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Develop a 'real-time' emissions monitoring strategy for your facility

An advanced environmental data management system is a possible solution to comply with strict air pollution regulations

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To improve air quality, states and localities are requiring more intense 24/7 monitoring of listed air pollutants from hydrocarbon processing facilities. Affected facilities must develop reliable and accurate environmental data management systems for reporting purposes.

In this case history, the BP Texas City site (a refinery and chemicals plant) successfully implemented a real-time environmental data management system to comply with the highly reactive volatile organic compound (HRVOC) rule from the Texas Commission on Environmental Quality (TCEQ). This unique rule is part of TCEQ's overall strategy within the Texas State Implementation Plan to bring the Houston area into attainment for ozone under the Clean Air Act. The BP Texas City site is located in the Houston/Galveston area in which this program applies.

The BP facility is widely regarded as the most complex refinery in the world, with a capacity of 460,000 bpd. Additionally, the BP Texas City chemicals plant is the largest producer of paraxylene and metaxylene globally. The challenges faced and benefits attained, when implementing the real-time environmental data management system for HRVOC rule compliance, will be presented. The Air Emissions Management System (AEMS) HRVOC Project was very complex due to the size, intricacy and geographic diversity of the site; coordination required with other internal related projects, such as an HRVOC infrastructure project; and the ongoing re-commissioning of the facility from an extended shutdown after Hurricane Rita. In the future, the system will be expanded to include nitrous oxides (NO_x) mass emissions cap and trade program, and flexible air permit requirements.

Background. In 2002, TCEQ issued regulations on HRVOC and NO_x emissions for the Houston/Galveston area. These regulations include monitoring, testing, record-keeping and reporting requirements as well as site emissions caps for atmospheric process vents, cooling water exchange systems and flares. It also included a regional NO_x cap with a requirement to calculate NO_x emissions within 5% accuracy.

HRVOCs are defined by TCEQ as ethylene and propylene for the seven counties outside of Harris County that make up the Houston/Galveston area including Galveston County, where the BP Texas City site is located. These counties were also exempted from the emissions cap requirement but are still required to monitor and calculate HRVOC emissions on an hourly basis. For Harris County, butadiene and butanes are also considered HRVOCs.

In addition to meeting the new TCEQ emissions calculations, there were concurrent drivers to develop an ongoing process to support emissions management and compliance within BP Texas City, as well as meet emission calculation requirements for other federally enforceable programs. Essential to this initiative was a goal to improve the information systems architecture for health, safety, security and environmental (HSSE) personnel. This project also included a formal evaluation of software packages, through which BP selected a platform for the system.

Project objectives. The overall goal was implementing an emissions-management system (EMS) at BP Texas City that supported associated management processes, organizational changes, roles/responsibilities and tracking tools to achieve ongoing compliance with state and federal air regulations. More specifically, the AEMS system was designed to provide a single, accurate, transparent source for air emissions data and calculations. This system is to be used for both short-term and long-term compliance monitoring by site personnel (HSSE and operations), reporting and data archiving as required by the regulations.

The initial phase of this project has focused on HRVOC per TCEQ requirements as outlined in 30 TAC Chapter 115 Subchapter H. With respect to the HRVOC rule, the project objectives included:

- Implement a common and reliable "book of record" for HRVOC data and calculations
- Support compliance via timely emissions calculations and proactive notification of performance with respect to HRVOC limits to both HSSE and operations
- Facilitate creation of long-term compliance reports (e.g, Title V Deviation Reporting)
- Provide a transparent and open system for all stakeholders.

Additional phases of the project are planned to address NO_x per TCEQ Chapter 117 NO_x reduction rules, as well as sulfur dioxide (SO_2) and carbon monoxide (CO) for areas impacted by a consent decree (CD) that BP entered into with EPA in 2001. There are also concurrent phases in development to measure compliance with the site's flexible permit emission limits.

Project and solution overview. Originally, the project was to focus on TCEQ's NO_x reduction rules. Initially, the set

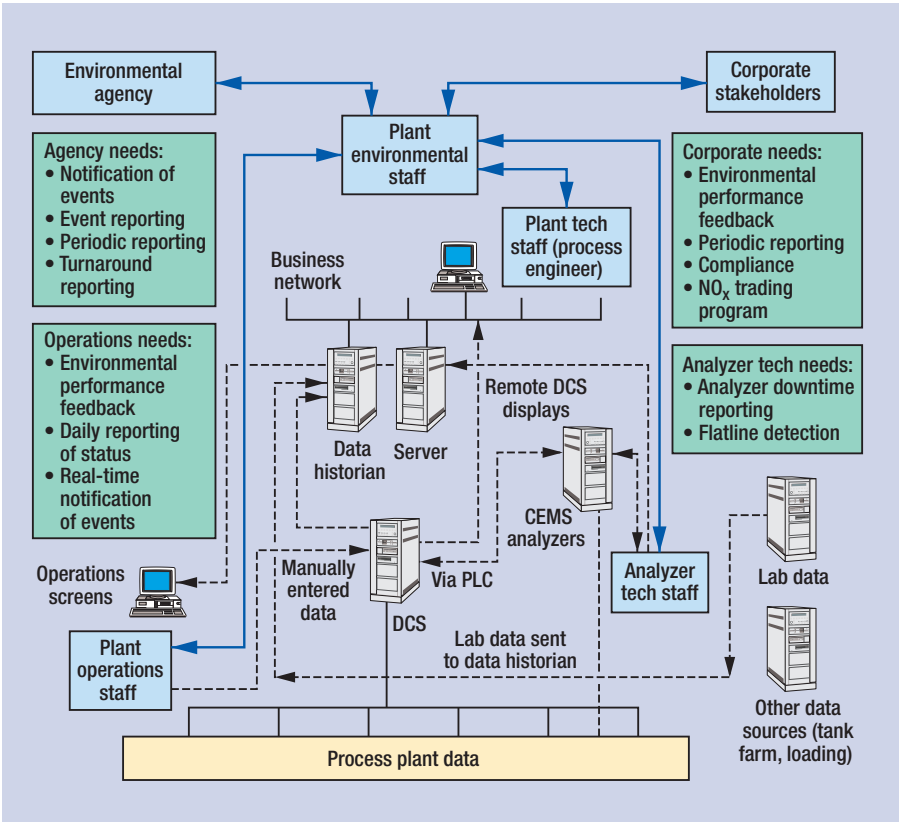

FIG. 1 Overview of new HRVOC work process.

of NO_x calculations were designed and documented, followed by a prototype of calculations onsite with live data. However, after an extended shutdown of the refinery, it was necessary to redirect the project and focus on the new, more imminent HRVOC regulations due to an impending compliance date of Dec. 31, 2005.

Thus, the scope of the first phase of the AEMS Project was to implement HRVOC calculations, tasks and event notifications for these sources:

- Flares (12)
- Cooling towers (11)
- Pressure relief valves (~180)
- Vents (~80).

The project implementation took approximately six months and was closely integrated with the BP Texas City HRVOC infrastructure project. The implementation of HRVOC calculations in the AEMS system was divided into two phases: staging and production.

Staging. In the staging phase, the BP Texas City Project Team provided the necessary regulatory interpretation and raw data sources for the calculations and the engineering contractor project team developed the calculation data flow and staged prototype HRVOC calculations. Each set of unique calculations was simulated in AEMS using typical operational values and compared to identical calculations staged in a spreadsheet to ensure that the calculations were performing correctly. Data flow diagrams and simulated cases were presented by the engineering contractor team members and reviewed by the BP project team several times to ensure that all regulatory aspects were satisfied prior to installing and commissioning any of the calculations on site.

In the case of HRVOC, rigorous quality checks and data conditioning of the raw instrument values are of particular importance. The calculations, including flat line and data frequency checks, ensure data validation requirements as stipulated in the rule. Downtime monitoring was also included in the configuration for gas chromatography analyzers and flow monitoring systems, which consist of a flow meter and pressure and temperature transmitters.

The staging of AEMS not only included the HRVOC calculations, but also the resulting events and tasks associated with HRVOC rule deviations. These tasks and events were designed to support the daily use and operation of AEMS by the HSSE and operations group to attain daily compliance assurance. A base set of tasks and events was configured based on the engineering contractor's experience with past project implementations, but was expanded by BP due to specific rule and permit requirements. Fig. 1 is an overview of the new work process.

A key element to successfully implementing the new system was providing tools to the operations teams to ensure that they would be engaged in the new work process. To ensure success, a thorough handoff between the AEMS HRVOC project team and operations with respect to the new HRVOC data and work process was necessary. This, combined with the fact that the impact of the new work process could be lessened by presenting data in a familiar system, led to the development of screens using the plant real-time historian desktop tools for use by plant operations. Data are queried directly from the AEMS database (book of record) and presented in a familiar environment. While the calculations were staged, initial designs were prepared by BP for the operations screens. Presenting the AEMS data in this way was essential to closing the gap between the project and operations' daily monitoring of the rule requirements.

Production. Once the majority of the infrastructure was in place, the project team shifted the focus to installing and configuring the new management system on the live environment. Calculations for each of the source types, e.g., heaters, flares and cooling water exchange systems, were done with live data and were vigorously reviewed prior to activating the configuration for the entire system. Additional quality assurance checks were done by comparing the live, calculated emissions to those produced by mirrored calculations in a spreadsheet as well as calculations programmed in the analyzers.

For example, for flares the AEMS system calculates both net heating value and molecular weight based on analyzer values. These values are also calculated in real-time by the analyzer for control purposes. The project team was able to do a side-by-side comparison and subsequent validation of values.

This phase quickly proved beneficial as some interpretation of

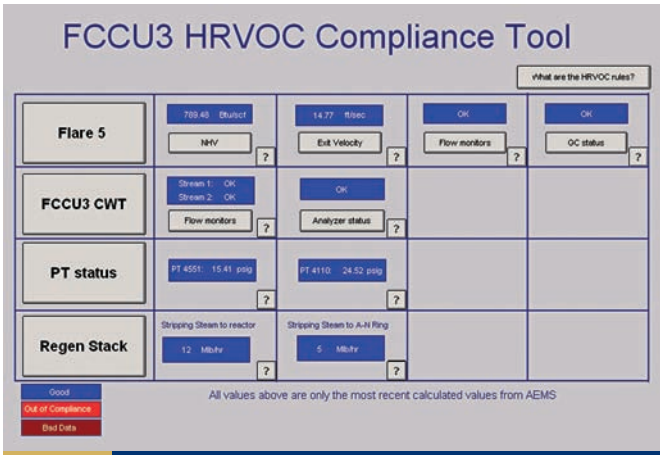

FIG. 2 Sample HRVOC compliance overview screen.

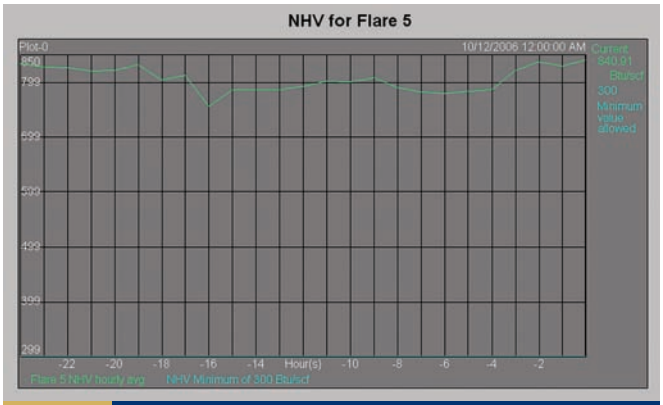

FIG. 3 Sample HRVOC drill down detail screen.

the rule was required where there were irregularities found within the regulations with respect to flares. TCEQ Chapter 115.725(d) gives monitoring requirements for flares in HRVOC service. Included in that requirement is a continuous online analyzer for HRVOC content and net heating value [115.725(d)(2)]. When that system is unavailable for more than eight hours, a daily sample is required for analysis using EPA Method 18 [115.725(d)(4)].

Method 18 analysis must be done on a dry basis, and this raises the question of how to adjust for moisture content. The rule does not give guidance for adjusting moisture on a manual sample. Commissioning the flare calculations in the field exposed the need to interpret this area. The BP team developed a compliance strategy to address moisture content. Due to the flexible nature of configuring aggregates within the software, the flare design was easily modified prior to deployment of calculations for all such sources. Interpretation of the rule was documented and archived for future reference.

The work process implemented via this project was the first of its kind within BP. In the past, operating teams typically assessed the unit's environmental deviations for the Title V reporting period via a quarterly look-back meeting. As the calculations went into service, AEMS served as the single source for Title V deviation reporting with respect to the HRVOC rule for the site.

The new system also allows plant operations to be involved on a real-time basis with AEMS by having a view into the AEMS data through the real-time historian desktop tools and the associated query data points. After the operations screens were developed, the links to the screens were centrally located where the operations teams are required to visit each shift and do multiple checks on the unit such as operating envelope, optimization, reliability, etc.

Allowing the operations teams to have separate access to data relieves the DCS of being further over-burdened with additional data and alarm points. These screens were designed to give unit operators a simple and quick view into current compliance. For the first time, operations personnel have a direct look at information related to potential deviations in real time and the ability to investigate underlying data. Sample screens are included in Figs. 2 and 3.

At this time, automatic report generation was also configured. Daily reports are generated each morning, which list events from the previous calendar day. The reports are used to reveal which sources are operating with potential compliance issues so that the appropriate oversight is achieved. Users are e-mailed links to their reports. Figs. 4 and 5 illustrate the automatically generated reports and report detail.

These reports are primarily used by environmental staff to interact with operations regarding potential environmental events. As this was a new and unique work process for the site, additional requirements were uncovered as the system began to run with live data. As such, more events, tasks and report templates were added. Design of the AEMS reporting system allowed this to be done quickly and without disruption of any existing reports or data.

Benefits. In the first quarter of its commissioning and use, AEMS has provided benefits in several areas including identifying operational issues, mitigating deviations and improving ease of generating reports and accuracy of long-term compliance reports. Additionally, there are some key anticipated benefits associated with the AEMS system in the future.

Identifying operational issues. During commissioning, AEMS assisted the HRVOC infrastructure project team by identifying instrumentation issues as new equipment and the AEMS software came online in parallel. These issues included:

- Data flow issues from instrumentation through the DCS to the real-time historian
- Issues with functionality of newly installed instrumentation
- Incomplete installation of hardware.

Because the AEMS calculation engine was attempting to read in and process data in real-time, these issues were quickly diagnosed and brought to the attention of the HRVOC infrastructure project team and other appropriate parties. Additionally, the AEMS system allows for data substitution in situations such as allowing best estimate of emissions calculations. The system maintains both the raw data set and substituted data should they ever need to be reviewed in the future.

During validation of the source calculations against the calculations mirrored in a spreadsheet and some values calculated on the analyzer, issues were discovered with respect to some of the analyzers' calculations. For example, a net heating value calculated off of a flare was found to be erroneous coming off of the analyzer. Many issues were inherent to the commissioning of new instrumentation. However, the ability of AEMS to review the data allowed for faster identification and resolutions of these issues.

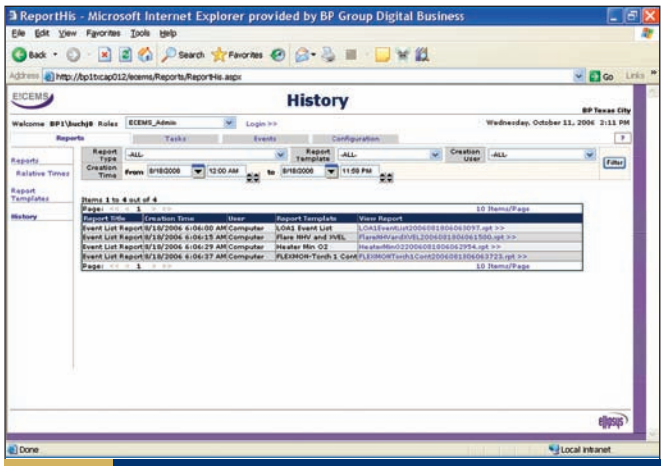

FIG. 4 Automatically generated reports.

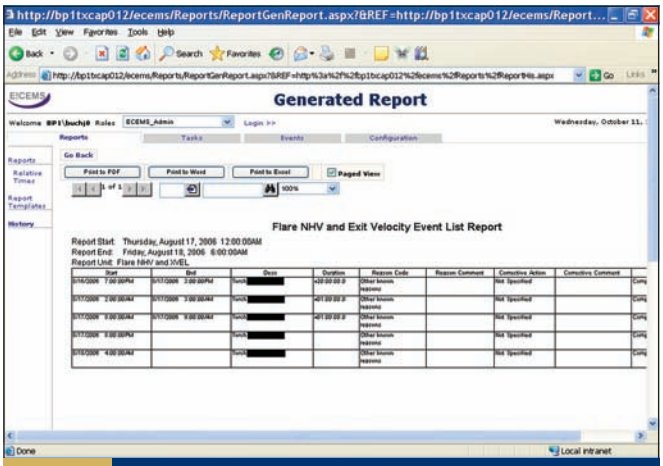

FIG. 5 Sample daily report detail.

Mitigating deviations. Via the automatically generated daily reports, AEMS users have identified in-progress deviations and have immediately reported the issues to operations for corrective action. An example was identifying a current issue with excess-oxygen limits on heaters. The operating conditions leading to the deviation were corrected and the deviation was logged.

Report accuracy and ease of generation. In use, the AEMS system has reduced over-reporting of Title V deviations, which were previously based on manual calculations. The rigorous quality check of data within the AEMS calculation engine has proven superior to the former calculations by users via existing desktop tools.

In one case, the average hourly net heating value was being calculated on a flare to determine compliance with 40 CFR 60.18. Prior to the AEMS system, the net heating value was read from the calculated value on the analyzer and pulled from real-time historian into spreadsheets and averaged using standard spreadsheet functionality. In some cases, invalid data in the real-time historian were being represented by a very small number. Without rigorous data checks, the averages were calculated to be much lower than they actually were, resulting in a greater number of deviations when the hourly average net heating value dipped below 300 Btu/scf. In the first three-month evaluation, it was determined and validated that the real-time historian data averaged using a spreadsheet calculated 11 hourly deviations, whereas AEMS correctly calculated only one hourly deviation.

The new information in AEMS has been used for Title V reporting of deviations from the HRVOC rule including instrument downtime and emissions standards deviations. Also, downtime recording is now being conducted by AEMS versus the historical method of manually evaluating analyzer data on a daily basis, which was managed by the analyzer group and sent to HSSE personnel.

Future benefits. As the AEMS system is in production for a longer period, there are many potential future uses of the resulting data. The data will be used for economic planning and emissions projections. These projections can be used to evaluate the feasibility of purchasing and processing an advantaged feedstock.

Additionally, the current HRVOC rule carries an exemption for the outlying seven counties in the Houston/Galveston non-attainment area. This exemption will be reevaluated by the TCEQ at the end of 2006. The AEMS system will allow BP Texas City to submit accurate data for the emissions allocation process. Using a transparent and open system will also allow them to justify the supplied data should it be necessary.

In preparing for the incoming NO_x mass-emissions cap and trade program, it is also critical to have an accurate accounting of these emissions. Due to the current market value of NO_x, it is cost-effective to have an understanding on buying credits, potential areas for emissions reductions and actual current, as well as projected future emissions.

The phase of the project applying AEMS to BP's flexible permit will also allow site optimization to understand how current operations are impacting the flexible permit emission limits. If an emission limit is close to being exceeded, site optimization will have the information in an at-a-glance format to understand which units are emitting more than their allocated estimate. The site can then make the determination of which units should be optimized and brought back into their estimated range to relax the gap between the emission cap and actual emissions, thus allowing the site to realize the full benefit of a flexible permit.

Finally, implementing such a system will ease future audit processes and agency inspections. The system provides one source that meets the full record-keeping requirements including documentation, record-keeping and compliance assurance of calculations. The open architecture of the software will also allow for future integration with other higher-level compliance systems or for the export of data into specified formats for governmental reporting.

Challenges. Coordination with other internal projects provided both benefits and challenges. Delays in the schedule of prerequisite efforts such as the HRVOC infrastructure project (due to the extended shutdown resulting from Hurricane Rita) impacted the efficiency of the commissioning of the calculations.

Since this project was not directly sponsored by BP's internal Digital Communications and Technology (DCT) group, it was difficult to identify internal resources to troubleshoot or perform routine maintenance on the server. As the project team encountered performance issues with the server, they struggled

to locate the correct persons with the authority to resolve the problems. In hindsight, it should have been a mandate to have DCT involvement and sign-off from project inception.

The lessons learned from the AEMS HRVOC project will undoubtedly be applicable to the AEMS projects for NO_x and flexible permit compliance, which are both currently in progress at the site, as well as future applications of the AEMS system. **HP**

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