JCM Verification Report Form

A. Summary of verification

A.1. General Information

Title of the project	Introduction of High Efficiency Electrolyzer in Chlor-Alkali Production Plant
Reference number	SA001
Monitoring period	25/01/2017 – 31/08/2018
Date of completion of the monitoring report	06/02/2019
Third-party entity (TPE)	Lloyd's Register Quality Assurance Limited (LRQA)
Project participant contracting the TPE	Kanematsu Corporation
Date of completion of this report	25/02/2019

A.2 Conclusion of verification and level of assurance

Overall verification opinion	☒ Positive ☐ Negative
☒ Unqualified opinion	Based on the process and procedure conducted, *Lloyd's Register Quality Assurance Limited (LRQA)* (TPE's name) provides reasonable assurance that the emission reductions for *Introduction of High Efficiency Electrolyzer in Chlor-Alkali Production Plant* (project name) ✓ Are free of material errors and are a fair representation of the GHG data and information, and ✓ Are prepared in line with the related JCM rules, procedure, guidelines, forms and other relevant documents
(If overall verification opinion is negative, please check below and state its reasons.) ☐ Qualified Opinion ☐ Adverse opinion ☐ Disclaimer	<State the reasons> Not applicable

A.3. Overview of the verification results

Item	Verification requirements	No CAR or CL remaining
The project	The TPE determines the conformity of the actual	☒

Item	Verification requirements	No CAR or CL remaining
implementation with the eligibility criteria of the applied methodology	project and its operation with the eligibility criteria of the applied methodology.	
The project implementation against the registered PDD or any approved revised PDD	The TPE assesses the status of the actual project and its operation with the registered/validated PDD or any approved revised PDD.	☒
Calibration frequency and correction of measured values with related requirements	If monitoring Option C is selected, the TPE determines whether the measuring equipments have been properly calibrated in line with the monitoring plan and whether measured values are properly corrected, where necessary, to calculate emission reductions in line with the PDD and Monitoring Guidelines.	☒
Data and calculation of GHG emission reductions	The TPE assesses the data and calculations of GHG emission reductions achieved by/resulting from the project by the application of the selected approved methodology.	☒
Avoidance of double registration	The TPE determines whether the project is not registered under other international climate mitigation mechanisms.	☒
Post registration changes	The TPE determines whether there are post registration changes from the registered PDD and/or methodology which prevent the use of the applied methodology.	☒

Authorised signatory:	Mr. ☒ Ms. ☐
Last name: Chiba	First name: Michiaki
Title: Climate Change Manager - Asia & Pacific	
Specimen signatur [redacted]	Date: 25/02/2019

B. Verification team and other experts

	Name	Company	Function*	Scheme competence*	Technical competence*	On-site visit
Mr. ☒ Ms. ☐	Michiaki Chiba	LRQA Ltd.	Team leader	☒	Technical competence authorised	☒
Mr. ☒ Ms. ☐	Stewart Niu	LRQA China	Internal reviewer	☒	N/A	☐
Mr. ☐ Ms. ☐				☐		☐
Mr. ☐ Ms. ☐				☐		☐

Please specify the following for each item.

* *Function: Indicate the role of the personnel in the validation activity such as team leader, team member, technical expert, or internal reviewer.*

* *Scheme competence: Check the boxes if the personnel have sufficient knowledge on the JCM.*

* *Technical competence: Indicate if the personnel have sufficient technical competence related to the project under validation.*

C. Means of verification, findings and conclusions based on reporting requirements

C.1. Compliance of the project implementation and operation with the eligibility criteria of the applied methodology

<Means of verification>

LRQA has determined during the verification process that the actual implementation and operation of the project has been conducted in conformance with the eligibility criteria of the applied methodology.

The project applied the approved methodology: JCM_SA_AM001_ver01.0 Introduction of High Efficiency Electrolyzer in Chlor-Alkali Processing Plant, Version 01.0.

LRQA assessed by means of an on-site visit that the physical features of the project are in place and that the PPs have operated the project as per the eligibility criteria of the applied methodology. The steps taken to verify each eligibility criterion and the conclusions about implementation of the project are summarised as below.

Criterion 1: Project electrolyzer employs an ion-exchange membrane technology in electrolyzers in the manufacturing process of chlor-alkali and the electrolyzer is the bipolar type.

Justification in the PDD: The project installs the bipolar type ion exchange membrane (IEM)

brine electrolyzers system in chlorine and caustic soda production process in Jubail Industrial City.
Steps taken for assessment: The verification team assessed the project documentation, technical specification, the commissioning report, and conducted physical on site assessment.
Conclusion: The verification team confirmed that the project installs the bipolar type ion exchange membrane brine electrolyzers in the chlorine and caustic soda production process of Jubail Chemical Industries Company (JANA) and the criterion is met.

Criterion 2: Specific electricity consumption (SEC) for project electrolyzer i under the standard conditions, 32% NaOH and 90 degrees Celsius is less than threshold SEC values set in the table below under the standard conditions, 32% NaOH and 90 degrees Celsius;

CD (Current density) [kA/m2]	Threshold SEC value of the electrolyzer [kWh(DC)/t-NaOH]
$4.0 \leq CD < 4.5$	2,045
$4.5 \leq CD < 5.0$	2,088
$5.0 \leq CD < 5.5$	2,131
$5.5 \leq CD < 6.0$	2,174
$5.5 \leq CD < 6.0$	2,217

Project specific electricity consumption is derived from specifications based on initial performance test by manufacturer.

Justification in the PDD: The project SEC derived from the specification of the project electrolyzer is 1990 kWh(DC)/t-NaOH when CD is between 4.5 and 5.0, and is less than the threshold SEC value (2,088 kWh(DC)/t-NaOH).
Steps taken for assessment: The verification team assessed the project documentation, technical specification, the commissioning report, and conducted physical on site assessment.
Conclusion: The verification team confirmed that the project SEC derived from the specification is 1990 kWh (DC)/t-NaOH when CD is between 4.5 and 5.0 that is less than the threshold SEC value of 2,088 kWh(DC)/t-NaOH and the criterion is met by the project.

The verification team confirmed that the eligibility conditions are satisfied by the project by reviewing the supporting documents and the on site assessment.
The details of the persons interviewed and the documents reviewed are shown in the Section F of this report.
<Findings>

Please state if CARs, CLs, or FARs are raised, and how they are resolved.

No issue was raised to the requirements of this section.

<Conclusion based on reporting requirements>

Please state conclusion based on reporting requirements.

The verification team confirmed that the project has been implemented in conformity with the eligibility criteria of the applied methodology.

C.2. Assessment of the project implementation against the registered PDD or any approved revised PDD

<Means of verification>

The project upgrades the existing elements of ion exchange membrane (IEM) brine electrolyzers to the latest model which will contribute to reducing energy consumption in chlorine and caustic soda production process of JANA in Jubail Industrial City, Eastern Province, the Kingdom of Saudi Arabia. The bipolar electrolyzer consists of multiple elements, which have cathode and anode chambers, and IEMs are installed between each element. The latest high efficiency model is developed for optimum performance design by optimizing elements' inner structures and electrode shape, reducing resistance (lowering the voltage) of various components and preventing the mechanical damage for IEM thus achieving lower power consumption and contributing to energy saving.

The project is implemented by JANA from the The Kingdom of Saudi Arabia and Kanematsu Corporation from Japan. The start date of project operation is on 25/01/2017 and the expected operational lifetime of the project is for 5 years.

The project receives financial support for JCM model projects from the Ministry of the Environment, Japan (MOE).

The verification team assessed the Monitoring Report (MR) that consists of Monitoring Report Sheet (MRS) parts of the Monitoring Spreadsheet and the supporting documents, conducted a physical site visit to assess the status of the actual project and its operation in accordance with the registered PDD. No revision to the registered PDD was requested.

The verification team determined through the verification process that the implementation and operation of the project has been in accordance with the description contained in the registered PDD. The verification team, by means of a desk review and an on-site visit, assessed that:

- all physical features of the JCM project described in the registered PDD are in place, and
- the PPs have operated the JCM project as per the registered PDD.

The MR follows the Monitoring Plan (MP) of the registered PDD that has been established based on the approved methodology. The parameters to be monitored ex-post is (1) EC_PJ,i,p Power consumption of project electrolyzer during the period p (in MWh/p). Electricity (DC) consumption of the 4 electrolyzer units upgraded by the project is directly and continuously

measured by cell voltage meters and electric current meters.
The roles and responsibilities of the persons are described in the Monitoring Structure Sheet (MSS) in accordance with the requirements of the applied methodology. There was no change in the organizational structure during the monitoring period.

Through the processes taken, CAR 1 and CL 1 were raised as the resolution detailed below.
The details of the persons interviewed and the documents reviewed are shown in the Section F of this report.

<Findings>

Please state if CARs, CLs, or FARs are raised, and how they are resolved.

Grade / Ref: CAR 1

Nature of the issue raised: The measurement methods and procedures including the details of calculation and QA/QC procedures needed to be described in the monitoring report sheet that includes the description of the measuring equipment, details on accuracy level and the calibration information (frequency, date of calibration and validity).
In doing this, the PPs should clarify:
1) How the PPs conduct checking of data measured and transferred for calculation,
2) Procedures to correct the measured data under irregular operations and confirm relevance and conservativeness if applicable, and
3) The details of the measurement equipment for electric current (kA) and QA/QC procedures applied.

Nature of responses provided by the PPs: The PPs submitted the revised MR including the details of calculation and QA/QC procedures with supporting documentation.

Assessment of the responses: The verification team reviewed the revised MR and the supporting documentation and confirmed implementation of the monitoring during the monitoring period in accordance with the registered MP. The PPs applied conservative calculation of the ERs by assuming the data during the days under irregular operational conditions, e.g. stop and re-start of the plant unit, as zero. As the result, the ERs were reduced from 3,027 tCO2 to 3,000 tCO2 in year 2017 and from 2,325 tCO2 to 2,300 tCO2 in year 2018. The CAR was closed.

Grade / Ref: CL 1

Nature of the issue raised: The PPs were requested to clarify implementation of the procedures to keep the relevant data and information required for the verification and issuance be kept and archived electronically for two years after the final issuance of the credits.

Nature of responses provided by the PPs: The PPs submitted the revised MR that was added reference to the monitoring procedures applied for clarification.

Assessment of the responses: The verification team reviewed the revised MR with the monitoring procedures being applied by the PPs and confirmed implementation of the procedures including the required data keeping as appropriate.
The CL was closed.

<Conclusion based on reporting requirements>

Please state conclusion based on reporting requirements.

The verification team confirmed that the project was implemented and operated in accordance with the registered PDD and no revision to the same was requested for the monitoring period.

C.3. Compliance of calibration frequency and correction of measured values with related requirements

<Means of verification>

The parameter No. (1) EC_PJ,i,p applies the monitoring Option C and the monitoring of the parameter uses cell voltage meters and electric current meters as the measuring equipment. The measurement of electricity consumption by the project electrolyzers is not a trade measurement and the regulations of the host country on measurement and calibration are not applicable.
The PPs apply calibration of the measuring equipment in the monitoring procedures based on recommendation of the equipment suppliers. In resolution of CAR 1 in the above Section C.2., the PPs revised the monitoring procedures and applied calibration frequency of every year for both cell voltage meters and electric current meters. The calibration was conducted on 22/12/2016 and 02/01/2018 for cell voltage meters. The monitoring period is from 25/01/2017 to 30/09/2018 and the period from 22/12/2017 to 01/01/2018 was not covered by the valid calibration. The calibration was conducted on 24/01/2019 for the electric current meters that was after the monitoring period. The results of all the delayed calibration confirmed that the errors were within the standard of permissible errors and there was no error exceeding +/- 5% to which correction of measured data is required by the JCM Guidelines.
The details of the persons interviewed and the documents reviewed are shown in the Section F of this report.

<Findings>

Please state if CARs, CLs, or FARs are raised, and how they are resolved.

Please refer to CAR 1 and the resolution details in the above Section C.2.

<Conclusion based on reporting requirements>

Please state conclusion based on reporting requirements.

The verification team confirmed that delayed calibrations were applied to the measuring equipment and no correction was required to the measured values during the monitoring period.

C.4. Assessment of data and calculation of GHG emission reductions

<Means of verification>

The MR is developed using the MRS applied to the registered JCM project that is confirmed fulfilment of the requirements of the MRS of the applied methodology.

LRQA has determined that:

1. a complete set of data for the specified monitoring period is available,
2. information provided in the MR has been cross-checked with other sources such as plant log books, inventories, purchase records, laboratory analysis,
3. calculations of reference emissions (REs) and project emissions (PEs), as appropriate, have been carried out in accordance with the formulae and methods described in the MP and the applied methodology,
4. any assumptions used in emission calculations have been justified, and
5. appropriate emission factors, default values and other reference values have been correctly applied.

The sources of GHG emissions are electricity consumption and CO2 emissions by the reference electrolyzers to determine the reference emissions (REs) and electricity consumption and CO2 emissions by the project electrolyzers to determine the project emissions (PEs) in accordance with the applied methodology.

The REs are calculated by electricity consumption of the project electrolyzers, ratio of specific electricity consumption (SEC) of the project and the reference electrolyzers, and CO2 emission factor of the consumed electricity. The CO2 emission factor of the consumed electricity is 0.654 tCO2/MWh as fixed ex-ante at the validation.

SEC of the reference electrolyzers is applied from the default value as 2,088 kWh(DC)/t-NaOH at the current density between 4.5 and 5.0 kA/m2 and SEC of the project electrolyzers are fixed ex-ante as 1,990 kWh(DC)/t-NaOH at the validation based on the manufacturer's performance guarantee.

The GHG emission reductions during the monitoring period (each for year 2017 and 2018) are calculated as: $ERp = REp - PEp = \Sigma_i EC_{PJ,i,p} \times SEC_{RE,i} \div SEC_{PJ,i} \times EF_{elec} - \Sigma_i EC_{PJ,i,p} \times EF_{elec}$

From 25/01/2017 to 31/12/2017

(23,191.35+23,176.48+23,410.88+23,387.98) x 2,088 / 1,990 x 0.654 tCO2/MWh – (23,191.35+23,176.48+23,410.88+23387.98) x 0.654 tCO2/MWh

= 97,754.80 x 0.654 tCO2/MWh – 93,166.69 x 0.654 tCO2/MWh

= 63,931.64 – 60,931.02 = 3,000.62 tCO2e

From 01/01/2018 to 31/08/2018

(17,786.62+17,771.16+17,938.14+17,922.03) x 2,088 / 1,990 x 0.654 tCO2/MWh – (17,786.62+17,771.16+17,938.14+17,922.03) x 0.654 tCO2/MWh

= 74,935.01 x 0.654 tCO2/MWh – 71,417.95 x 0.654 tCO2/MWh

= 49,007.49 – 46,707.33 = 2,300.16 tCO2e

Total electricity consumption in first monitoring period of 20 months (584 days) is 164,584.64 MWh that is 102,865.40 MWh in a year (164,584.64 x 365/584 = 102,936.96) and is 100.7% of ex-ante estimate in the PDD.
The verification team assessed the reported data with documented evidence and by means of on site visit.
The details of the persons interviewed and the documents reviewed are shown in the Section F of this report.

Parameters	Monitored values	Method to check values in the monitoring report with sources
EC_PJ,i,p (2017)	i = 1: 23,191.35 MWh/p i = 2: 23,176.48 MWh/p i = 3: 23,410.88 MWh/p i = 4: 23,387.98 MWh/p	Assessment was conducted based on records of meter readings and on site assessment.
EC_PJ,i,p (2018)	i = 1: 17,786.62 MWh/p i = 2: 17,771.16 MWh/p i = 3: 17,938.14 MWh/p i = 4: 17,922.03 MWh/p	Assessment was conducted based on records of meter readings and on site assessment.

<Findings>

Please state if CARs, CLs, or FARs are raised, and how they are resolved.

Please refer to CAR 1 and the resolution details in the above Section C.2. and below Section C.6. on the corrections of the monitored data.

<Conclusion based on reporting requirements>

Please state conclusion based on reporting requirements.

The verification team confirmed that appropriate methods and formulae for calculating REs and PEs have been followed. The verification team is of the opinion that all assumptions, emissions factors and default values that were applied in calculations have been justified.

C.5. Assessment of avoidance of double registration

<Means of verification>

The verification team assessed and confirmed relevance of the written confirmation from the PPs that the project is not registered under the other international climate mitigation mechanisms.

The team, in addition to the interviews with the PPs, checked publicly accessible information of Clean Development Mechanism (CDM), Joint Implementation (JI), Verified Carbon Standard (VCS) and Gold Standard (GS) and found no identical project as the proposed JCM project in terms of the name of entities, applied technology, scale and the location. The result of researches confirmed that the proposed project was not registered under the other international climate mitigation mechanisms than JCM and it will not result in a double counting of GHG emission reductions.

The details of the persons interviewed and the documents reviewed are shown in the Section F of this report.

<Findings>

Please state if CARs, CLs, or FARs are raised, and how they are resolved.

No issue was raised to the requirements of this section.

<Conclusion based on reporting requirements>

Please state conclusion based on reporting requirements.

The verification team confirmed that the project is not registered under other international climate mitigation programs.

C.6. Post registration changes

<Means of verification>

The verification team identified that the parameter EC_PJ,i,p was not monitored in accordance with the registered MP in some days during the monitoring period when the electrolyzers stopped operation and re-started and cell voltage measurement showed abnormal values. The PPs were requested in resolution of CAR 1 in above Section C.2. to justify means of correction of the abnormal data monitored for assessment of the post registration changes by the verification team. The verification team assessed the project documentation, conducted the on site visit and confirmed that the post registration changes from the registered MP do not prevent application of the approved methodology since the PPs assumed that the data is zero if it is monitored from the days the operation of the project electrolyzers stopped to the days the

operation re-started for calculation of the ERs in the revised MR and the verification team confirmed that the treatment is conservative as the data is used for calculation of both REs and PEs.

<Findings>

Please state if CARs, CLs, or FARs are raised, and how they are resolved.

Please refer to CAR 1 and its resolution details in the above Section C.2.

<Conclusion based on reporting requirements>

Please state conclusion based on reporting requirements.

The verification team through the verification processes determined that there was no post registration change from the registered PDD or approved methodology which prevent from use of the applied methodology.

D. Assessment of response to remaining issues

An assessment of response to the remaining issues including FARs from the validation and/or previous verification period, if appropriate

No FAR was issued in the validation and this is the first verification of the project.

E. Verified amount of emission reductions achieved

Year	Verified Reference Emissions (tCO_2e)	Verified Project Emissions (tCO_2e)	Verified Emission Reductions (tCO_2e)
2013			
2014			
2015			
2016			
2017	63,931.64	60,931.02	3,000
2018	49,007.49	46,707.33	2,300
2019			
2020			
2021			
2022			
2023			
2024			
2025			
2026			
2027			
2028			
2029			
2030			
Total (tCO_2e)			5,300

F. List of interviewees and documents received

F.1. List of interviewees

Jubail Chemical Industries Company (JANA)

B.G. Krishnanand, Lead Process Engineer
Tariq Farooq, Senior Process Engineer
M. Ali Akbar, Lab Section Manager
Muhammad Saleem, Mechanical Section Manager
J. Harikrishnakumar, Section Manager - Operation
Abdul Wajib, Instrument Supervisor-DCS, CVMS & Instrument
G. Anwar Habys, Electrical Supervisor

Anil Somaiya, Electrical Engineer Environmental Resource Management (ERM) Japan Ltd. Tsuyoshi Nakao, Team Leader, Sustainability Management Team

F.2. List of documents received

Category A documents (documents prepared by the PPs) - Monitoring Report submitted on 20/11/2018 - Revised Monitoring Report completed on 25/01/2019 and 06/02/2019 - Calculation spreadsheets and the revisions - Technical specification of project electrolyzer - Power supply system diagram - General specification for Cell Voltage Monitoring System - Calibration certificates for Cell Voltage Monitoring System dated 21/12/2017 - Calibration certificates for Cell Voltage Monitoring System dated 03/01/2018 - Sales contract for bi-polar electrolyzer unit for 44,467 TPY-Chlorine (50,000 TPY-Caustic Soda) Chlor-Alkali Plant - Certificate of performance guarantee acceptance dated 25/01/2017 - Technical appendix for cell room package - Acceptance certificate dated 25/01/2017 - Company profile and project overview - MV&LV single line diagram - Single line diagram - power circuits, measurement – controls, overvoltage protections, DC site measurements - MX100/MW100 Main unit specifications - Calibration Procedure for Rosemount Smart Transmittes (Pressure, Flow, Level and Temperature) - Calibration Verification Procedure for CVMS System and the revision - Monitoring of Electrolyzers Performance in Chlor Alkali Plant and the revision - Training records dated 20 & 21/12/2016 - Preventive Maintenance Report DCS & ESD System dated 12-14/12/2017 - Declaration letter from the project participants on avoidance of double registration dated 26/11/2018 - Electrolyzer Monitoring Report

- Calibration Procedure for GEFRAN Meter (kA meter)
- Calibration Certificate for Current Meters

Category B documents (other documents referenced)
- PDD Version 02.0 dated 5/3/2018 including the annexes
- Validation Report dated 20/03/2018
- JCM_SA_AM001_ver01.0 Introduction of High Efficiency Electrolyzer in Chlor-Alkali Processing Plant, Version 01.0
- Additional information to the Proposed Methodology "Introduction of High Efficiency Electrolyzer in Chlor-Alkali Processing Plant"
- JCM Project Cycle Procedure JCM_SA_PCP_ver02.0
- JCM Guidelines for Validation and Verification JCM_SA_GL_VV_ver01.0
- JCM Guidelines for Developing PDD and MR JCM_SA_GL_PDD_MR_ver02.0
- JCM Glossary of Terms JCM_SA_Glossary_ver01.0
- Approved Small Scale Methodology AMS II.C. Demand-side energy efficiency activities for specific technologies
- Proposed and registered projects under CDM, VCS, Gold Standard, and the other international schemes

Annex Certificates or curricula vitae of TPE's verification team members, technical experts and internal technical reviewers

Please attach certificates or curricula vitae of TPE's validation team members, technical experts and internal technical reviewers.

Certificate of Appointment is attached to this report.

Joint Crediting Mechanism Certificate of Appointment

Title of Project: Introduction of High Efficiency Electrolyzer in Chlor-Alkali Production Plant (Ref# SA001)
Verification for the first monitoring period: 25/01/2017 – 31/08/2018

We hereby certify that the following personnel have engaged in the verification process that has fully satisfied the competence requirements of the verification of the JCM project.

Name of Person	Assigned Roles
Michiaki Chiba	Team Leader
Stewart Niu	Technical Reviewer

Signed by

Michiaki Chiba
Climate Change Manager – Asia & Pacific
07/12/2018