ANNEX F INVESTIGATION REPORT

Investigation Report of CEMS Exceedances	
Date	1 – 31 October 2024
Time	Continuous Monitoring throughout October 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: • Total Odour from CAPCS; • NO_x and HCl from CHP1; • NO_x from CHP2; • NO_x from CHP3; • NO_x, SO_2, NH_3, and HCl from the ASP; • HF from the Standby Gas Flaring Unit The Contractor has investigated the cause of the exceedances and identified that: • In the previous monthly EM&A report (September 2024), explanation for exceedances of VOCs and Total Odour identified at the CAPCS were still pending as at the date of report submission. After investigation, the Contractor found these exceedances (which continued into October 2024) were caused by issues with the sensors and are working on an improvement. • The exceedances of NO_x and HCl and from the CHPs; NO_x, SO_2, NH_3, and HCl from the ASP occurred due to system instability. • Regarding the NO_x and HCl exceedances from CHP1, the Contractor has identified that the exceedances may be attributed to the frequent stopping/ starting of the system. • Regarding the NO_x exceedances from CHP2, the Contractor has identified that the exceedances may be attributed to the frequent stopping/ starting of the system. • Regarding the NO_x exceedances from CHP3, the Contractor has identified that the exceedances may be attributed to the frequent stopping/ starting of the system.

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	• 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 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 HF exceedances from the Standby Gas Flaring Unit were caused by 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 and August 2024 – October 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 will implement fine-tuning measures and adjustment in the operation of the system in October 2024.
Cogeneration Unit 1 (CHP 1)	• To address the ongoing NO_x exceedances recorded from October 2023 – October 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 and August 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.	• The new cylinder heads were installed in May 2024, and further works are ongoing. • The updated SO_2 correction factor was implemented on 17 May 2024. • The fine-tuning measures were implemented during May 2024. • The CHP expert visited in from 20-24 May 2024 and report submitted in June 2024; Contractor reviewed the report from July 2024 and ordered spare parts

Monitoring Location	Measures/ Actions to Address any Exceedances	Implementation Timeline & Status
	• 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 from 20-24 May to review the performance of the CHPs. • The Contractor will receive additional advanced training from the manufacturer for the operation and maintenance of the equipment. • The Contractor will continue additional maintenance works for the CHPs during the coming month.	expected to arrive in December 2024. • A further tuning was carried out for the CHP on 12 August 2024. • The Contractor will receive additional training in December 2024.
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 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 cylinder to reduce the fluctuations in HCl emissions and keep within the permissible limit. • A CHP expert from Europe visited the ORRC1 facility in May 2024 to review the performance of the CHPs. • The Contractor will receive additional advanced training from the manufacturer for the operation and maintenance of the equipment. • The Contractor will continue additional maintenance works for the CHPs during the coming month.	• The fine-tuning measures were implemented in May 2024, and further works are ongoing. • The updated SO_2 correction factor was implemented on 17 May 2024. • The CHP expert visited in from 20-24 May 2024 and report submitted in June 2024; Contractor reviewed the report from July 2024 and ordered spare parts expected to arrive in December 2024. • A further tuning was carried out for the CHP on 12 August 2024. • The Contractor will also receive additional training in December 2024.

Monitoring Location	Measures/ Actions to Address any Exceedances	Implementation Timeline & Status
Cogeneration Unit 3 (CHP 3)	• To address the ongoing NO_x exceedances, fine tuning measures of CHP 3 were implemented such as reviewing the ignition temperature curve, spark plug condition check and adjusting the intake & exhaust valves on the cylinder is being conducted 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 CHP expert from Europe visited the ORRC1 facility in May 2024 to review the performance of the CHPs. • The Contractor will receive additional advanced training from the manufacturer for the operation and maintenance of the equipment. • The Contractor will continue additional maintenance works for the CHPs during the coming month.	• The fine-tuning measures were implemented in May 2024, and further works are ongoing. • The updated SO_2 correction factor was implemented on 17 May 2024. • The CHP expert visited in from 20-24 May 2024 and report submitted in June 2024; Contractor reviewed the report from July 2024 and ordered spare parts expected to arrive in December 2024. • A further tuning was carried out for the CHP on 12 August 2024. • The Contractor will also receive additional training in December 2024.
Ammonia Stripping Plant (ASP)	• To address the ongoing NO_x exceedances recorded from October 2023 – October 2024, the Contractor conducted an overhaul of the ASP and arranged for a visit by the supplier to improve the reliability and performance of the system. • To address the ongoing SO_2 exceedances recorded from October 2023 – October 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 – October 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 – October 2024, the Contractor conducted an overhaul of the ASP and arranged for a visit by the supplier. • To address the ongoing exceedances and loss of control of the louvres for the Thermal Combustion Unit (TCU), the Contractor	• The overhaul of the ASP was completed 6 May 2024. • The supplier could not visit in June 2024 as planned and was planned to be rescheduled; however, the Contractor identified the problem to fix before the rescheduled visit. • The updated SO_2 correction factor was implemented on 17 May 2024.

Monitoring Location	Measures/ Actions to Address any Exceedances	Implementation Timeline & Status
	approached the Supplier to remedy the situation, but was able to identify and fix the issue on their own in October 2024.	

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