ANNEX F INVESTIGATION REPORT

Investigation Report of CEMS Exceedances	
Date	1 – 30 November 2024
Time	Continuous Monitoring throughout November 2024
Monitoring Location	Continuous Environmental Monitoring Systems (CEMS)
Parameter	Various emission parameters of the Centralised Air Pollution Control Unit (CAPCS), Cogeneration Units (CHPs), Ammonia Stripping Plant (ASP), and the Standby Gas Flaring Unit.
Exceedance Description	Continuous monitoring was carried out at the CAPCS, CHPs, and ASP throughout the reporting period using the CEMS. According to the EM&A Manual, an exceedance is considered if the emission concentration of the concerned pollutants is higher than the emission limits stated in Tables 2.2, 2.3, 2.4, and 2.5 of the EM&A Manual (Version F) for the CAPCS, CHPs, Standby Flare, and ASP respectively. The concentrations of the concerned air pollutants were monitored on-line by the CEMS. Exceedances of various emission parameters were recorded on the CEMS including: • VOCs and Total Odour from CAPCS; • NO_x and SO_2 from CHP1; • NO_x and SO_2 from CHP2; • NO_x, SO_2, and HCl from CHP3; • NO_x, SO_2, NH_3, and HCl from the ASP; and • Dust, CO, NO_x, SO_2, VOCs, HCl, and HF from the Standby Gas Flaring Unit. The Contractor has investigated the cause of the exceedances and identified that: • The exceedances of VOCs and Total Odour from CAPCS occurred due to issues with the sensor, and the Contractor is working on an improvement. • The exceedances of NO_x and SO_2 from CHP1 were caused by system instability, the Contractor has identified that the exceedances may be attributed to the frequent stopping/ starting of the system. • The exceedances of NO_x and SO_2 from CHP2 were caused by system instability, the Contractor has identified that the exceedances may be attributed to the frequent stopping/ starting of the system. • The exceedances of NO_x, SO_2, and HCl from CHP3 were caused by system instability, the Contractor has identified that the exceedances may be attributed to the frequent stopping/ starting of the system. • Regarding the SO_2 exceedances from the CHPs in previous monthly EM&A reports, SO_2 sampling and testing was completed by a third-party laboratory that showed lower SO_2 values than those reported by the CEMS. The lower values measured by the laboratory was

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	attributed to methane gas interference. Based on this study, it was proposed to implement a correction factor in the CEMS to adjust for the methane gas interference. After review by MT and IEC, the correction factor was implemented on 17 May 2024. • The various exceedances from the ASP can be attributed to the frequent starting and stopping of the system which has been causing unstable process conditions during operation. • The exceedances of Dust, CO, NO_x, SO_2, VOCs, HCl, and HF from the Standby Gas Flaring Unit occurred due to start-up issues and the flare not operating at the working temperature.
Action Taken / Action to be Taken	The Contractor investigated the reason for the exceedances and arranged Remedial Works and Follow-up Actions (see below).
Remedial Works and Follow-up Actions	The Remedial Works and Follow-up Actions to be implemented by the Contractor to address the above exceedances (as well as updates on any exceedances from recent months) are detailed in the following table below.

Monitoring Location	Measures/ Actions to Address any Exceedances	Implementation Timeline & Status
Centralised Air Pollution Unit (CAPCS)	• To address the exceedances for Total Odour (ou/Nm^3) recorded in January 2024 – February 2024, the Contractor ordered a new H_2S / ORP sensor to replace the faulty one which was installed on 23 May 2024. • The cleaning of the ventilation pumps was conducted in April 2024. • The Contractor further identified that the ongoing exceedances for Total Odour and VOCs from August 2024 – November 2024 were caused by chemical pipeline leakage, sensor issues, and the inefficiency of the chemical scrubber. • Fine-tuning measures and adjustment in the operation of the system were implemented in October 2024. • An enclosure has been set up to protect the VOC and H_2S sensors, and an ozone deodorization unit has been installed as of November 2024.	• The Contractor will repair the leakage in the chemical pipeline and clean the chemical scrubber in January 2025.
Cogeneration Unit 1 (CHP 1)	• To address the ongoing NO_x exceedances recorded from October 2023 – November 2024, the Contractor ordered 3 new cylinder heads from the supplier to replace the old ones and improve performance which were installed in May 2024. • To address the SO_2 exceedances recorded from October 2023 – June 2024, August 2024, and November 2024, SO_2 sampling and testing was completed by a third-party laboratory that showed lower SO_2 values than those reported by the CEMS. The lower values	• The Contractor will receive additional training in December 2024. • Contractor ordered spare parts for the CHPs which expect to be delivered in December 2024. • The Contractor will complete the cleaning of silicon deposits on

Monitoring Location	Measures/ Actions to Address any Exceedances	Implementation Timeline & Status
	measured by the laboratory was attributed to methane gas interference. Based on this study, it was proposed to implement a correction factor in the CEMS to adjust for the methane gas interference. After review by MT and IEC, the correction factor was implemented in May 2024. • The fine-tuning measures were implemented during May 2024, and a further tuning was carried out on 12 August 2024. • To address the HCl exceedances recorded from October 2023 – April 2024, July 2024, and September – October 2024, the Contractor implemented in May 2024 fine tuning measures such as reviewing the ignition temperature curve, spark plug condition check and adjusting the intake & exhaust valves on the cylinder to reduce the fluctuations in HCl emissions and keep within the permissible limit. • A CHP expert from Europe visited the ORRC1 facility in August 2024 to review the performance of the CHPs and recommended various spare parts be replaced. • The Contractor will receive additional advanced training from the manufacturer for the operation and maintenance of the equipment. • The Contractor identified that a buildup of silicon deposits on the cylinder heads of the CHPs is preventing the engines from reaching full loading and will require cleaning to resolve.	the cylinder heads and the exhaust heat exchanger replacement works by Q1 2025.
Cogeneration Unit 2 (CHP 2)	• To address the ongoing NO_x exceedances recorded from October 2023 – October 2024, fine tuning of CHP 2 such as reviewing the ignition temperature curve, spark plug condition check and adjusting the intake & exhaust valves on the cylinder was conducted in May 2024 to reduce the fluctuations in NO_x emissions and to keep within the permissible limit. • To address the SO_2 exceedances recorded from October 2023 – April 2024, SO_2 sampling and testing was completed by a third-party laboratory that showed lower SO_2 values than those reported by the CEMS. The lower values measured by the laboratory was attributed to methane gas interference. Based on this study, it was proposed to implement a correction factor in the CEMS to adjust for the methane gas interference. After review by MT and IEC, the correction factor was implemented in May 2024. • To address the HCl exceedances recorded from November 2023 and April 2024, the Contractor implemented fine tuning measures such as reviewing the ignition temperature curve, spark plug condition check and adjusting the intake & exhaust valves on the	• The Contractor is waiting for parts delivery to conduct remedial works and will also receive additional training in December 2024. • The Contractor will complete the cleaning of silicon deposits on the cylinder heads and the exhaust heat exchanger replacement works by Q1 2025.

Monitoring Location	Measures/ Actions to Address any Exceedances	Implementation Timeline & Status
	cylinder to reduce the fluctuations in HCl emissions and keep within the permissible limit. • A CHP expert from Europe visited the ORRC1 facility in August 2024 to review the performance of the CHPs and recommended various spare parts be replaced. • A further tuning was carried out for the CHP on 12 August 2024. • The Contractor will receive additional advanced training from the manufacturer for the operation and maintenance of the equipment. • The Contractor identified that a buildup of silicon deposits on the cylinder heads of the CHPs is preventing the engines from reaching full loading and will require cleaning to resolve.	
Cogeneration Unit 3 (CHP 3)	• To address the ongoing NO_x exceedances, fine tuning measures of CHP 3 were implemented in May 2024 such as reviewing the ignition temperature curve, spark plug condition check and adjusting the intake & exhaust valves on the cylinder to reduce the fluctuations in NO_x emissions and to keep within the permissible limit. • To address the SO_2 exceedances recorded from October 2023 – April 2024, SO_2 sampling and testing was completed by a third-party laboratory that showed lower SO_2 values than those reported by the CEMS. The lower values measured by the laboratory was attributed to methane gas interference. Based on this study, it was proposed to implement a correction factor in the CEMS to adjust for the methane gas interference. After review by MT and IEC, the correction factor was implemented in May 2024. • A further tuning was carried out on 12 August 2024. • A CHP expert from Europe visited the ORRC1 facility in August 2024 to review the performance of the CHPs and recommended various spare parts be replaced. • The Contractor will receive additional advanced training from the manufacturer for the operation and maintenance of the equipment. • The Contractor identified that a buildup of silicon deposits on the cylinder heads of the CHPs is preventing the engines from reaching full loading and will require cleaning to resolve.	• The Contractor is waiting for parts delivery to conduct remedial works and will also receive additional training in December 2024. • The Contractor will complete the cleaning of silicon deposits on the cylinder heads and the exhaust heat exchanger replacement works by Q1 2025.
Ammonia Stripping Plant (ASP)	• To address the ongoing NO_x exceedances recorded from October 2023 – November 2024, the Contractor conducted an overhaul of the ASP and arranged for a visit by the supplier to improve the reliability and	• The Contractor has arranged the visit with the supplier to inspect the ASP in December 2024.

Monitoring Location	Measures/ Actions to Address any Exceedances	Implementation Timeline & Status
	performance of the system. The overhaul was completed 6 May 2024. • To address the ongoing SO_2 exceedances recorded from October 2023 – November 2024, SO_2 sampling and testing was completed by a third-party laboratory that showed lower SO_2 values than those reported by the CEMS. The lower values measured by the laboratory was attributed to methane gas interference. Based on this study, it was proposed to implement a correction factor in the CEMS to adjust for the methane gas interference. After review by MT and IEC, the correction factor was implemented in May 2024. • To address the ongoing NH_3 exceedances recorded from October 2023 – November 2024, the Contractor conducted an overhaul of the ASP and arranged for a visit by the supplier. • To address the HCl exceedances recorded from October 2023 – May 2024 and August 2024 – November 2024, the Contractor conducted an overhaul of the ASP and arranged for a visit by the supplier. • The automatic situation of the TCU louvres has been resolved as of October 2024.	• The Contractor will also implement further fine-tuning measures in December 2024.

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