAA Boilers (gas fuel): BX-3917X HVAC System H/V Burner capacity 1250000 kcal/hour G.C. Broach Company Model Maxon HC-1.5 Duct Burner, 1.5 MW				
BOOSTER STATION 2					
16.	2 Units x 26 MW Gas turbines for gas compression facilities Rolls Royce KT-0401A/B	Small Combustion Facilities Emissions Guidelines, turbines (15MWth to <50 MWth), Natural gas fuel (O2@15%) NO_x: 25 ppm/ 51,3 mg/m Particulate matter: N/A	Technical passport (5200-10507MP08101-P01-043-00-02) @ 15 %O2 NOx = 25 ppm CO = 25 ppm	Minimum Annual Stack Emission Testing: NOx and for liquid fuel SO2. Equipment runtime and fuel consumption is monitored daily and emissions are calculated in accordance with RF calculation rules, and these emissions are reported.	Comply
17.	2 Units x 6 MW Crude oil booster pump turbine driver Ural PT-8201A/B	Small Combustion Facilities Emissions Guidelines, turbines (15MWth to <50 MWth), natural gas fuel (O2@15%) NO_x: 25 ppm/ 51,3 mg/m	Technical passport (5200-2009-E02-002-01-E) @ 15 %O2 NOx = 25 ppm		Comply

Ref	Component	IFC EHS Guidelines April 2007	Project Specification	Monitoring Overview	Compliance/ Comments
		Particulate matter: N/A			
18.	3 Units x 3.3 MW Main power gas turbine driven generator GT-4002A/B/C	Small Combustion Facilities Emissions Guidelines, turbines (15MWth to <50 MWth), natural gas fuel (O2@15%) NO_x: 25 ppm/ 51,3 mg/m Particulate matter: N/A	MPA application package NOx = 50 mg/m3		Comply
19.	3 Units x 1.32 MW emergency diesel generator QSK60-G4 (Cummins) GD-4001A/B/C (tested 20 minutes per week)	IFC 2007 requirements for Small Combustion processes (systems designed to deliver electrical or mechanical power, steam, heat, or any combination of these, regardless of the fuel type, with a total, rated heat input capacity of between 3 Megawatt thermal (MWth) and 50 MWth) are applicable only to equipment operating more than 500 hours per year, and with an annual capacity utilization of more than 30 percent.	Various	Equipment runtime and fuel consumption is monitored daily and emissions are calculated in accordance with RF calculation rules, and these emissions are reported	No applicable requirements.
PIPELINE (PMD, BVS, PIG TRAPS)					
20.	BVS 104 Units Gas fired power generator 0.16 MW Pig traps 4 Units Gas fired power generator 0.07 MWBVS 40 Units Diesel power generator 10kW MW Yanmar-3TNV 88-GGEP PMD Nogliky 3 Units x 400 kW 2 main and 1 stand by PMD Gastello 2 Unit x 400 kW 1 main and 1 stand by PMD Yasnoe 3 Units x 400 kW 2 main and 1 stand by PMD OPF 2 Unit x 400 kW 1 main and 1 stand by PMD Sovetskoe 3 Units x 400 kW 2 main and 1 stand	IFC 2007 requirements for Small Combustion processes (systems designed to deliver electrical or mechanical power, steam, heat, or any combination of these, regardless of the fuel type, with a total, rated heat input capacity of between 3 Megawatt thermal (MWth) and 50 MWth) are applicable only to equipment operating more than 500 hours per year, and with an annual capacity utilization of more than 30 percent.	Various	Equipment runtime and fuel consumption is monitored daily and emissions are calculated in accordance with RF calculation rules, and these emissions are reported.	No applicable requirements.

Ref	Component	IFC EHS Guidelines April 2007	Project Specification	Monitoring Overview	Compliance/ Comments
	by				
GAS TRANSFER TERMINALS NORTH AND SOUTH					
21.	3 Units x Gas engine 80 kW GTT North 2 Units x Gas engine 80 kW GTT South	IFC 2007 requirements for Small Combustion processes (systems designed to deliver electrical or mechanical power, steam, heat, or any combination of these, regardless of the fuel type, with a total, rated heat input capacity of between 3 Megawatt thermal (MWth) and 50 MWth) are applicable only to equipment operating more than 500 hours per year, and with an annual capacity utilization of more than 30 percent.	Various	Equipment runtime and fuel consumption is monitored daily and emissions are calculated in accordance with RF calculation rules, and these emissions are reported	No applicable requirements.
ONSHORE PROCESSING FACILITY (OPF)					
22.	OPF Main Power Generation Package (Hitachi) – 2 x 25 MW Gas Turbines; 2 x 25 MW Dual Fuel (Gas/Diesel) Turbines.	Small Combustion Facilities Emissions Guidelines, turbines (15MWth to <50 MWth), natural gas fuel (O2@15%) NO_x: 25 ppm/ 51,3 mg/m3 Fuels other than Natural Gas (O2@15%) NOx = 74 ppm / 152 mg/m3	Based on Technical Passport: With IGV/ IBH system Gas fuel: 100% load NOx 25 ppm / under 50 mg/m3 55% load NOx 50 mg/m3 Diesel fuel 100% load NOx 520 mg/m3	Minimum Annual Stack Emission Testing: NOx and for liquid fuel SO2 Equipment runtime and fuel consumption is monitored daily and emissions are calculated in accordance with RF calculation rules, and these emissions are reported	Comply, with the exception of NO_x emissions for the one turbine that uses diesel oil (this turbine only very infrequently operates on diesel). See Justification for Deviation 3 below.
23.	OPF Main Standby Generation Package (Sakhalin Machinery/Caterpillar D3612) – 2 No. 3.7 MW Power Output Diesel Generators OPF Fire Water Pumps Package (Flowserve/Worthington SPA) – 1 No. 480 KW Caterpillar Diesel Engine 3508 DITA OPF Standby	IFC 2007 requirements for Small Combustion processes (systems designed to deliver electrical or mechanical power, steam, heat, or any combination of these, regardless of the fuel type, with a total, rated heat input capacity of between 3 Megawatt thermal (MWth) and 50 MWth) are applicable only to equipment operating more than 500 hours per year, and with an annual capacity utilization of more than 30 percent.	This equipment is not included in this definition (operates approximately 200 hours per year). Generators shall be used during emergency or abnormal events; however, they shall be operated between 1-4 hours per week for testing purposes only.	Equipment runtime and fuel consumption is monitored daily and emissions are calculated in accordance with RF calculation rules, and these emissions are reported	No applicable requirements.

Ref	Component	IFC EHS Guidelines April 2007	Project Specification	Monitoring Overview	Compliance/ Comments
	Generation Package Administrative building (Sakhalin Machinery/Caterpillar 3512) –1.12 MW Power Output Diesel Generator OPF Standby Generation Package Administrative building 2 x C32TA –0.88 MW Power Output Diesel Generators				

Ref	Component	IFC EHS Guidelines, April 2007	EC Standards	Project Specification	Monitoring overview	Compliance/Comments
PRIGORODNOYE COMPLEX						
24.	GE Frame 5 main power generators: 5 units, 25.8 MW_e @ 7°C GE gas fuel generators Nuovo Pignone	Small Combustion Facilities Emissions Guidelines, turbines (15MWth to <50 MWth), natural gas fuel (O2@15%) NO_x: 25 ppm/ 51,3 mg/m		Technical passport data @15%O2 NOx 50 mg/m3	Minimum Annual Stack Emission Testing: NOx Equipment runtime and fuel consumption is monitored continuously (indicative monitoring) and emissions are calculated in accordance with RF calculation rules, and these emissions are reported.	Comply
25.	GE Frame 7: 4 units, 93.3 MW compressor driver	**IFC ESH Industry Sector Guidelines Thermal Power Plant (April 2007)** **Combustion turbine natural gas fuel (>50MWth)** NO2: 25 ppm / 51 mg/Nm3 (15% O2 dry) IFC EHS Guidelines for Thermal Power (Table 7) requires continuous or indicative monitoring for plant 50MW or greater.	**LCP Directive (2001/80/EC)** Thermal input >50 MW NO2 ANNEX IV NO2: 50 mg/Nm^3 (15% O2 and above 70% load) (natural gas). NO2: 75 mg/Nm^3 (15% O2 turbines for mechanical drive) (natural gas).	Technical passport data @15%O2 NOx 50 mg/m3 Soot 5 mg/m3	Minimum Annual Stack Emission Testing: NOx Equipment runtime and fuel consumption is monitored continuously (indicative monitoring) and emissions are calculated in accordance with RF calculation rules, and these emissions are reported.	Comply

Ref	Component	IFC EHS Guidelines, April 2007	EC Standards	Project Specification	Monitoring overview	Compliance/Comments
			NO2: 120 mg/Nm^3 (15% O2) (liquid fuel). SO2 ANNEX V SO2: 35 mg/Nm^3 (3% O2 dry) for gaseous fuels. Dust ANNEX VII Dust: 5 mg/Nm^3 (gaseous fuel). Dust: 50 mg/Nm^3 (liquid fuels).			
26.	2 units, 642 KW (ISO Gross) diesel-driven fire water pump (tested one hour per week) Caterpillar 3412 DITTA 2 units, 3.2 MWe diesel driven emergency standby generators (tested one hour per week) Caterpillar 3612 DITA 1 unit, 485 KW (ISO Gross) diesel driven emergency air compressor (tested one hour per week) Caterpillar 3412E DITA	IFC 2007 requirements for Small Combustion processes (systems designed to deliver electrical or mechanical power, steam, heat, or any combination of these, regardless of the fuel type, with a total, rated heat input capacity of between 3 Megawatt thermal (MWth) and 50 MWth) are applicable only to equipment operating more than 500 hours per year, and with an annual capacity utilization of more than 30 percent.		Various	Equipment runtime and fuel consumption is monitored daily and emissions are calculated in accordance with RF calculation rules, and these emissions are reported	No applicable requirements.
27.	3 Units B-9001 A/B/C Burner for Boiler Package Space Heating (A-9000 / BLD-	IFC 2007 requirements for Small Combustion processes (systems designed to deliver electrical or mechanical power, steam, heat, or		Technical passport Gas fuel NOx@15O2 150 mg/m3 CO 63 mg/m3	Equipment runtime and fuel consumption is monitored daily and emissions are calculated in accordance with RF calculation rules, and these emissions are	No applicable requirements.

Ref	Component	IFC EHS Guidelines, April 2007	EC Standards	Project Specification	Monitoring overview	Compliance/Comments
	12 / SH-12) dual fuel burners/furnaces GKP 280M 2.5 MW each 1 Unit B-9002 Burner for Boiler Package Space Heating (A-9000 / BLD-12 / SH-12) dual fuel burners/furnaces GKP 90H 1 MW 2 Units B-9011A/B Burner for Space Heating Boiler of Controlled Discharge Facility (A-9011 / SH-13) dual fuel burners/furnaces GKP 140H (2x)1.25 MW each 2 Units B-9021 A/B Burner for Boiler Package OET/ETP Building (A-9021 / SH-19) dual fuel burners/furnaces GKP 80H (2x) 0.6 MW 2 Units Marine Administrative building F-4501 A/B 0.35 MW	any combination of these, regardless of the fuel type, with a total, rated heat input capacity of between 3 Megawatt thermal (MWth) and 50 MWth) are applicable only to equipment operating more than 500 hours per year, and with an annual capacity utilization of more than 30 percent.		PM 10 kg/hr Diesel fuel NOx@25O2 150 mg/m3 CO 63 mg/m3 PM 35 kg/hr SO2 1000 mg/m3	reported	
28.	1 Unit F-4101 Stand-by HTF Furnace Enviromix 315FD 5.5 MW	Small combustion facilities (boilers gas fuel): Gas fuel O2@3% NOx = 320 mg/m3		Technical passport Gas fuel NOx@15O2 150 mg/m3	Equipment runtime and fuel consumption is monitored daily and emissions are calculated in accordance with RF calculation rules, and these emissions are reported	Comply
29.	1 Unit Acid gas	Small combustion facilities (boilers		Technical passport @ 3% O2	Equipment runtime and fuel consumption	Comply

Ref	Component	IFC EHS Guidelines, April 2007	EC Standards	Project Specification	Monitoring overview	Compliance/Comments
	incinerator NFK BF-18 (burner) 20.3 x 10^6 kcal/h 23.6 MW	gas fuel): Gas fuel O2@3% NOx = 320 mg/m3		NOx 150 mg/m3	is monitored daily and emissions are calculated in accordance with RF calculation rules, and these emissions are reported	

Ref	Location	IFC EHS Guidelines, April 2007	EC Standards	Project Specification	Compliance/Comments
AMBIENT AIR QUALITY					
30.	Ambient Air Quality Standards for all sites	Guidelines for air quality, WHO (2005): PM_{10}: 24-hr average 50 µg/m^3 CO: 8-hr average, max rolling: 10000 µg/m^3 NO_2: hourly average 200 µg/m^3 SO_2: 24-hr average 125 µg/m^3 PM_{10}: 24-hr average 125 µg/m^3 TSP: 24-hr average 150-230 µg/m^3 Black smoke: 24-hr average: 120 µg/m^3	96/62/EC 11.06.2008 Framework Directive on Ambient Air Quality Assessment and Management (and 99/30/EC 11.06.2008, 00/69/EC 11.06.2008) NO_2: annual average (2010) 40 µg/m^3 NO_2: hourly average, not to be exceeded more than 18 times per calendar year (2010) 200 µg/m^3 CO: 8-hr average, max rolling: 10000 µg/m^3 SO_2: 24-hr average 125 µg/m^3 (not to be exceeded more than 3 times per calendar year) PM_{10}: 24-hr average 50 µg/m^3, not to be exceeded more than 35 times per year (2005). Benzene: The limit value is 5 µg/m^3 (as from 1 January 2010).	Russian air quality standards refer to maximum allowable concentrations (MAC) which are expressed as a single maximum (20 minute sample) and as a daily average value (20 minute samples repeated 3 or 4 times per day). GN 2.1.6.695-98 CO: 5,000 µg /m^3 (20-mins); 3,000 µg /m^3 (24-hrs) SO_2: 500 µg /m^3 (20-mins); 50 µg /m^3 (24-hrs) NO_2: 85 µg /m^3 (20-mins); 40 µg /m^3 (24-hrs) NO: 400 µg /m^3 (20-mins); 60 µg /m^3 (24-hr) Hydrocarbons C12-C19: 1000 µg/m^3 (20-mins) Dust: 500 µg /m^3 (20-mins) PM_{10} / Soot: 150 µg /m^3 (20-mins); 50 µg /m^3 (24-hrs)GN 2.1.6.695-98 Safe reference levels of impact Hydrocarbons C1-C5: 0.050 µg/m^3 Hydrocarbons C6-C10 0.030 µg /m^3	In relation to ambient air quality standards (as opposed to emissions), the RF MPCs are difficult to fully compare with the IFC/WHO standards as they are framed in different time averaging periods. However, generally the RF MPCs are equivalent to or more stringent than the WHO/IFC standards for the main combustion products (the only minor exception is the short-term SOx standard which is 500ug/m3 for both RF and WHO, but where the MPC is a 20 min time average and the WHO is a 10min average). Ambient Air Monitoring is included in the separate Sanitary Monitoring Programme (refer HSE Monitoring Overview).

JUSTIFICATION FOR DEVIATION 1: NO_x EMISSIONS FROM PLATFORM PA-A

Specification

PA-A platform has the following turbine units operational and fitted with low NO_x burners:

- Typhoon generator turbine (GT-5501X – dual fuel)
- Tornado HP compressor turbine (CT-0203X- gas only)
- Tornado IP Compressor Turbine (CT-0204X- gas only).

The low NO_x burners were installed circa 1998 when PA-A entered Russian waters.

PA-A platform, however, has the following turbine units operational but not fitted with low NO_x burners:

- Typhoon water injection turbine (PT-0601A- dual fuel)
- Typhoon water injection turbine (PT-0601B – dual fuel)
- Typhoon power generation turbine (GT-5511X- dual fuel).

The non-low NO_x equipment was installed as part of PMP in 2003.

Design, installation and running of the above is as approved by the relevant Russian authorities (Ministry of Natural Resources, the Ministry of Health and Gostgortechnadzor).

Rationale

The primary reasons for not incorporating low NO_x generators for all PA-A turbines are set out below:

- Low NO_x systems currently available in the market in the required power ratings are not fully reliable at part load conditions, causing output power instability and other operational problems, for example, starting problems when running on liquid fuel
- Turbine drives for the PA-A generator sets and water-flood sets need to be operated on both gas and diesel, since no gas is available during winter closed season
- Given the importance of water injection to sustained PA-A production and the high up-time required, non-low NO_x equipment was deemed unsuitable
- With the move to year round production (completion of the PA-A Tie-In project during 2006) equipment shall run principally on clean, lean natural gas.

Characteristics of Low NO_x Combustion Systems

- High sensitivity to variations in fuel quality (LHV and Wobbe index) leading to flame-out, especially when operating at part load when running on liquid fuel
- Low availability problems confirmed by majority of operators (source Gas Turbine Users Conferences) and actual PA-A experience when operating low NO_x burners
- Higher system complexity (hardware, software and controls) and resultant higher maintenance requirements (e.g. frequent burner change outs on liquid fuel).

In summary, low NO_x machines are more complex with respect to equipment and software and they are more unreliable to operate. The experienced problems are greater with resultant poor up-time.

JUSTIFICATION FOR DEVIATION 2: NO_x EMISSIONS FROM PLATFORM PA-B

Specification

PA-B platform has two power generators: 2 x 24MW of electrical power output dual fuel (gas/diesel) Rolls Royce RB211 turbine driven (fitted with waste heat recovery).

The power generators are standard engines without low NO_x burners, but have the capability for future retrofitting low NO_x burners. The emission limits for NO_x emissions from the turbines are defined in the Project Specific Technical specification (PSTS) Number 11, which was approved by the relevant Russian authorities (Ministry of Natural Resources, the Ministry of Health and Gostgortechnadzor).

Two PA-B and LUN-A 1.5 MW diesel fire water pumps (item 10) and two PA-B 1.6 MW standby generators (item 11) are also tested weekly.

Rationale

The primary reasons for not incorporating low NO_x generators on PA-B are set out below:

- Gas turbines shall be operated at part load conditions, which shall vary over the life of the platforms;
- Low NO_x systems currently available in the market in the required power ratings are not fully effective at part load conditions, causing instability and other operational problems;
- Turbine drives for the PA-B generator sets need to be operated on both gas and liquid condensate. There are no dual fuel gas turbines in the market with low NO_x combustion systems rated at the required power;
- It should be noted that we did specify the requirement for the turbines to include provisions for future retrofit of low NO_x systems (if, and when, required).

Characteristics of low NO_x combustion systems

- High sensitivity to variations in fuel quality (LHV and Wobbe index) leading to flame-out, especially when operating at part load
- Low availability problems confirmed by majority of operators (source Gas Turbine Users Conferences) and as experienced on PA-A low NO_x turbines (consequently, the additional generator set was ordered for PA-A with a conventional combustion system, i.e. without the low NO_x)
- Higher system complexity (hardware and software) and resultant higher maintenance requirements
- Testing of the turbine at the manufacturer's works does not employ the actual fuel gas utilised at site, so considerable time is required to tune the systems once the turbines are *in situ*
- Considerably higher CAPEX (circa US$6million total for three low NO_x turbines on PA-B).

PA-B Main Generator sets

There were no suitable dual fuel gas turbines with low NO_x combustion systems available on the market at the time of platform design and construction.

PA-B export compressor

The unit (gas fuel only) was designed based on operation at 69% of the General Electric LM2500 gas turbine rated load. The following is a comparison of NOx emissions between conventional and Low NOx versions of LM2500 gas turbines (data when running at a load of 14 MW):

Ambient Temp °C	-12	18	34
Conventional (as purchased) NOx dry ppmv	108.4	114.8	92
DLE unit NOx dry ppmv	40	40	25

At the time of dasign PA-B 18 MW compressor driven turbine KT-0401 was specified to meet requirements applicable at that (IFC 200). It is not practicable to modify this equipment hence deviation is in place.

JUSTIFICATION FOR DEVIATION 3: NOx EMISSIONS FROM OPF (Turbines, Row 22)

Normal operation comprises four turbines running continually on gas (variable load subject to demand). . The specification for the turbines included Dry Low NO_x Burners, together with Inlet Guide Vanes (IGV) and Inlet Bleed Heating (IBH); these measures shall ensure that NO_x emissions remain below 50 mg/m^3 whilst operating in the 55-100% load range.

They must be of a fully proven design in order to assure the safety of operations. The dual fuel turbines shall only operate with diesel fuel during emergency or abnormal situations. Minimum requirement is that all units shall be tested monthly. In these instances NO_x emissions shall exceed the emission standards given above. Emission concentrations expected in these situations shall be in the range 400 – 1000 mg/m^3.

Further emission control systems were evaluated, notably water quenching, but this would require water injection at a rate of 7 tonnes/hr, which would reduce NO_x emissions to between 150 – 200 mg/m^3. As diesel fuel shall only be used during abnormal situations, this option was not incorporated within the design. Other important factors considered also were the need to conserve local water resources. The emissions are industry standard for these types of engines; the project equipment and plant selection is in line with normal oil and gas industry practice.