Reserve Special Topic:

Nitric Acid Production Project Protocol v1.0

CLIMATE ACTION RESERVE

Webinar will begin shortly

For audio, please dial (773) 945-1010

Access code: 183-528-628

Presentation Overview

1. Introduction
   – **Max DuBuisson** – Business Development Associate, Climate Action Reserve
2. Nitric Acid Production Project Protocol v1.0
   – **Nancy Kong** – Policy Associate, Climate Action Reserve

Current Statistics

- Reserve launched: **May 2008**
- Account-holders: **202**
- Total submitted projects: **181**
  - Located in **39** states
- CRTs issued: **~2.47 million**
- Recent average price: **$6.80 per CRT**
  - According to ***New Energy Finance, Global Carbon Quarterly Q3 2009***, September 2009

Agenda

- Introduction to the Nitric Acid Production Project Protocol
  - Background
  - Project definitions
  - Eligibility rules
  - Calculations
  - Monitoring and reporting requirements
  - Verification guidance
- Q&A

What are these projects?

- Activities that reduce nitrous oxide (N_2O) emissions from nitric acid plants (NAPs) at nitric acid production facilities in the U.S.
- Why?
  - N_2O is a potent greenhouse gas
  - Global warming potential of 310 tCO_2e

Protocol Development Goals

- Develop a standardized approach for quantifying, monitoring and verifying GHG reductions from N_2O emissions abatement projects at NAPs in the U.S.
- Improve upon existing methodologies
  - AM 0028: *Catalytic N_2O destruction in the tail gas of Nitric Acid or Caprolactuam Production Plants*
  - AM 0034: *Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants*
- Ensure accuracy and practicality of projects

Protocol Differences from CDM Methodologies

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- A more flexible, yet still conservative, baseline approach for secondary projects that allows for shorter sampling timeframes
- A modified safeguard against overproduction of nitric acid based on plant- specific historical production levels rather than nameplate capacity
- Removal of a difficult to verify CDM restriction that limits changes in primary catalyst composition
- Removal of requirement for secondary projects to use a moving average for the calculation of project emissions.
  - The Reserve has taken a more direct approach by requiring consistent operating conditions throughout the baseline sampling and project crediting period.

Protocol Development Process

- Internal protocol scoping
- Stakeholder scoping meeting in DC on May 19, 2009
- Form multi-stakeholder workgroup
- Legal requirements and performance standard research
- Send draft through workgroup process
  - Workgroup provides technical expertise and practitioner experience
  - Periodic meetings and individual consultation when needed
- Draft protocol released for 30-day public review Oct 2009
- Public comments incorporated
- Protocol adopted by Reserve Board on Dec 2, 2009

Workgroup

Kevin Townsend	Blue Source, LLC
Lei Guo	California Air Resources Board
William Flederbach	ClimeCo America Corporation
Trine Kopperud	DNV
William Herz	The Fertilizer Institute
Marten von Velsen-Zerweck	N. Serve Environmental Services
David Hind	Orica Canada Inc /ANNA
Jim Schellhorn	Terra Industries Inc.
Mausami Desai	U.S. Environmental Protection Agency
Nathan Frank	U.S. Environmental Protection Agency

Background – Nitric Acid Production Process

- 2 step process:
  - Ammonia is first oxidized over a precious metal gauze catalyst to form NO and NO_2
  - Absorption in water creates nitric acid (HNO_3)
- Bi-products of these reactions are
  - NO and NO_2 (or collectively, NO_x)
  - N_2O
- In the U.S., current pollution control technology targets NO_x only.

Background – NO_x Abatement

- **Non-selective catalytic reduction** (NSCR)
  - Installed until late-1970s
  - Controls NO_x and controls N_2O up to ~80%
  - Requires high temperature and energy inputs
  - Some U.S. nitric acid plants still using NSCR to control NO_x

- **Selective catalytic reduction** (SCR)
  - Employed in most U.S. nitric acid plants today
  - Controls only NOx, does not control N_2O
  - Lower cost of operation, lower temperature requirements

Background – Potential N_2O Abatement Measures

Measure	Point of Application
Primary abatement	Prevents N_2O formation in the ammonia burner by modification of (i.e. optimizing) the ammonia oxidation process and/or primary catalysts.
Secondary abatement	Removes N_2O from the gases between the ammonia oxidation reactor (AOR) and the absorption tower. Usually this will mean intervening at the highest temperature, immediately downstream of the primary catalyst and catalytically reducing the N_2O once it has been formed in the AOR.
Tertiary abatement	Treats the tail-gas leaving the absorption tower to destroy N_2O. N_2O abatement can be placed upstream or downstream of the tail-gas expansion turbine. These abatement measures may include catalytic decomposition or NSCR.

Project Definition

- Installation any of the following N_2O abatement technology at a single Nitric Acid Plant (NAP)
- Two Eligible Project Types:
  - "Secondary" Abatement
    - Installation of secondary catalyst inside or directly below reactor
  - "Tertiary" abatement
    - Installation of tertiary catalyst or a NSCR unit in tail gas

Project Definition

- **Eligible NAPs**
  - Existing, relocated and upgraded NAPs
- **Non- Eligible NAPs**
  - NAPs that have been idle for more than 24 months at any time since December 2, 2007
  - NAPs constructed after December 2, 2009 (unless permitted before December 2, 2009)
  - NAPs using NSCR for NO_x abatement now or at anytime since December 2007

Project Eligibility Rules

1. Location	U.S. and its territories
2. Project Start Date	- Not earlier than December 2, 2007 - Within 6 months prior to project submission
	Projects that started between Dec. 2007 and Dec. 2009 must be listed by December 2010
3. Additionality	Exceed legal requirement
	Meet performance standard
4. Regulatory Compliance	Compliance with all applicable laws
5. Crediting Period	10 years, renewable one time

Performance Standard

- Technology-specific threshold
- Installation of any of the following technologies for N_2O abatement goes beyond common practice:
  - Secondary catalyst
  - Tertiary catalyst
  - NSCR (at eligible NAPs only)
- Performance Standard Test is applied once at the beginning of each crediting period

Legal Requirement Test

- Regulatory analysis identified no existing laws or regulations obligate N_2O abatement at NAPs
  - EPA mandatory reporting rule does not legally require N_2O abatement.
  - Under CAA, NOx abatement is required but there is no prescription of technology to achieve performance standards
    - SCR is common practice
    - NSCR (which also abates N_2O) is NOT common practice
- Project developers are required to submit signed Regulatory Compliance Attestation and Voluntary Implementation Attestation for each verification
- Emission reductions can be reported up until date N_2O is legally required to be abated or N_2O from NAPs is capped

Roadmap of Project Process

- Determine Historical maximum HNO_3 Production; Permitted Operating Conditions; Campaign Length Cap
- Establish CEMS for N_2O emissions monitoring
- Develop Monitoring Plan
- Run baseline N_2O sampling (secondary projects only)

Before Project Starts

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- Install N_2O Abatement Unit

Project Starts

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- Monitor required variables (see Table 6.1 and 6.2)
- Ensure staying within permitted range for operating conditions
- Calculate baseline and project emission factors and emission reductions

Each Reporting Period

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- Verification

After each Reporting Period

Historical HNO_3 Production

- **Purpose:** to provide assurance that HNO_3 production levels are consistent with business as usual
  - HNO_{3MAX} is used to limit the emission reductions that can be claimed
- Based on the maximum annual average production of HNO_3 for 5 years
- If 5 years of data are not available HNO_{3Max} may be based on:
  - Five or more campaigns prior to project start
  - Or, nameplate capacity (as specified in the operating manuals and permits)
- Upgraded NAPs** base historical production on historical data from before the upgrade

  ** upgraded within 24 months before the project starts or anytime during the project crediting period.

Emission Reductions: Secondary Catalyst Projects

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$$ER = (EF_{BL} - EF_{P}) \times HNO3_{ER} \times GWP_{N2O}$$

- Equation 5.1
- Difference in baseline and project emission factor (EF)
  - EF is metric tons N_2O per metric ton HNO_3 produced in a single campaign
- Times nitric acid production ($HNO3_{ER}$), which is based on the lower of:
  - Historical maximum annual average HNO_{3MAX}
  - Actual HNO_3 produced during a campaign
- Calculated at end of each campaign after project is initiated

Secondary Catalyst Projects: Baseline Sampling + Calculating Baseline Emission Factor

- Baseline sampling period (OH_{BC}): at minimum, sampling occurs the first 10 weeks of a campaign and before installing the secondary project catalyst
- Continuously measure gas flow (VSG_{BC}) and N_2O ($NCSG_{BC}$) in the stack gas
- To account for distortions before and after downtime or malfunctions, data outside of 95% confidence interval are eliminated before calculating BE_{BC}

$$BE_{BC} = VSG_{BC} \times NCSG_{BC} \times OH_{BC} \times 10^{-9}$$

$$EF_{BL} = BE_{BC} \div HNO3_{BC}$$

(See Equation 5.2 and 5.3)

Permitted Operating Conditions (POC)

- Purpose: to ensure N_2O emissions during baseline sampling are representative of typical conditions and comparable to those during the project
  - NAPs must operate within POC during baseline and project campaign (if not, N_2O data may be eliminated or sampling could be considered invalid and baseline must be repeated.

- Permitted ranges of the following must be determined:
  - Oxidation temperature and pressure in ammonia oxidation reactor
  - Ammonia gas flow rates and ammonia to air ratio input to ammonia oxidation reactor
- Determined by:
  - Historical data on operations from the previous 5 campaigns
  - Operating manuals and ammonia oxidation catalyst specifications
  - Or, combination of above
  - Ranges constrained by eliminating extremes (upper and lower 2.5 percentiles are dropped)
  - Determined from data post-upgrade or -relocation, if applicable

Secondary Projects: Project Emission Factor (EF_P)

- Measured for duration of each campaign following the start of the project
- Same as baseline approach (see Equations 5.4 and 5.5)
  - Continuously measure the stack gas volume flow and N_2O concentration and use data to calculate N_2O emissions
  - Divide total N_2O emissions by HNO_3 produced during the project campaign
  - Values outside the 95% confidence interval around the mean are excluded
  - If NAP operates outside POC for more than 50% of the time, data are invalid
  - Operations may not be significantly different statistically than POC

Tertiary Catalyst Projects: Baseline Emissions + Sampling

$$BE = \left(\sum_{i}^{n} F_i \times CI_{N_2O,i} \times M_i \right) \times GWP_{N_2O}$$

- Equation 5.7
- Based on N_2O from nitric acid production (i.e. N_2O in the tail gas before tertiary abatement unit)
- Continuously measure:
  - N_2O concentration ($CI_{N2O,i}$) at the inlet
  - Gas flow rate at a location near the tertiary abatement unit (F_i)
- Calculate N_2O for each interval i (M is length of the interval)
- Summarize over the reporting period (n) and convert to tCO_2e

Tertiary Projects: Historical HNO_3 Production Limit

$$BE = \left[\left(\sum_{i}^{n} F_i \times CI_{N_2O,i} \times M_i \right) \times GWP_{N_2O} \right] \times HNO_{3MAX} / HNO_{3RP}$$

- If HNO_3 produced during the reporting period (HNO_{3RP}) exceeds the maximum annual average (HNO_{3MAX}), then the above equation must be used
- Maximum annual average determined the same way as in secondary catalyst projects, but scaled from a per campaign basis to the reporting period length

Permitted Operating Conditions (POC)

- Determined in the same way as secondary catalyst projects
- If pressure and temperature are outside POC ranges at anytime during interval i, baseline emissions during that interval are the lowest of:
  - N_2O emissions measured during that interval
  - N_2O emissions calculated using the IPCC default emission factor of 4.5 $kgN_2O/tHNO_3$ and HNO_3 production during the interval
- If daily ammonia flow rate exceeds upper limit of POC, then baseline emissions are based on the IPCC default factor for that day
- If NAP operates outside POC for > 50% of the time, data are invalid
- Operations may not be significantly different statistically than POC

Tertiary Catalyst Projects: Project Emissions

$$PE = PE_{N_2O} + PE_{NH} + PE_{HC} + PE_{EE}$$

- Equation 5.8
- Sources:
  - N_2O at outlet to tertiary abatement unit
  - GHG from external energy used to heat tail gas
  - GHG from hydrocarbons (reducing agent or reheat tail gas)
  - GHG from ammonia production

Project Emissions: N_2O

$$PE_{N_2O} = \left(\sum_{i}^{n} F_i \times CO_{N_2O,i} \times M_i \right) \times GWP_{N_2O}$$

OR

$$PE_{N_2O} = \left[\left(\sum_{i}^{n} F_i \times CO_{N_2O,i} \times M_i \right) \times GWP_{N_2O} \right] \times HNO_{3MAX} / HNO_{3RP}$$

- Equation 5.9
- Same as Eq. 5.7 (Baseline N_2O emissions), except:
  - concentration is measured at the outlet

Project Emissions: Other Sources

- Amount of additional ammonia input times an ammonia production GHG emission factor (Equation 5.10)
- Amount of hydrocarbon used and amount converted to CO_2 and not converted, i.e., remaining as CH_4 (Equations 5.11, 5.12, and 5.13)
- External energy use based on net change in steam import, tail gas utilization, and tail gas heating (Equations 5.14, 5.15, and 5.16)

Tertiary Catalyst Projects: Emission Reductions

$$ER = BE - PE$$

- Equation 5.6
- Emission reductions are the difference between baseline and project emissions
- Calculated at end of each reporting period

Monitoring Requirements

- Develop a Monitoring Plan for verification
  - Procedures that will be followed to meet protocol requirements (e.g. Legal Requirement Test)
  - Frequency of data collection
  - Record-keeping plan
  - Meter calibration
  - QA/ QC
- Installation and certification of CEMS prior to project start date
- Follow Code of Federal Regulations Title 40, Parts 60 and 75 and specified appendices for CEMS
- Collect data for all parameters found in Table 6.1 and Table 6.2

CEMS Requirements

Accuracy testing and audit (RATA)	EPA test method 320 or ASTM D6348-03 for FTIR spectroscopy
Calibration procedures	Performance Specification 2, 40 CFR Part 60 Appendix B and 40 CFR Part 75 Appendix A
Frequency of testing	40 CFR Part 75 Appendix B
QA/ QC requirements and data management	40 CFR Part 75 Appendix B
Missing data substitution	75.33 of 40 CFR Part 75

Verification Guidance

- Three resources containing verification guidance:
  - NAP project-specific guidance in Section 8
  - General verification guidance in Verification Program Manual
  - Program Manual
- ISO- accredited verification bodies must be trained by the Reserve for this project type (February 17, 2009)
- Allows for “joint project verification” - single verification body to very multiple projects at a single facility
- Verification at a minimum annually; reporting period can be NO longer than 12 months (except for the first). Sub-annual reporting and verification is allowed.

Project Documentation

Required project documentation (will be made publicly available on Reserve website) includes:

- Completed Project Submittal form
- Project diagram*: diagram of the NAP, showing where the project is located within the NAP
- Signed Attestation of Title+
- Verification Report+
- Verification Opinion+
- Signed Regulatory Compliance Attestation+
- Signed Voluntary Implementation Attestation+

* Must be updated if a NAP upgrades or if there is a change in project activities

\+ Submitted for each reporting period

Any questions?

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