MONITORING REPORT FORM (F-CDM-MR)
Version 02.0

MONITORING REPORT

Title of the project activity	N_2O abatement in HP Nitric Acid plants at Rashtriya Chemicals & Fertilizers Limited, India
Reference number of the project activity	2792
Version number of the monitoring report	1
Completion date of the monitoring report	19/06/2012
Registration date of the project activity	20/11/2009
Monitoring period number and duration of this monitoring period	4, 05/12/2010 to 10/05/2012 (Both days inclusive)
Project participant(s)	Rashtriya Chemicals & Fertilizers Ltd. (Public Entity)
Host Party(ies)	India
Sectoral scope(s) and applied methodology(ies)	05, AM0034 Version 03.2
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	For Campaign period – 4: 159,314 tCO2 (447,305 tCO2 x 130 days / 365 days) For Campaign period – 5: 167,893 tCO2 (447,305 tCO2 x 137 days / 365 days) For Campaign period – 6: 161,765 tCO2 (447,305 tCO2 x 132 days / 365 days) For Campaign period – 7: 151,961 tCO2 (447,305 tCO2 x 124 days / 365 days)
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	478,929 t CO_2

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

RCF is a Public sector undertaking of Government of India. It is one of the leading producers of fertilizer in India. The fertilizer production facility of RCF is located in Trombay near Mumbai in the state of Maharashtra. RCF is having two Nitric Acid Plants, one is medium pressure plant which operates at 5 to 6 bar (absolute) and other is high pressure plant which operates at 7 to 8 bar (absolute) respectively, both the units are located at Trombay. This monitoring report is for project activity in the high pressure Nitric Acid Plant of RCF.

This project activity is about N2O abatement generated during the process of nitric acid production. Nitric Acid production involves oxidation of ammonia on precious metal gauze of essentially platinum – rhodium in ammonia burner in the presence of air. This is an exothermic reaction which releases substantial heat. In the process, ammonia is oxidized to form NO, which is further oxidized to form NO_2, which is converted into Nitric Acid by absorbing NO_2 in water. N_2O is an undesirable and unavoidable by product resulted during oxidation of Ammonia which is potent greenhouse gas (GHG) and do not possess any economic value.

The purpose of the project activity is to reduce the emission of N_2O (a greenhouse gas) by installing of secondary N_2O decomposition (DeN_2O) catalyst in the ammonia reactors of HP Nitric Acid Plant of Rashtriya Chemicals and Fertilizers Limited (hereafter referred as RCF). The HP Nitric acid plant was commissioned in1968. The plant was subsequently revamped and restarted in Jan. 2005 with annual capacity of 128,480 MT (352 MT per day) of 100 % Nitric Acid. The DeN2O catalyst was procured from well known supplier M/s BASF Germany, which has been installed down stream of platinum gauze. The project activity helps in catalytic reduction of N2O which is an undesirable by product of nitric acid production process and reduces its emission in to the atmosphere. The N_2O is potent greenhouse gas with a very high global warming potential of 310. EN14181 compliant continuous emission monitoring system was procured from M/s ABB Germany.

SN	Particulars	Details
1	Installation and commissioning of DeN_2O catalyst	31st March 2009
2	Commissioning of AMS	24th July 2008
3	QAL 2 Test	21st to 23rd October 2008
4	AST for the year 2010	4th and 5th March 2010
5	AST for the year 2011	1st, 2nd and 3rd March 2011
6	Annual Maintenance of AMS (During the Monitoring Period)	ABB Engineer visited on 14/08/2010 for routine maintenance job of AMS.
7	Date of Replacement of Primary Catalyst (During Monitoring Period)	Nil
8	Jobs pertaining to Secondary Catalyst	Nil

Start and end dates of the all four campaign period with this monitoring period is as given below:

Campaign	From	To	Remarks
Campaign Period – 4	05/12/2010	13/04/2011	Both dates inclusive
Campaign Period – 5	14/04/2011	28/08/2011	Both dates inclusive
Campaign Period – 6	29/08/2011	07/01/2012	Both dates inclusive
Campaign Period – 7	08/01/2012	10/05/2012	Both dates inclusive

The Purpose of this monitoring report is to calculate and clarify the GHG emission reduction quantity achieved by this project for periodic verification. The total emission reduction during the monitoring period through this project activity is 478,929 tCO2.

A.2. Location of project activity

Host Country : India
State : Maharashtra
Town : Trombay, Sion
Latitude : 18^{0}56'33" N
Longitude : 72^{07}50'9" E

A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
India (host)	Rashtriya Chemicals & Fertilizers Ltd. (Public entity)	No
Switzerland	Rashtriya Chemicals & Fertilizers Ltd. (Public entity)	No

A.4. Reference of applied methodology

- Approved baseline methodology AM0034 **"Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants"**
  Reference: Version 03.2, Sectoral Scope 05, EB 41

- **Tool for the demonstration and assessment of additionality**
  Reference: Version 05.2, EB39

A.5. Crediting period of project activity

Crediting Period: 21 Years (7 years x 3, Renewable Period)

Crediting Period Starts from 20/11/2009

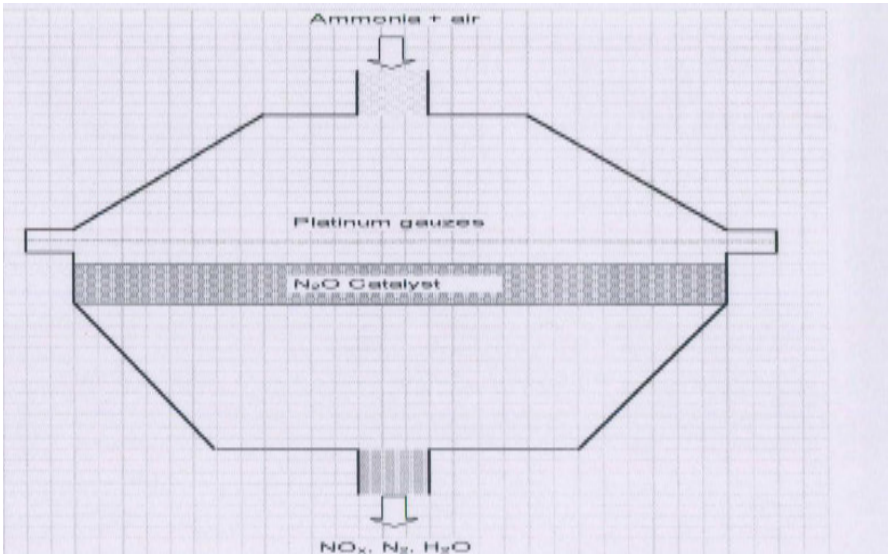
SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

Nitric Acid (HNO_3) is produced through the oxidation of ammonia (NH_3) on precious metal catalyst gauze in the ammonia burner of a nitric acid plant. Nitrous Oxide (N_2O) is an undesirable by-product gas produced in the manufacture of nitric acid. Waste N_2O from nitric acid production was typically released into the atmosphere as it does not have any economic value at emission levels typical of nitric acid manufacture.

RCF has installed secondary catalyst in the ammonia burner of nitric acid unit after primary catalyst, which has resulted in reduction of N_2O emission.

Technical Specifications:
RCF has purchased the catalyst from one of the reputed internationally well known catalyst suppliers M/s BASF. In presence of the catalyst N_2O is reduced to harmless N_2. The catalyst has been installed just below the primary catalyst in place of rasching rings installed initially as shown below.



The technology is based on selective reduction of N_2O. The reduction is done as below in an exothermic reaction.

$$N_2O \rightarrow N_2 + ½\ O_2 \qquad \Delta H = -82\ kJ/\ mol$$

Following instrument was replaced during the Monitoring Period:

	Old Instrument details	New Instrument details	Date of replacement
Product Acid Mass flow meter (FI10121)	Sensor Sr. no : 12031565 Transmitter Sr. no. : 3781972	Sensor Sr. no : 14206043 Transmitter Sr. no. : 3170443	05/05/2011

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

As per registered PDD, operating hour recording at CEM system is based on temperature limits of the reactor. However during 20/11/2009 to 09/07/2010 (1st and 2nd monitoring period) the operating hours were recorded at CEM system based on ammonia flow to the reactor.

From 10/07/2010 onwards operating hour recording was made back on the base of temperature limits of the reactor.

The deviation (I-DEV0395) was requested to UNFCCC for the period from 20/11/2009 to 09/07/2010 (1st and 2nd monitoring period). UNFCCC has accepted the request for deviation, provided that a revision of monitoring plan is requested in order to continue recording the operating hours based on the ammonia flow to the reactor.

In line with above recommendation from UNFCCC, from 07/01/2012 onwards recording of operating hours is being done on the basis of ammonia flow to the reactor. The revision in the Monitoring Plan shall be done and revised Monitoring Plan shall be submitted for approval in due course of time.

B.2.2. Corrections

NA

B.2.3. Permanent changes from registered monitoring plan or applied methodology

As per registered PDD, operating hour recording at CEM system is based on temperature limits of the reactor. However now the operating hours are recorded based on ammonia flow to the reactor.

This is in line with the deviation request (I-DEV0395) submitted by RCF and subsequent acceptance & recommendation from UNFCCC.

B.2.4. Changes to project design of registered project activity

NA

B.2.5. Changes to start date of crediting period

NA

B.2.6. Types of changes specific to afforestation or reforestation project activity

NA

SECTION C. Description of monitoring system

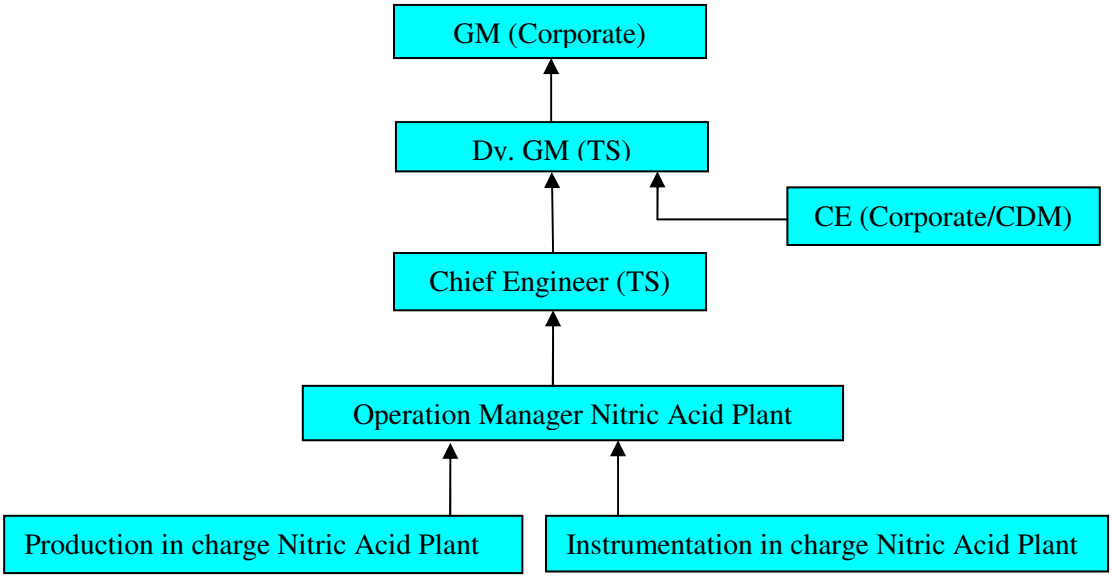
RCF is an ISO 9001 certified company and has procedure for monitoring and recording of data on operation of the plant/equipments. ISO 9001 procedures have been formulated for all new monitoring instruments. All instruments used for CDM project monitoring are calibrated as per ISO 9001 procedures.

1. CDM Team for monitoring & recording of data:

A CDM project team is constituted with participation from relevant sections. This team is responsible for data collection and archiving. This team is periodically reviews CDM project activity, check data collected and estimate emissions reduced. On a monthly basis, the monitoring reports are checked and discussed by the senior CDM team members. In case of any irregularity observed by any of the CDM team members, it is informed to the concerned person for necessary actions. Further these reports will then be forwarded to the management monthly basis.

Daily report (Hourly average, in pdf format) from CEM system is archived by plant personnel and forwarded to CDM team members. Corporate CDM team member convert these PDF file in excel format and consolidate the data for entire campaign. Consolidated data is used for emission reduction calculation for final verification by verifier.

Organizational structure for monitoring plan



1.1 Data collection and record keeping:

Frequency of data monitoring and recording:
The frequency for data monitoring is as per the monitoring details in Section D.

Archiving of data:

Data shall be kept for two years after the crediting period or the last issuance whichever is later

CDM data is archived in electronic and paper form.

1.2 Quality Control and Quality Assurance

RCF has installed EN 14181 compliant continuous emission monitoring system. As per detailed out in the methodology AM0034, a three level quality assurance has been implemented. These three levels are Quality Assurance Level 1 (QAL1), Quality Assurance Level 2 (QAL2) and Quality Assurance Level 3 (QAL3).

QAL1 precisely ensures the suitability of the CEM to meet the requirements. CEM system at RCF has already undergone this level and a report has been availed from reputed certifying agency TUV SUD, Germany. QAL2 has been carried out by M/s TUV SUD, Germany in 2008 and again in 2011 by TUV Rhinland. Under QAL3, the analyzer carries out auto calibration on weekly basis.

Annual Surveillance test (AST) is also carried out by third party as a part of EN14181. AST was carried out by SGS Netherland in 2011.

1.3 Span Gas Details

Span Gas Concentration	Supplier	Concentration Valid till
3,650 PPM	Chemtron Science Laboratories Pvt. Ltd.	29/04/2010
3,532 PPM	Chemtron Science Laboratories Pvt. Ltd.	10/03/2011
3,672 PPM	Chemtron Science Laboratories Pvt. Ltd.	26/03/2012

2. Description of the CEM installed at RCF HP Nitric Acid plant:

2.1 Components of CEM

In its HP Nitric Acid plant, RCF has installed an CEM system supplied by M/s ABB, AO2000 URAS 26 comprising of Continuous Emissions Analyser (for N_2O concentration in stack gas), Sample probe, Sample Conditioning System, SDF Flow Sensor (for stack gas flow measurement).
Following are the data logger and data acquisition system in the CEM system:
Data logger: Beckhoff DATA Logger
Data Acquisition System: ITBK EMI3000

2.2 Selection of Sample points

RCF has selected sample points for collection of samples to meet the requirements of EN14181. The sample points have been selected as advised by the supplier ensuring its correctness,

2.3 Analyser System

The ABB AO2000 URAS 26 is capable of analysing N_2O concentration in gas mixtures on continuous basis. The URAS 26 is continuous NDIR industrial photometer that can selectively measure concentrations of up

to four sample components. In this case it is equipped for the measurement of N_2O only. The analyzer features gas-filled opto-pneumatic detectors. Detector is filled with corresponding gas being measured. This means that the detector provides optimum sensitivity and high selectivity compared with the other gas components in the sample. Calibration cells filled with N_2O gas is used for automatic calibration. The Analyser is QAL1 tested for the measurement of N_2O.

2.4 Sample Conditioning System

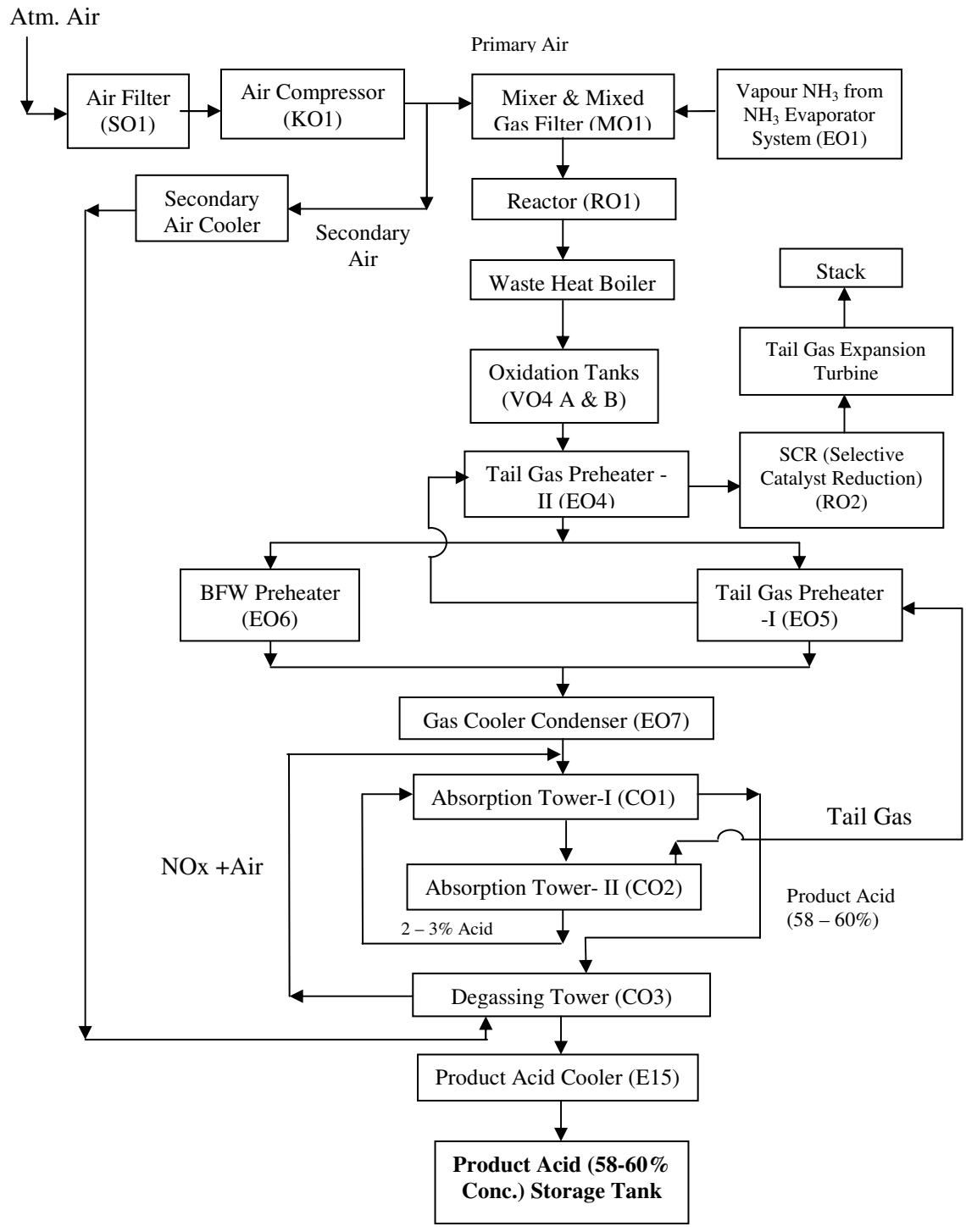
The gas sample is extracted at the sampling point, particles are removed by the heated filter unit and the clean sample gas is delivered through a heated sampling line to the analyser cabinet. Before being fed to the analyser, moisture is removed by the sample gas cooler and sample gas feed unit installed side-by-side in the analyser cabinet. This sample gas cooler unit maintains a constant dew point of the sample gas of 3°C and efficiently separates the moisture from the sampling gas. The minimum flow rate to the analyser is controlled and connected to an alarm. The dry gas after the cooler is controlled for moisture break through. In case of moisture leaks in due to a failure of the cooler, the sampling pump will be stopped automatically and an alarm is given to the EMI3000 system.

2.5 Flow Meter

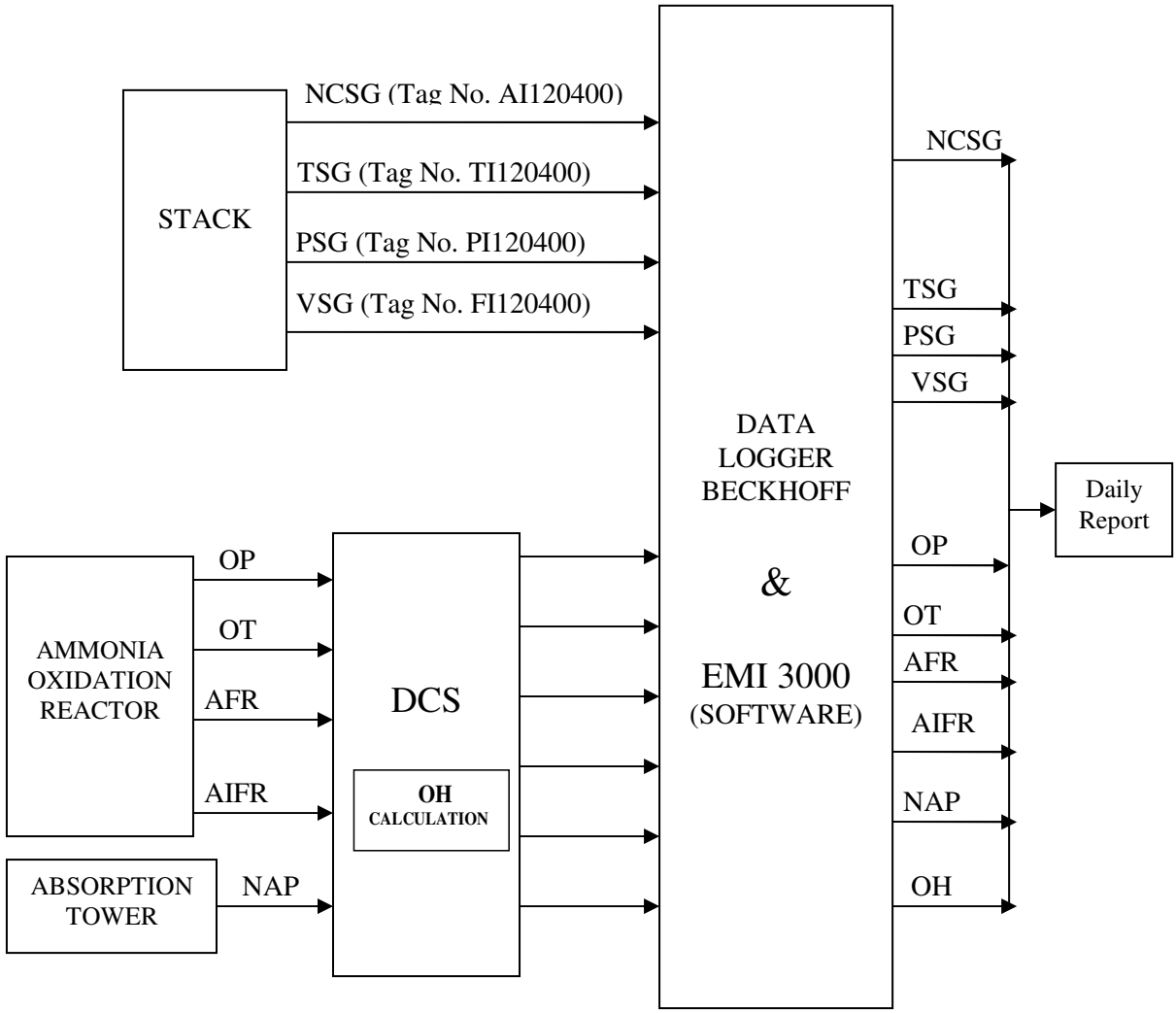
The SDF Flow measuring system allows continuous determination of the flow rate of stack gas. It is performance tested according to 17. BImSchV and "TA Luft" (test report No. 936/802015, TUV Rheinland 1993) for use in plants. The unit's suitability was tested by TUV Rheinland Germany.
The SDF flow sensor which is a flow measuring device is a highly sensitive system for continuous, in-situ flow measurement. The stack gas flow is measured in the stack by measuring the dynamic differential pressure generated by the SDF flow sensor probe rod and using ABB's Differential pressure transmitter. Thereby the differential pressure is continuously measured and the signal is feed to Beckhoff DATA Logger and ITBK EMI3000 – CDM Data acquisition and data evaluation system. The Data Logger has been calibrated by ABB Germany during manufacturing stage and calibration was again rechecked during QAL2 test by TUV SUD Germany.

Process Block diagram for HP Nitric Acid Plant is given below.

Process Block Diagram: HP Nitric Acid Plant



The individual monitoring parameters with respect to each equipment are described below:



The ABB's Differential pressure type transmitter is used for stack gas flow measurement which gives 4 to 20 mA signal which is directly proportional to the stack gas flow. The differential pressure transmitter signal is fed to the Beckhoff data logger. The stack gas pressure and temperature is also measured separately by transmitters and the corresponding 4 to 20 mA signal generated is fed to data logger as input for further converting the stack flow from operating to standard conditions. This is done by EMI3000 by compensating the flow for pressure and temperature and correcting the volume flow.

2.6 The data acquisition system

The RCF HP nitric acid plant is equipped with a data communication unit that collects and stores all the raw values for NCSG, VSG, TSG, PSG, OT_h, OP_h, AFR, AIFR and NAP as well as different status signals from the AMS. From the data communication unit the data is transferred to the ITBK EMI3000 server grade PC in Analyser room. In the EMI3000 PC all data evaluation and storage takes place. The data is stored simultaneously on different hard disks to prevent the loss of data in case one hard disk fails.

3. Emergency preparedness

The maximum emissions possible during the crediting period, in case of emergency situation like complete deactivation of DeN_2O catalyst shall be same as that of base line emissions.

The emissions are monitored using CEM system which complies with EN14181 as required by the methodology in the project activity.

It is expected that all the instruments shall be functioning continuously for recording data. However in case AMS is not functioning due to any reason, RCF will follow the following emergency preparedness procedures.

Failure of Data Acquisition System	A Provision of auto backup of data is provided in the system so that data is retrieved even if the system is down for 22 days. In case, due to any reason data is not available due to failure of data recording following shall be considered.
Failure of N_2O Analyzer (NCSG)	In case N_2O analyzer is not functioning, data for the period shall be taken as highest measured value during the campaign for calculating the campaign average.
Failure of Stack gas Flow meter (VSG)	In case Stack gas flow meter is not functioning, data for this period shall be replaced with highest measured value during the campaign for calculating the campaign average.
Failure of Stack Gas Pressure (PSG)	In case Stack gas pressure meter is not functioning, Hourly average of measured data for next hour shall be considered for the down period, for taking further processing.
Failure of Stack gas Temperature (TSG)	In case Stack gas Temperature meter is not functioning, Hourly average of measured data for next hour shall be considered for the down period, for taking further processing.
Operating Hours OH	In case Operating hours counter is not functioning, data from Shift log book shall be taken after ascertaining for how many hours the plant has run.
Failure of Mass Flow meter (NAP)	In case Mass flow meter is not functioning any time during the day, Nitric acid Production for the day shall be calculated using Average Ammonia Specific consumption for previous three operating days and Ammonia consumption for plant for the day from meter no FI 120101. The production data for the day shall be used for further processing; all other data from the Nitric acid mass flow meter for this day shall be ignored. In case concentration of nitric acid has not been determine for the day due to any reasons like shutdown, start-up etc, then: ➢ In case of shut down data for concentration shall be taken from previous day.

	➢ In case of start-up data for concentration shall be taken from next day. ➢ In case of shut down and start-up both data for concentration shall be taken from average of previous available day and next available day. ➢ For any other reason not foreseen now decision from production in charge of the plant shall be taken for correctness of data based on reason of not availability. He will give decision whether previous day data to be used or next day data to be used.
Operating Temperature(OT)	In case operating Temperature meter is not functioning, average of measured data for previous hour and next available hours, shall be considered for the down period, for taking further processing.
Operating Pressure(OP)	In case operating Pressure meter is not functioning, average of measured data for previous hour and next available hours, shall be considered for the down period, for taking further processing.
Ammonia Flow (AFR)	In case Ammonia Flow meter is not functioning, Hourly average of measured data for previous hour shall be considered for the down period, for taking further processing.
Ammonia to Air Ratio (AIFR)	In case Ammonia to Air Ratio meter is not functioning, Hourly average of measured data for previous hour shall be considered for the down period, for taking further processing.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

Data / Parameter:	**AFR_{max}**
Data unit:	**Nm^3/hr**
Description:	Maximum Ammonia Flow Rate
Source of data used:	Plant Records
Value(s) :	7,992 (This is equivalent to 6.076 tNH_3/h)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline Emission
Additional comment:	The methodology gives the unit of measurement in tNH_3/h but RCF have been measuring the parameter in Nm3/h in the past. The conversion factor from Nm^3/h to Kg/h is 0.7602 (which is 17. 03/22.4). RCF has converted this measured value in Kg/h for the project activity.

Data / Parameter:	$AIFR_{max}$
Data unit:	%
Description:	Maximum ammonia to air ratio
Source of data used:	Calculated
Value(s) :	11.5
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline Emission/Project Campaign
Additional comment:	-

Data / Parameter:	**OT normal**
Data unit:	Deg C
Description:	Normal Operating Temperature
Source of data used:	Monitored
Value(s) :	Max = 930 Min = 860
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline Emission
Additional comment:	-

Data / Parameter:	OP_{normal}
Data unit:	Bar (gauge)
Description:	Normal operating pressure
Source of data used:	Monitored
Value(s) :	Max = 7.65 (765 kPa) (gauge)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline Emission
Additional comment:	1 Pa = 10^-5 bar. Methodology gives unit of measurement in Pa. But RCF were measuring this parameter in bar. In the project activity however, RCF has converted this measuring value in kPa for the project activity

Data / Parameter:	GS_{BL}
Data unit:	-
Description:	Gauze Supplier for the baseline campaign
Source of data used:	Monitored
Value(s) :	Rashtriya Chemicals & Fertilizer Ltd
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline Emission
Additional comment:	Rashtriya Chemicals & Fertilizers limited is getting fabricated the catalyst gauze from three vendors (Baseline Vendor RHPL) RHPL/ HPL/ Aurora Mathey, on labour charge basis, giving them metal and specification of catalyst.

Data / Parameter:	**GC_{BL}**
Data unit:	**-**
Description:	Gauze Composition during Baseline Campaign
Source of data used:	Monitored
Value(s) :	Pt – 92%, Rh – 8%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline Emission
Additional comment:	-

Data / Parameter:	**$NCSG_{BC}$**
Data unit:	mgN_2O/Nm^3
Description:	N2O Concentration in the stack gas
Source of data used:	N2O analyser
Value(s) :	For the baseline campaign run by RCF during 01/07/2008 and 07/11/2008, the N_2O concentration values comes at 4,054.1 mg N_2O/Nm^3
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline Emission
Additional comment:	Regular Calibration is done according to ISO 9001 procedure. This analyser is tested as per QAL 2 test of recognised industry standards (EN 14181) by third party TUV SUD, Germany. Staff has been trained in maintenance of monitoring Instrument. Staff is also trained in monitoring procedures and a reliable technical support infrastructure is set up.

Data / Parameter:	**VSG_{BC}**
Data unit:	Nm^3/h
Description:	Volume flow rate of the stack gas
Source of data used:	From CEM system supplied by M/s. ABB along with analyser
Value(s) :	For the baseline campaign run by RCF during 01/07/2008 and 07/11/2008, the volume flow rate of the stack gas comes at 49,077.4 Nm3/h
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline Emission
Additional comment:	Regular Calibration is done according to ISO 9001 procedure. This analyser is tested as per QAL2 test of recognised industry standards (EN 14181) by third party TUV SUD, Germany. Staff is also trained in monitoring procedures and a reliable technical support infrastructure is set up.

Data / Parameter:	**OH_{BC}**
Data unit:	Hours
Description:	Operating Hours
Source of data used:	From CEM System

Value(s) :	For the baseline campaign run by RCF during 01/07/2008 and 07/11/2008, the operating hours comes at 2,861 hours.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline Emission
Additional comment:	Included in evaluation by third party validator.

Data / Parameter:	**NAP_{BC}**
Data unit:	$tHNO_3$
Description:	Nitric Acid (as 100%) over baseline campaign
Source of data used:	This is calculated data based on the following- 1) Quantity of dilute nitric acid from mass flow meter. 2) Average concentration of nitric acid determined by the plant laboratory for the day.
Value(s) :	For the baseline campaign run by RCF during 01/07/2008 and 07/11/2008, the nitric acid comes at 43,326 $tHNO_3$.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline Emission
Additional comment:	**Nitric Acid Flow:** Calibration of flow meter once in three years as per OEM Recommendation. **Nitric Acid Concentration:** Calibration of Hydrometer and Thermometer shall be ensured by ISO 9001 procedures. In case mass flow meter is not functioning for any period during the day, Nitric acid production for the day is calculated using average ammonia specific consumption for previous operating days and ammonia consumption for plant for the day from meter no FI 120101. The calculated production value for the day is used for further processing; all other data from nitric acid mass flow meter for this day is ignored. In case concentration of nitric acid has not been determined for the day due to any reason like shut down, start up etc. then; • In case of shut down data for concentration is taken from previous day • In case of start up data for concentration is taken from next day. • In case of shut down and start up both data for concentration is taken from average of previous available day and next available day. • For any other reason not foreseen now decision from production in charge of the plant is taken for correctness of data based on reason of not availability. He gives decision whether previous day data to be used or next day data to be used. Conservativeness of the value will be maintained

	Operations Manager nitric acid plant takes appropriate decision for replacing the mass flow meter with similar or better instrument, if they are made available by instrument vendors in future.

Data / Parameter:	**CL_{BL}**
Data unit:	**$tHNO_3$**
Description:	Length of Baseline Campaign
Source of data used:	As per the Production Data
Value(s) :	43,326
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline Emission
Additional comment:	-

Data / Parameter:	**CL_{Normal}**
Data unit:	$tHNO_3$
Description:	Normal Campaign Length
Source of data used:	Calculated from nitric acid production data
Value(s) :	44,435
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline Emission
Additional comment:	-

Data / Parameter:	**GS_{Normal}**
Data unit:	**-**
Description:	Normal gauze supplier for the operating conditions campaigns, there are three gauge fabricators for RCF, they work on labour charge basis for gauze fabrication, precious metal and specification is given by RCF. Hence RCF is the gauze supplier.
Source of data used:	Plant Data
Value(s) :	Rashtriya Chemicals and Fertilizer Ltd.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline Emission
Additional comment:	Frequency of recording: Each Campaign (Rashtriya Chemicals & Fertilizers limited is getting fabricated the catalyst gauze from any one of the three parties RHPL/ HPL/ Aurora Mathey, on labour charge basis, giving them metal and specification of catalyst)

Data / Parameter:	**GC_{Normal}**
Data unit:	**-**
Description:	Gauze Composition during the operating campaign
Source of data used:	Monitored
Value(s) :	Pt – 92%, Rh – 8%
Indicate what the data are used for (Baseline/ Project/ Leakage emission	Baseline Emission

calculations)	
Additional comment:	-

D.2. Data and parameters monitored

Data / Parameter:	**NCSG**
Data unit:	mgN_2O/m^3
Description:	N_2O concentration in the stack gas
Measured /Calculated /Default:	Measured
Source of data:	N_2O Analyser
Value(s) of monitored parameter:	1,458 For campaign period – 4 482 For campaign period – 5 681 For campaign period – 6 669 For campaign period – 7
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project Emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Given in Appendix III
Measuring/ Reading/ Recording frequency:	Frequency of monitoring: Every second
Description of measurement methods and procedures to be applied:	N_2O analyzer to be used for the data measurement proceeds using appropriate software. RCF have in place a Continuous Emission Monitoring (CEM) system from ABB. The repeatability of this instrument is < 0.5% of span.
Calculation method (if applicable):	-
QA/QC procedures applied:	N_2O monitor have auto calibration feature. Regular Calibrations according to ISO 9001 procedure and this analyzer was tested as per QAL2 test of recognized industry standards (EN 14181) by third party TUV SUD, Germany. Staffs have been trained in monitoring procedures and a reliable technical support infrastructure has been set up. In AST 2011, SGS has recommended that measuring inaccuracy constant for NCSG which is 62 should not be subtracted and the value of this constant should be made zero in the system. Accordingly, to comply with the recommendation of SGS, all NCSG readings during the monitoring period are added with 62 and further used for CER calculation.

Data / Parameter:	**VSG**
Data unit:	Nm^3/h
Description:	Volume flow rate of the stack gas
Measured /Calculated /Default:	Measured

Source of data:	From CEM System
Value(s) of monitored parameter:	51,754 For campaign period – 4 45,868 For campaign period – 5 41,414 For campaign period – 6 41,669 For campaign period – 7
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project Emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Given in Appendix III
Measuring/ Reading/ Recording frequency:	Frequency of monitoring: Every second
Description of measurement methods and procedures to be applied:	The data output from the stack flow meter is processed using appropriate software. RCF have in place a Continuous Emission Monitoring (CEM) System from ABB. The base accuracy of this instrument is ± 0.04%.
Calculation method (if applicable):	-
QA/QC procedures applied:	Regular Calibrations according to ISO 9001 procedure and this instrument was tested as per QAL2 test of recognized industry standards (EN14181) by third party TUV SUD, Germany.

Data / Parameter:	**OH**
Data unit:	Hours
Description:	Operating hours
Measured /Calculated /Default:	Calculated
Source of data:	From CEM system
Value(s) of monitored parameter:	2,875 For campaign period – 4 2,914 For campaign period – 5 2,874 For campaign period – 6 2,892 For campaign period – 7
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project Emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Given in Appendix III
Measuring/ Reading/ Recording frequency:	Frequency of recording: Hourly compiled for entire campaign
Description of measurement methods and procedures to	As soon as ammonia is introduced in the reactor OH counter starts automatically. Similarly when ammonia flow to reactor is cut off OH

be applied:	counter is stopped automatically.
Calculation method (if applicable):	-
QA/QC procedures applied:	Included in evaluation by third party validator.

Data / Parameter:	**NAP**
Data unit:	$tHNO_3$
Description:	Nitric Acid (As 100%)
Measured /Calculated /Default:	Calculated
Source of data:	This is a calculated data based on the following 1. Quantity of dilute nitric acid from mass flow meter. 2. Average Concentration of nitric acid determined by the plant laboratory for the day.
Value(s) of monitored parameter:	41,246 For campaign period – 4 43,767 For campaign period – 5 42,873 For campaign period – 6 43,341 For campaign period – 7
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project Emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Given in Appendix III
Measuring/ Reading/ Recording frequency:	Hourly Compiled for entire campaign
Description of measurement methods and procedures to be applied:	**Nitric Acid Flow:** Mass flow meter installed at project site and displayed on CEM system shall give hourly average flow of dilute nitric acid (from the day report of CEM system). Plant laboratory will determine the average concentration of nitric acid for the day. Hourly value shall be multiplied with average concentration to arrive at hourly nitric acid production. The sum of hourly production shall be used to calculate day production. **Nitric Acid Concentration:** Concentration will be determined by measuring specific gravity by hydrometer and temperature by thermometer. Chart indicating concentration at various temperatures and specific gravity, available with production department shall be used for determining concentration of product nitric acid. In case Mass flow meter is not functioning for any period during the day, Nitric acid Production for the day shall be calculated using Average Ammonia Specific consumption for previous three operating days and Ammonia consumption for plant for the day from meter no FI 120101. The calculated production value for the day shall be used for

	further processing; all other data from the Nitric acid mass flow meter for this day shall be ignored. In case concentration of nitric acid has not been determine for the day due to any reasons like shutdown, start-up etc, then: • In case of shut down data for concentration shall be taken from previous day. • In case of start-up data for concentration shall be taken from next day. • In case of shut down and start-up both data for concentration shall be taken from average of previous available day and next available day. • For any other reason not foreseen now decision from production in charge of the plant shall be taken for correctness of data based on reason of not availability. He will give decision whether previous day data to be used or next day data to be used. Conservativeness of the value will be maintained. Operation manager Nitric acid plant shall take appropriate decision for replacing the mass flow meter with similar or better instrument, if they are made available by instrument vendors in future The NAP value is calculated based on the mass flow of dilute Nitric acid and the acid concentration. The Concentration of Nitric acid is determined by using Hydrometer and Thermometer. The instrument accuracy of Mass flow measurement of dilute Nitric acid is ± 0.1% of rate.
Calculation method (if applicable):	-
QA/QC procedures applied:	**Nitric Acid Flow:** Calibration of flow meter once in three years as per OEM recommendation. **Nitric Acid Concentration:** Calibration of Hydrometer and Thermometer shall be ensured by ISO 9001 Procedures.

Data / Parameter:	**TSG**
Data unit:	Deg C
Description:	Temperature of stack gas
Measured /Calculated /Default:	Measured
Source of data:	Continuous Emission Monitoring system from ABB
Value(s) of monitored parameter:	Continuously Monitored
Indicate what the data are used for (Baseline/ Project/ Leakage emission	-

calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Given in Appendix III
Measuring/ Reading/ Recording frequency:	Frequency of monitoring: Every second
Description of measurement methods and procedures to be applied:	Temperature transmitter (TI 120400) is used for measurement of stack gas temperature. The accuracy of this instrument is ≤ 0.1 % of FS.
Calculation method (if applicable):	-
QA/QC procedures applied:	Regular calibrations according to ISO 9001 procedure and this instrument were tested as per QAL2 test of recognized industry standards (EN 14181) by Third Party TUV SUD, Germany.

Data / Parameter:	**PSG**
Data unit:	hPa
Description:	Pressure of stack gas
Measured /Calculated /Default:	Measured
Source of data:	Continuous Emission monitoring system from ABB
Value(s) of monitored parameter:	Continuously Monitored
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	-
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Given in Appendix III
Measuring/ Reading/ Recording frequency:	Frequency of recording: Every second
Description of measurement methods and procedures to be applied:	Pressure transmitter (PI 120400) is used for measurement of stack gas pressure. The accuracy of this instrument is 0.5 % of FSO.
Calculation method (if applicable):	.
QA/QC procedures applied:	Regular calibrations according to ISO 9001 procedure and this instrument were tested as per QAL2 test of recognized industry standards (EN 14181) by Third Party TUV SUD, Germany.

Data / Parameter:	**AFR**
Data unit:	Kg NH_3/h
Description:	Ammonia gas flow rate to AOR
Measured /Calculated /Default:	Measured
Source of data:	From CEM System

Value(s) of monitored parameter:	Continuously Monitored
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project Emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Given in Appendix III
Measuring/ Reading/ Recording frequency:	Frequency of monitoring: Continuous.
Description of measurement methods and procedures to be applied:	To be obtained from operating condition campaign. Ammonia flow meter is used. Transmitted from DCS. The accuracy of this instrument is ± 0.075 % of span.
Calculation method (if applicable):	-
QA/QC procedures applied:	Included in evaluation by third party validator

Data / Parameter:	**UNC**
Data unit:	%
Description:	Overall measurement uncertainty of the monitoring system
Measured /Calculated /Default:	Calculated
Source of data:	Calculated combined uncertainty factor determined by M/s TUV SUD, during QAL2 Test of monitoring equipment as per EN14181 guide line.
Value(s) of monitored parameter:	4.52
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline Emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not Applicable
Measuring/ Reading/ Recording frequency:	Frequency of recording: Once after monitoring system is commissioned.
Description of measurement methods and procedures to be applied:	QAL2 test by third party validator M/s. TUV SUD, Germany of Instrument as per guideline of EN14181
Calculation method (if applicable):	UNC value was calculated as part of QAL2 procedures of EN14181.
QA/QC procedures applied:	This value is calculated by Third party TUV SUD, Germany

Data / Parameter:	**AIFR**
Data unit:	-
Description:	Ammonia to Air ratio

Measured /Calculated /Default:	Measured
Source of data:	From CEM System
Value(s) of monitored parameter:	Obtained from DCS
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project Emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Given in Appendix III
Measuring/ Reading/ Recording frequency:	Frequency of recording: Every Hour.
Description of measurement methods and procedures to be applied:	Ammonia to Air ratio is calculated in DCS using signals transmitted from Ammonia flow transmitters (Tag no. FI 120211) and Air Flow transmitters (Tag no FI 120213). This signal is transmitted to CEM system. Accuracy of ammonia flow transmitter is ± 0.075% of span and that of Air Flow Transmitter is ± 0.1% of span.
Calculation method (if applicable):	Ratio is obtained from Ammonia flow Tag no FY 120211-M and Air Flow tag no FI 120213, transmitted from DCS
QA/QC procedures applied:	Regular calibrations are carried out for Ammonia Flow meter FY 120211-M and Air Flow meter FI 120213 as per ISO 9001 procedure.

Data / Parameter:	**OT_h**
Data unit:	Deg C
Description:	Oxidation temperature of each hour
Measured /Calculated /Default:	Measured
Source of data:	Continuous Emission Monitoring (CEM) system from ABB.
Value(s) of monitored parameter:	Continuously monitored
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project Emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Given in Appendix III
Measuring/ Reading/ Recording frequency:	Frequency of monitoring: Every hour
Description of measurement methods and procedures to be applied:	Transmitted from DCS. There are three duplex K type thermocouples are installed in reactor. These are used for temperature measurement, with Tag No. TI120332A, TI120333A and TI120334A. The D/A accuracy of this instrument is ± 0.03 % of span.
Calculation method (if	Not Applicable

applicable):	
QA/QC procedures applied:	Instruments are regularly calibrated as per ISO 9001 procedure.

Data / Parameter:	**OP_h**
Data unit:	kPa (guage)
Description:	Oxidation pressure of each hour
Measured /Calculated /Default:	Measured
Source of data:	Continuous Emission Monitoring (CEM) system from ABB.
Value(s) of monitored parameter:	Continuously monitored
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project Emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Given in Appendix III
Measuring/ Reading/ Recording frequency:	Frequency of monitoring: Every hour
Description of measurement methods and procedures to be applied:	Oxidation Pressure is measured by pressure transmitter tag no PT 120212A/B/C. The accuracy of this instrument is ± 0.075 % of span.
Calculation method (if applicable):	Not Applicable
QA/QC procedures applied:	Instruments are regularly calibrated as per ISO 9001 procedure.

Data / Parameter:	**$GS_{project}$**
Data unit:	-
Description:	Gauze Supplier for project campaign
Measured /Calculated /Default:	Measured
Source of data:	Plant Data
Value(s) of monitored parameter:	Rashtriya Chemicals & Fertilizer Ltd.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project Emission
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable
Measuring/ Reading/ Recording frequency:	Frequency of monitoring: Every Campaign
Description of measurement	Rashtriya Chemicals & Fertilizers limited is getting fabricated the

methods and procedures to be applied:	catalyst gauze from any one of the three parties RHPL/ HPL/ Aurora Mathey, on labour charge basis, giving them metal and specification of catalyst
Calculation method (if applicable):	Not Applicable
QA/QC procedures applied:	Not applicable.

Data / Parameter:	**$GC_{project}$**
Data unit:	-
Description:	Gauze Composition during project campaign
Measured /Calculated /Default:	Measured
Source of data:	Monitored
Value(s) of monitored parameter:	Pt - 92%, Rh - 8%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not Applicable
Measuring/ Reading/ Recording frequency:	Frequency of monitoring: Every Campaign
Description of measurement methods and procedures to be applied:	Rashtriya Chemicals & Fertilizers limited is getting fabricated the catalyst gauze from any one of the three parties RHPL/ HPL/ Aurora Mathey, on labour charge basis, giving them metal and specification of catalyst
Calculation method (if applicable):	Not Applicable
QA/QC procedures applied:	Precious metal composition is checked by Third Party Ledoux & Company

Data / Parameter:	**EF_{reg}**
Data unit:	
Description:	Emissions level set by incoming policies or regulations
Measured /Calculated /Default:	Not Applicable
Source of data:	Maharashtra Pollution Control Board
Value(s) of monitored parameter:	Currently India does not have any regulation w.r.t. N_2O emissions
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project
Monitoring equipment (type, accuracy class, serial number, calibration	Not Applicable

frequency, date of last calibration, validity)	
Measuring/ Reading/ Recording frequency:	-
Description of measurement methods and procedures to be applied:	Currently there is no regulation for N_2O emission. The new regulation will get reflected in consent to operate the plants. Consent to operate will be checked for N_2O emission applicability for each campaign
Calculation method (if applicable):	Not Applicable
QA/QC procedures applied:	Updated when new regulations comes into force

QAL2 Correction Factors: (As per QAL2 test August 2008)

Measuring Parameter	Correction Factor	
	a	b
N_2O	- 1,240	310.1
Volume Flow	- 72,552	18,138
Temperature	-37.7	9.43
Pressure	-402	100.4

There is no change in the QAL2 Correction Factors.
In AST 2011, SGS has recommended that measuring inaccuracy constant for NCSG which is 62 should not be subtracted and the value of this constant should be made zero in the system. Accordingly, to comply with the recommendation of SGS, all NCSG readings during the monitoring period are added with 62 and further used for CER calculation.

D.3. Implementation of sampling plan

NA

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

As per the registered PDD, the baseline emission factor is 0.0125 $tCO_2e/ tHNO_3$

Particulars	Unit	Value
Volume flow rate of stack gas	Nm^3/h	49,077
N_2O concentration in stack gas - baseline	mg N_2O/ Nm^3	4,054.10
Operating hours	h/campaign	2,861
Baseline emissions	$tN_2O/$ campaign	569.23
Uncertainty UNC	%	4.52%
HNO_3 production	$tHNO_3/$ campaign	43,326
N_2O emission factor – baseline	**$tN_2O/ tHNO_3$**	**0.0125**

The CEM down time details is given in Annexure II. The lowest value between the IPCC default value and the last measured value is used in the down time period for the baseline emission factor. There is no

change in the baseline emission factor as given in the registered PDD while considering the lowest value in the down time period.

Adjustment of baseline:
As per the methodology, baseline emission factor is to be adjusted in following cases –

If $CL_n < CL_{normal}$, recalculate EF_{BL} by eliminating those N_2O values that were obtained during the production of tonnes of nitric acid beyond the CL_n (i.e. the last tonnes produced) from the calculation of EF_n.

Project Campaign 3:

SN	Description	Unit	Campaign – 4	Campaign – 5	Campaign – 6	Campaign – 7
1	CL_n	$tHNO_3$	41,246	43,767	42,873	43,341
2	CL_{normal}	$tHNO_3$	44,435	44,435	44,435	44,435
3	CL_{BL}	$tHNO_3$	43,326	43,326	43,326	43,326

Here, for campaign – 4, CL_n is less than CL_{normal}. Hence Baseline emission factor is recalculated.
For campaign – 5, CL_n is less than CL_{normal}. Hence recalculation of Baseline emission factor is required.
However CL_{BL} is even lesser than CL_n therefore recalculation of Baseline is not possible.
For campaign – 6, CL_n is less than CL_{normal}. Hence Baseline emission factor is recalculated.
For campaign – 7, CL_n is less than CL_{normal}. Hence recalculation of Baseline emission factor is required.
However CL_{BL} is even lesser than CL_n therefore recalculation of Baseline is not possible.
This is in compliance of "Clarification to AM0034 (Version 02): Catalytic Reduction of N_2O inside the Ammonia Burner of Nitric Acid Plants" given in EB 51 Annex 12.

E.2. Calculation of project emissions or actual net GHG removals by sinks

Over the duration of the project activity, N_2O concentration and gas volume flow in the stack of the nitric acid plant as well as the temperature and pressure of ammonia gas flow and ammonia-to-air ratio have been measured continuously. The daily report comprising of the data for the day is generated by N_2O measuring AMS. The daily reports for the campaign period are compiled. The data pertaining to shut-down period of the plant is deleted form this compiled data and procedures defined under emergency preparedness are applied wherever applicable. The data so obtained is called Base data.

All the individual data readings where parameters are not within the specification of the facility are deleted. The data so obtained is called valid data.

Sample mean i.e. average value and standard deviation is determined for VSG and NCSG values in valid data sheet. 95% confidence level value is determined by multiplying standard deviation value by 1.96. This value is then added and subtracted from the sample mean value to arrive at new maximum and minimum limits. The new sample mean is determined by taking average of the NCSG and VSG values which are within these maximum and minimum limits.

Estimation of campaign-specific project emissions:

$$PE_n = VSG * NCSG * OH * 10^{-9}$$

Where,

VSG = Mean Stack Gas volume flow rate for the project campaign (m^3/h)

NCSG = Mean Concentration of N_2O in the stack gas for the project campaign (mg N_2O/Nm^3)
OH = Number of hours of operation in the specific monitoring period (h)
PE_n = Total N_2O emissions of the n^{th} project campaign (tN_2O)

Derivation of a moving average emission factor

Step 1:
Campaign specific emissions factor for each campaign is estimated during the project's crediting period by dividing the total mass of N_2O emissions during that campaign by the total production of 100% concentrated nitric acid during that same campaign

$EF_n = PE_n / NAP_n$

Results:

Parameter	Unit	Campaign – 4	Campaign – 5	Campaign – 6	Campaign – 7
VSG	Nm^3/h	51,754	45,868	41,414	41,669
NCSG	mgN_2O/ Nm^3	1,458	482	681	669
OH	Hours	2,875	2,914	2,874	2,892
NAP	$tHNO_3$	41,246	43,767	42,873	43,341
PE n	tN_2O	217	64	81	81
EF	**$tN_2O/tHNO_3$**	**0.0053**	**0.0015**	**0.0019**	**0.0019**

Step 2: Estimate a moving average emissions factor is calculated at the end of a campaign 'n' as follows:

$EF_{ma,n} = (EF_1+EF_2+……..EF_n) / n$

And consider the maximum of $EF_{ma,\,n}$ and EF_n for estimation of project emissions.

Results:

Project Campaign 4:

$EF_1 = NA$[1]	$EF_2 = 0.0032$
$EF_3 = 0.0026$	$EF_4 = 0.0053$

Moving Average Emission Factor = $EF_{ma,4} = (EF_2 + EF_3 + EF_4) / 3$
$= (0.0032 + 0.0026 + 0.0053) / 3$
$= 0.0037$

EF for the Project = $EF_4 = Max (EF_{ma,4}, EF_4)$
$= Max (0.0037, 0.0053)$
$= 0.0053$

[1] As per Recommendation by the Meth Panel (Date of Meth Panel meeting: 7 - 11 March 2011) on request for clarification (AM_CLA_0204) on Approved Methodologies (reference 'F-CDM-AM-Clar_Resp_ver 01.1 '). For the calculation of the moving average emission factor EF ma,n, the emission factor of the first campaign shall be excluded if it is partially outside the crediting periods.]

Project Campaign 5:

EF_1 = NA	EF_2 = 0.0032
EF_3 = 0.0026	EF_4 = 0.0053
EF_5 = 0.0015	

Moving Average Emission Factor = $EF_{ma,5}$ = (EF_2 + EF_3 + EF_4 + EF_5) / 4
= (0.0032 + 0.0026 + 0.0053 + 0.0015) / 4
= 0.0031

EF for the Project = EF_5 = Max ($EF_{ma,5}$, EF_5)
= Max (0.0031, 0.0015)
= 0.0031

Project Campaign 6:

EF_1 = NA	EF_2 = 0.0032
EF_3 = 0.0026	EF_4 = 0.0053
EF_5 = 0.0015	EF_6 = 0.0019

Moving Average Emission Factor = $EF_{ma,6}$ = (EF_2 + EF_3 + EF_4 + EF_5 + EF_6) / 5
= (0.0032 + 0.0026 + 0.0053 + 0.0015 + 0.0019) / 5
= 0.0029

EF for the Project = EF_6 = Max ($EF_{ma,6}$, EF_6)
= Max (0.0029, 0.0019)
= 0.0029

Project Campaign 7:

EF_1 = NA	EF_2 = 0.0032
EF_3 = 0.0026	EF_4 = 0.0053
EF_5 = 0.0015	EF_6 = 0.0019
EF_7 = 0.0019	

Moving Average Emission Factor = $EF_{ma,7}$ = (EF_2 + EF_3 + EF_4 + EF_5 + EF_6 + EF_7) / 6
= (0.0032 + 0.0026 + 0.0053 + 0.0015 + 0.0019 + 0.0019) / 6
= 0.0027

EF for the Project = EF_7 = Max ($EF_{ma,7}$, EF_7)
= Max (0.0027, 0.0019)
= 0.0027

Emission reductions calculation:

The emission reduction is calculated by baseline emissions minus the project emissions. The following formula is adopted for calculating emission reductions generated by the project activity:

Emission Reductions:

$$\mathbf{ER = (EF_{BL} - EF_p) * NAP * GWP_{N2O}}$$

Where

ER = Emission reductions of the project for the specific Monitoring period (tCO2e)
EF_{BL} = Baseline Emission Factor ($tN_2O/tHNO_3$)
EF_P = Emission Factor used to calculate the emissions from this particular Monitoring Period (i.e the higher of $EF_{ma,\ n\ and}\ EF_n$)
NAP = Nitric Acid production for the Monitoring Period ($tHNO_3$). The Maximum Value of NAP shall not exceed the design capacity
GWP_{N2O} = Global Warming Potential for the N_2O as per IPCC default value.

Results:

Parameter	Unit	Campaign – 4	Campaign – 5	Campaign – 6	Campaign – 7
NAP	$tHNO_3$	41,246	43,767	42,873	43,341
EF_{BL}	$tN_2O/tHNO_3$	0.0125	0.0125	0.0125	0.0125
EF_p	$tN_2O/tHNO_3$	0.0053	0.0031	0.0029	0.0027
GWP_{N2O}	tCO_2/tN_2O	310	310	310	310

Project Campaign 4:
ER = (0.0125 - 0.0053) * 41,246 * 310
= 92,579 tCO_2

Project Campaign 5:
ER = (0.0125 - 0.0031) * 43,767 * 310
= 127,080 tCO_2

Project Campaign 6:
ER = (0.0125 - 0.0029) * 42,873 * 310
= 127,790 tCO_2

Project Campaign 7:
ER = (0.0125 - 0.0027) * 43,341 * 310
= 131,480 tCO_2

Total Emission Reduction during Monitoring period = 92,579 + 127,080 + 127,790 + 131,480
= 478,929 tCO_2

E.3. Calculation of leakage

NA

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Time Period	Baseline emissions or baseline net GHG removals by sinks (tCO_2e)	Project emissions or actual net GHG removals by sinks (tCO_{2e})	Leakage (tCO_2e)	Emission reductions or net anthropogenic GHG removals by sinks (tCO_2e)
Campaign Period – 4 (05/12/2010 - 13/04/2011)	159,828	67,248	NA	92,579 (Round down figure)
Campaign Period – 5 (14/04/2011 - 28/08/2011)	169,599	42,519	NA	127,080 (Round down figure)
Campaign Period – 6 (29/08/2011 - 07/01/2012)	166,134	38,344	NA	127,790 (Round down figure)
Campaign Period – 7 (08/01/2012 - 10/05/2012)	167,947	36,466	NA	131,480 (Round down figure)
Total	663,508	184,577	NA	478,929

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (tCO_2e) for campaign period – 4	159,314 tCO2 (447,305 tCO2 x 130 days / 365 days)	92,579 tCO2
Emission reductions or GHG removals by sinks (tCO_2e) for campaign period – 5	167,893 tCO2 (447,305 tCO2 x 137 days / 365 days)	127,080 tCO2
Emission reductions or GHG removals by sinks (tCO_2e) for campaign period – 6	161,765 tCO2 (447,305 tCO2 x 132 days / 365 days)	127,790 tCO2
Emission reductions or GHG removals by sinks (tCO_2e) for campaign period – 7	151,961 tCO2 (447,305 tCO2 x 124 days / 365 days)	131,480 tCO2

E.6. Remarks on difference from estimated value in registered PDD

The emission reduction during this monitoring period is less than the ex – ante value mainly due to lower catalyst efficiency of 58%, 86%, 80% and 81% during Campaign Period – 4, 5, 6 and 7 respectively as against the estimated catalyst efficiency of 90% for ex-ante values.

Appendix-I

Base Data (As validated during validation)

Parameter	Unit	Value
AFR max	$kgNH_3$/ h	5113
AIFR max	%	11.50%
OT normal	Deg C	863-900
OP normal	Bar(guage)	660 – 626
GS BL		RCF
GC BL	-	Pt - 92%, Rh – 8%
NCSG BC	mgN_2O/ Nm^3	4054.1
VSG BC	Nm^3/h	49,077
OH BC	hours	2861
NAP BC	$tHNO_3$	43,326
CL BL	$tHNO_3$	43,326
CL normal	$tHNO_3$	44,435
GS normal	-	Rashtriya Chemicals & Fertilizer Ltd
GC normal	-	Pt – 92%, Rh - 8%
Design Capacity	MT/ annum	128,480

Historical Data:

Unit 1 : 352 TPD(HP) Campaign 1	Catalyst Running Hrs. : 2,879
Date: 08.11.2005 to 12.03.2006	Production : 44,469

Unit 1 : 352 TPD (HP) Campaign 2	Catalyst Running Hrs. : 2,871
Date: 13.03.2006 to 14.11.2006	Production : 43,796

Unit 1 : 352 TPD(HP) Campaign 3	Catalyst Running Hrs. : 2,879
Date: 17/11/2006 to 17/06/2007	Production : 45,570

Unit 1 : 352 TPD(HP) Campaign 4	Catalyst Running Hrs. : 2,880
Date: 21/06/2007 to 18/01/2008	Production : 43,715

Unit 1 : 352 TPD(HP) Campaign 5	Catalyst Running Hrs. : 2,902
Date: 20/01/2008 to 01/07/2008	Production : 44,625

Parameters	Unit	Historical Values (a)	Design Data (b)	Permitted Range
Oxidation Temp	Deg C	863-900	860-930	860-930
Oxidation Pr	bar(g)	6.60-6.26	7.65	7.65
Ammonia Flow Rate (Max)	Nm3/ h	6,725	7,992	7,992
Ammonia Flow Rate (Max)	kg/ h	5113	6076	6076
Ammonia - air ratio (Max)	%	11.9	11.5	11.5

Appendix - II

HP NA Plant shutdown/start-up and CEM System down time details

CEM system down time records during monitoring period:
The details for down time of CEM system for monitoring various parameters for HP Nitric acid Plant is as follows:

SN	From	To	Reason
1	07.12.2010 13:00	07.12.2010 14:00	AFR reading not available due to card failure
2	31.12.2010 11:00	31.12.2010 17:00	AFR reading not available due to card failure
3	06.04.2011 01:00	06.04.2011 06:00	NCSG error readings due to vacuum pump tripping.
4	27.04.2011 18:00	28.04.2011 08:00	Data loss due to relay failure
5	11.05.2011 21:00	11.05.2011 21:00	Data loss due to remote login
6	19.01.2012 17:00	20.01.2012 09:00	NCSG error readings due to sampling probe temp.

Plant Shutdown / Start-up records during monitoring period:
HP Nitric acid Plant shutdown and start-up records during the monitoring period is as follows

Plant Shutdown From	Plant Shutdown up-to	Duration of shutdown (In hr)	Reason of shutdown
Campaign – 4			
05.12.2010 00:00	05.12.2010 02:00	3	For primary catalyst replacement
04.01.2011 05:00	04.01.2011 23:00	19	For primary catalyst inspection
02.02.2011 04:00	03.02.2011 07:00	28	For Cooling water shortage
10.02.2011 22:00	11.02.2011 02:00	5	Woodward governor problem
13.02.2011 02:00	13.02.2011 10:00	9	Woodward governor problem
13.02.2011 16:00	14.02.2011 01:00	10	Woodward governor problem
24.02.2011 05:00	25.02.2011 03:00	23	Woodward governor problem
17.03.2011 20:00	21.03.2011 08:00	85	For Cooling water shortage
01.04.2011 19:00	03.04.2011 12:00	42	For Cooling water shortage
13.04.2011 04:00	13.04.2011 23:00	20	Annual turnaround jobs
Campaign – 5			
14.04.2011 00:00	22.04.2011 07:00	200	For primary catalyst replacement
22.04.2011 09:00	22.04.2011 11:00	3	-
03.05.2011 12:00	09.05.2011 03:00	136	Due to high stock
26.05.2011 17:00	28.05.2011 01:00	33	Instrument air low pressure
28.08.2011 00:00	28.08.2011 23:00	24	For primary catalyst replacement
Campaign – 6			
29.08.2011 00:00	07.09.2011 00:00	217	Due to high stock
29.09.2011 07:00	29.09.2011 15:00	9	Cooling water limitation
05.11.2011 04:00	06.11.2011 00:00	21	For primary catalyst inspection
24.11.2011 12:00	24.11.2011 17:00	6	Power failure
06.12.2011 05:00	06.12.2011 22:00	18	Low water level in boiler
07.12.2011 02:00	07.12.2011 04:00	3	-
07.01.2012 04:00	07.01.2012 23:00	20	For primary catalyst replacement
Campaign – 7			
31.01.2012 16:00	31.01.2012 18:00	3	Cooling water limitation
28.03.2012 05:00	30.03.2012 16:00	60	For primary catalyst inspection
10.05.2012 04:00	10.05.2012 23:00	20	For primary catalyst replacement

Appendix - III
Technical Details of Monitoring Instruments:

Data Variable	Description	Data Unit	Instrument Type	Instrument Tag no.	Sr. No	Accuracy	Data of Previous calibration	Date of calibration	Calibration frequency	Next calibration conducted on	Calibration Agency
AFR	Amm gas to N 001	Nm3/ Hr	D.P Type Transmitter	FT120 211A	S0198 744	± 0.075% of span	06/08/2010	19/04/2011, 28/03/2012	1 Year	27/03/13	Plant
AFR	Amm gas to N 001	Nm3/ Hr	D.P Type Transmitter	FT120 211B	S0198 745	± 0.075% of span	06/08/2010	19/04/2011, 28/03/2012	1 Year	27/03/13	Plant
AFR	Amm gas to N 001	Nm3/ Hr	D.P Type Transmitter	FT120 211C	S0198 746	± 0.075% of span	06/08/2010	19/04/2011, 28/03/2012	1 Year	27/03/13	Plant
OP	Amm - inlet to N001	Barg	Pressure Transmitter	PT 120212A	01209 936	± 0.075% of span	04/08/2010	16/04/2011, 29/03/2012	1 Year	28/03/13	Plant
OP	Amm - inlet to N001	Barg	Pressure Transmitter	PT 120212B	01209 934	± 0.075% of span	04/08/2010	16/04/2011, 29/03/2012	1 Year	28/03/13	Plant
OP	Amm - inlet to N001	Barg	Pressure Transmitter	PT 120212C	01209 937	± 0.075% of span	04/08/2010	16/04/2011, 29/03/2012	1 Year	28/03/13	Plant
AFR & AIFR	Amm - inlet to N001 temp	Deg.cent	RTD with R/I converter	TT 120212A	NA	Deviation after calibration: 0.1% of F.S. value	02/08/2010	19/04/2011, 30/03/2012	1 Year	29/03/13	Plant
AFR & AIFR	Amm - inlet to N001 temp	Deg.cent	RTD with R/I converter	TT 120212B	NA	Deviation after calibration: 0.1% F.S. value	02/08/2010	19/04/2011, 30/03/2012	1 Year	29/03/13	Plant
AFR & AIFR	Amm - inlet to N001 temp	Deg.cent	RTD with R/I converter	TT 120212C	NA	Deviation after calibration: 0.1% F.S. value	02/08/2010	19/04/2011, 30/03/2012	1 Year	29/03/13	Plant
AIFR	Air Flow-N001	Nm3/ Hr	D.P Type Transmitter	FT 120213A	S0198 740	± 0.10% of span	06/08/2010	19/04/2011, 28/03/2012	1 Year	27/03/13	Plant
AIFR	Air Flow-N001	Nm3/ Hr	D.P Type Transmitter	FT 120213B	S0198 741	± 0.10% of span	06/08/2010	19/04/2011, 28/03/20	1 Year	27/03/13	Plant

								12			
AIFR	Air Flow-N001	Nm3/Hr	D.P Type Transmitter	FT 120213C	S0198742	± 0.10% of span	06/08/2010	19/04/2011, 28/03/2012	1 Year	27/03/13	Plant
AIFR	Air inlet to N001	Barg	Pressure Transmitter	PT120214A	S0198760	± 0.075% of span	05/08/2010	18/04/2011, 29/03/2012	1 Year	28/03/13	Plant
AIFR	Air inlet to N001	Barg	Pressure Transmitter	PT120214B	S0198761	± 0.075% of span	05/08/2010	18/04/2011, 29/03/2012	1 Year	28/03/13	Plant
AIFR	Air inlet to N001	Barg	Pressure Transmitter	PT120214C	S0198762	± 0.075% of span	05/08/2010,	18/04/2011, 29/03/2012	1 Year	28/03/13	Plant
AIFR	Air inlet to N001 temp	Deg.cent	RTD with R/I converter	TT 120214A	NA	Deviation after calibration: 0.1% of F.S. value	04/08/2010	19/04/2011, 30/03/2012	1 Year	29/03/13	Plant
AIFR	Air inlet to N001 temp	Deg.cent	RTD with R/I converter	TT 120214B	NA	Deviation after calibration: 0.1% of F.S. value	04/08/2010	19/04/2011, 30/03/2012	1 Year	29/03/13	Plant
AIFR	Air inlet to N001 temp	Deg.cent	RTD with R/I converter	TT 120214C	NA	Deviation after calibration: 0.1% of F.S. value	04/08/2010	19/04/2011, 30/03/2012	1 Year	29/03/13	Plant
OT	Catalyst Temp ROO1	Deg.cent	Temp. Transmitter	TT120332A	199556	D/A Accuracy ± 0.03% of span	02/08/2010	20/04/2011, 28/03/2012	1 Year	27/03/13	Plant
OT	Catalyst Temp ROO1	Deg.cent	Temp. Transmitter	TT120333A	199558	D/A Accuracy ± 0.03% of span	02/08/2010	20/04/2011, 29/03/2012	1 Year	28/03/13	Plant
OT	Catalyst Temp ROO1	Deg.cent	Temp. Transmitter	TT120334A	199560	D/A Accuracy ± 0.03% of span	02/08/2010	20/04/2011, 29/03/2012	1 Year	28/03/13	Plant
NCSG	N2O Analyser	Mg/m3	N2O Analyser	AI 120400	02400 71228 /2400	Repeatability ≤ 0.5% of span	19/11/10	02/2/11, 28/4/11, 06/7/11, 06/9/11, 06/12/11 31/1/12, 28/3/12	3 Months	27/06/12	Plant
VSG	Stack Flow	mBar	D.P Type Transmitter	FI120400	265DS 66000 28331	Base Accuracy ±	08/07/2010	21/04/2011, 30/03/20	1Year	29/03/13	Plant

						0.04%		12			
PSG	Stack Pressure	hPa	Pressure Transmitter	PI120400	1198949	0.5% of FSO	08/07/2010	21/04/2011, 30/03/2012	1Year	29/03/13	Plant
TSG	Stack Temp	Deg.cent	RTD with R/I converter	TI120400	NA	Linearity error : <0.1 % FS	08/07/2010	21/04/2011, 30/03/2012	1Year	29/03/13	Plant
NAP	Product acid flow	T/hr	Mass flow meter	FI10121	NEW SENSOR SR.NO 14206043 NEW TRANS. SR.NO 3170443 OLD SEN.-12031565, TRANS.-3781972	± 0.1% of rate	24/06/08	19/04/2011	3 Years	19/04/2014	External Agency
NAP	Acid Density	gm/cc	Hydrometer	NA	NA	Least count: 0.001	17/11/2010	16/5/2011, 14/11/2011	6 months	13/5/12	CC Lab
NAP	Acid Temperature	Deg C	Thermometer	NAG/L/TM-1	NA	Least count: 1	18/11/2010	25/10/2011	1 Year	25/10/12	Instrument Workshop

Appendix –IV

Abbreviations

AFR	Ammonia Gas Flow Rate to AOR
AIFR	Ammonia to Air Ratio
AOR	Ammonia Oxidation Reactor
BC	Baseline Campaign
BE	Baseline Emission
CDM	Clean Development Mechanism
CEM	Continuous Emission Monitoring
ER	Emission Reduction
FSO	Full Scale Operation
FS	Full Scale
GHG	Green House Gases
GWP	Global Warming Potential
MR	Monitoring Report
NAP	Nitric Acid Production
NH_3	Ammonia
N_2O	Nitrous Oxide
OH	Operating Hours
OP	Operating Pressure
OT	Operating Temperature
RCF	Rashtriya Chemicals and Fertilizers Limited
TSG	Temperature of Stack Gas
VSG	Volume flow rate of the Stack Gas