

Implementation of a Real-Time Environmental Data Management System to Ensure HRVOC Program Compliance

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Introduction

The BP Texas City Site (Refinery and Chemicals Plant) has successfully implemented a real-time environmental data management system in order 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 per the Clean Air Act. The BP Texas City Site is located in the Houston/Galveston area to which this program applies.

The BP Texas City Refinery is widely regarded as the most complex refinery in the world, with a capacity of 460,000 barrels per day. Additionally, the BP Texas City Chemicals Plant is the largest producer of paraxylene and metaxylene globally. This paper presents the challenges faced, and benefits attained, when implementing the real-time environmental data management system (based on the Mustang/Ellipsys E!CEMS software suite) at the BP Texas City Site for HRVOC rule compliance. The Air Emissions Management System (AEMS) HRVOC Project implementation was very complex due to the size, intricacy and geographic diversity of the site; the coordination required with other internal related projects, such as the HRVOC infrastructure project (Program Clear Skies); 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 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 emissions site caps for atmospheric process vents, cooling water exchange systems and flares as well as 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 making up the Houston/Galveston area. These counties were also exempted from the emissions cap requirement but still required to monitor and calculate HRVOC emissions. This includes Galveston County in which the BP Texas City site is located. For Harris County, Butadiene and butanes are also considered HRVOCs.

In addition to the need to support 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 in other federally enforceable governances. Essential to this initiative was a goal to improve the information systems architecture for Health, Safety, Security and Environmental (HSSE) personnel. This project included a formal evaluation of software packages to arrive upon a decision to use Mustang/Ellipsys E!CEMS Suite of software as the platform for the system.

Project Objectives

The overall goal of the project was to implement an emissions management system (EMS) at BP Texas City along with associated management processes, organizational changes, roles/responsibilities and tracking tools to ensure ongoing compliance with state and federal air regulations. More specifically, the AEMS system was designed and implemented to provide a single, accurate, transparent source for air emissions data and information. This system is to be used for short term compliance monitoring by site personnel (HSSE and Operations), long term compliance monitoring and reporting and data archiving as required by the regulations.

The initial phase of this project has focused on Highly Reactive Volatile Organic Compounds per the 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 to HRVOC 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 will address nitrous oxides (NO_x) per TCEQ Chapter 117 NO_x Reduction Rules, as well as sulfur dioxide (SO₂) and carbon monoxide (CO) for areas impacted by the BP Project Sunshine EPA Consent Decree. There are also concurrent phases in development to measure compliance with the site’s flexible permit emission limits.

Project and Solution Overview

The original intent of the project was to focus on TCEQ’s NO_x Reduction Rules. The set of calculations for NO_x was designed and documented, followed by a prototype of calculations on site with live data. However, after an extended shutdown of the refinery, it was necessary to redirect the project and focus on the more imminent HRVOC regulations due to an impending compliance date.

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

- Flares (12)
- Cooling towers (11)
- Pressure Relief Valves (PRVs) (~180)
- Vents (~80)

The project implementation took approximately six months and was closely integrated with the BP Texas City HRVOC Infrastructure Project, Program Clear Skies.

The implementation of HRVOC calculations in the AEMS system was divided into two phases: staging and production.

Staging

In the staging phase, while the BP Texas City Project Team provided the necessary raw data sources for the calculations, the Mustang project team developed the calculation data flow and staged prototype HRVOC calculations in their offices. Each set of unique calculations was simulated in E!CEMS using typical operational values and compared to identical calculations staged in Excel to ensure that the calculations were performing correctly.

Data flow diagrams and simulated cases were presented by the Mustang team members and reviewed by the BP Project Team several times to ensure that all of the regulatory aspects were satisfied prior to installing and commissioning any of the calculations on site. A sample data flow diagram for a flare calculation is included in Figure 1.

HRVOC Calculation
Typical Flare

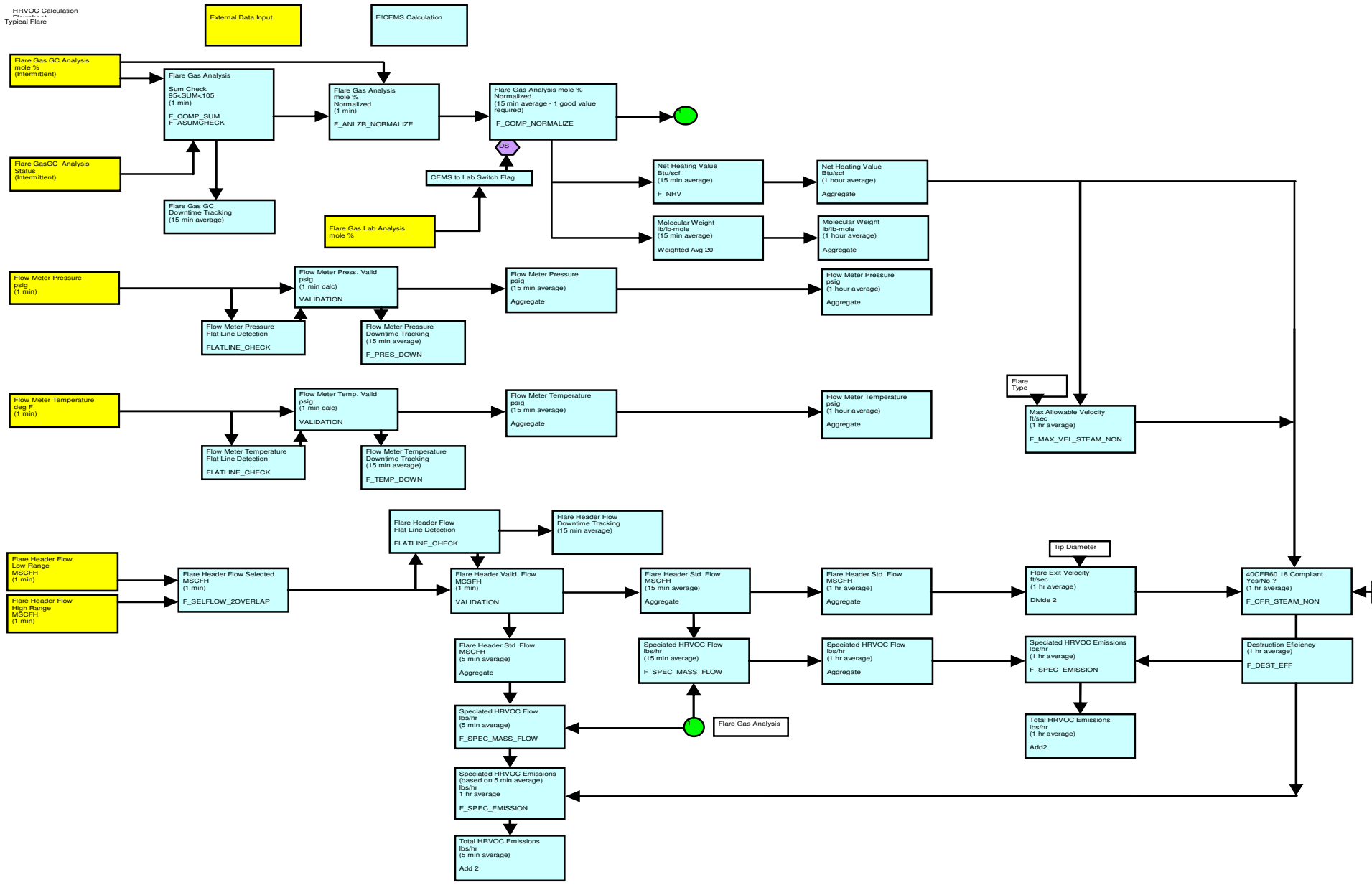


Figure 1: Flare Calculation Data Flow Diagram

familiar system, led to the development of PI ProcessBook screens for use by Operations. Data are queried directly from the AEMS database (book of record) and presented in a familiar environment. As the calculations were staged, initial designs were prepared for the ProcessBook screens. Presenting the AEMS data in this way was essential to closing the gap between the project and Operations implementation of the rule requirements.

Production

Once the majority of the infrastructure was in place, the project team shifted the focus of project activities to the site to install the configuration into the live environment. Calculations for each of the source types, e.g. heaters, flares and cooling water exchange systems, were implemented with live data and vigorously reviewed prior to activating the configuration for all sources on the live system. Additional quality assurance checks were done by comparing the live, calculated emissions to those produced by mirrored calculations in Excel, as well as calculations coming directly off 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 on the fly by the analyzer for control purposes. The project team was able to do a side by side comparison and validation of values.

This phase quickly proved beneficial as some interpretation of 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 on-line 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 carried out on a dry basis, and this raises the question of how to adjust for moisture content. The rule does not give guidance for how to adjust for moisture on a grab sample. Commissioning the flare calculations in the field exposed the need for interpretation in this area and allowed the BP team to use their best judgment on how to adjust for the moisture content. Due to the flexible nature of configuring EICEMS aggregates, the flare design was easily modified prior to deployment of calculations for all such sources and the 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 began to serve as the single-source for Title V deviation reporting for the site for the HRVOC rule.

The new system also allows for operations to be involved on a real-time basis with AEMS by having a view into the AEMS data through ProcessBook and the associated PI query data points. After the operations screens were developed, the ProcessBooks were stored in the one place where Operations teams are required to visit each shift to perform multiple checks on the unit, be it operating envelope, optimization, reliability, etc.

Allowing Operations Teams to access data in this manner relieves the DCS of being further over-burdened with additional data and alarm points.

These screens are designed to give unit operators a simple and quick window 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 drill down into the underlying data. Sample screens are included in Figures 3 and 4.

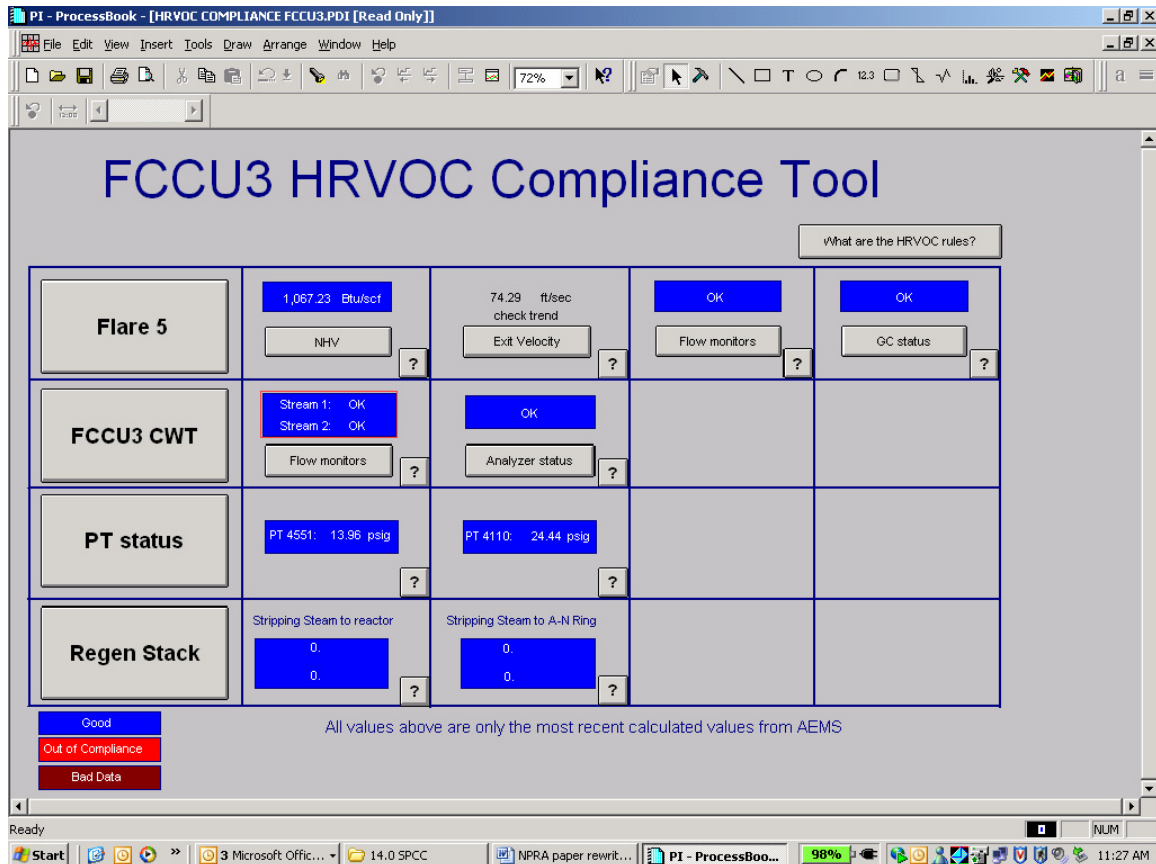


Figure 3: Sample HRVOC Compliance Overview Screen

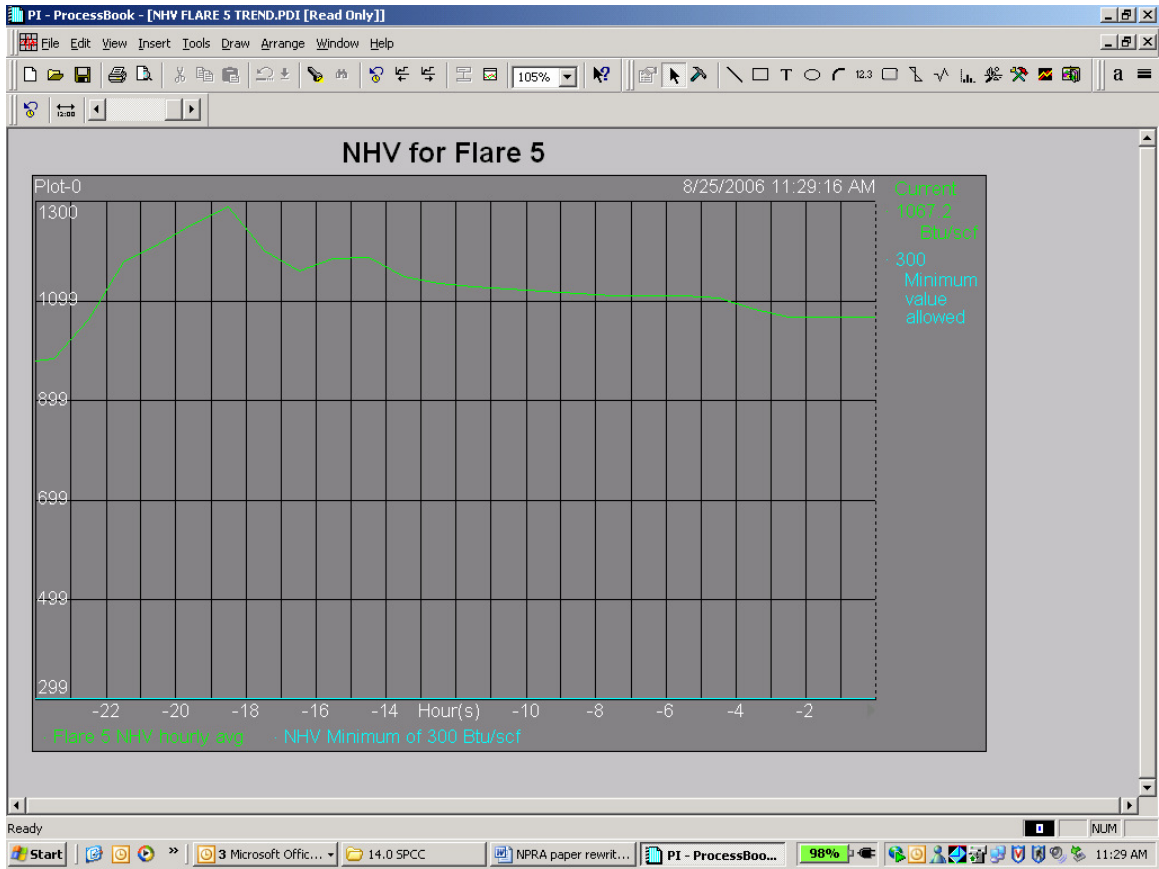


Figure 4: Sample HRVOC Drill Down Detail Screen

At this time, automatic report generation was also configured. Daily reports are generated each morning which outline the deviations from the previous calendar day and are utilized to reveal which sources are operating with compliance issues so that the appropriate oversight is achieved. Users are e-mailed links to their reports. Figures 5 and 6 illustrate the automatically generated reports and report detail.

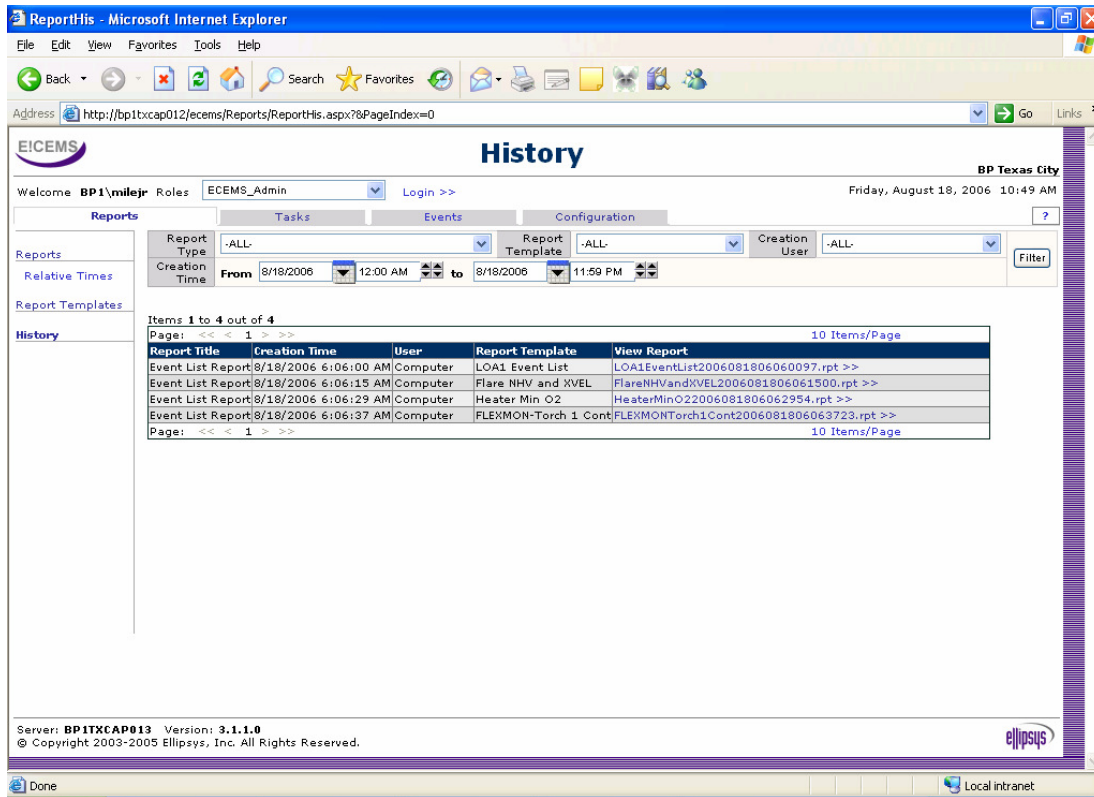


Figure 5: Automatically Generated Reports

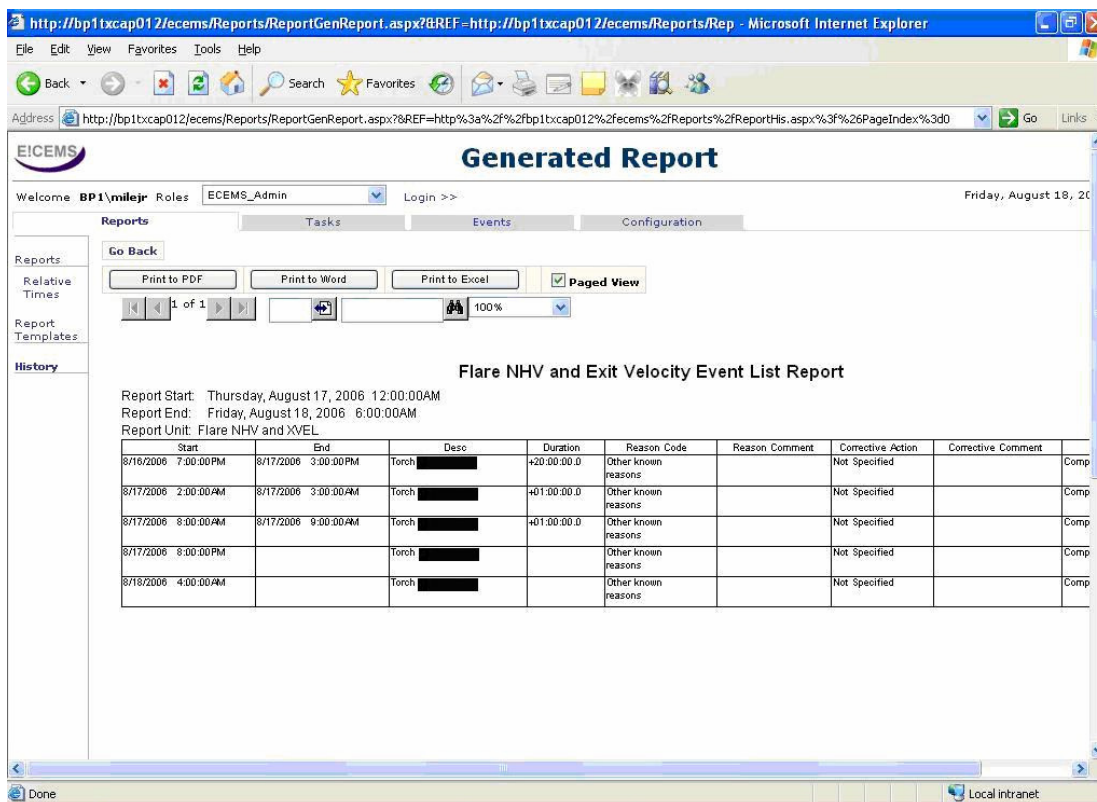


Figure 6: Sample Daily Report Detail

These reports are primarily used by Environmental Staff to interact with Operations regarding ongoing 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 to the system as it went into production. The design of the E!CEMS 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 identification of operational issues, mitigation of deviations and improvement in ease of generation and accuracy of long term compliance reports. Additionally, there are some key anticipated benefits associated with the AEMS system in the future.

Identification of Operational Issues

During commissioning, AEMS assisted Project Clear Skies 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 Project Clear Skies project team and other appropriate parties.

Additionally, the AEMS system allows for data substitution in situations such as these, allowing for a best estimate of emissions to be calculated. The system maintains 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 Excel 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 of the issues were inherent to the commissioning of new instrumentation. However, the visibility of AEMS into the data allowed for faster identification and resolutions of these issues.

Mitigation of Deviations

Via the automatically generated daily reports, the AEMS users have identified in-progress deviations and have immediately reported the issues to operations for corrective action. An example of this was the identification of an ongoing issue with excess O₂ limits on heaters. The operating conditions leading to the deviation were corrected and the deviation was logged.

As the system is used for a longer period time, configuration may also be added to send notifications before permit limits are exceeded.

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.

For example, in one case the average hourly net heating value was being calculated on a flare to determine compliance with 40CFR60.18. Prior to the AEMS system, the net heating value was read from the calculated value on the analyzer and pulled from PI into Excel spreadsheets and averaged using standard Excel functionality. In some cases, "bad" data in PI 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 per standard cubic feet. In the first three-month evaluation, it was determined and validated that the PI-Excel tool 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.

Future Benefits

As the AEMS system is in production for a longer period of time, 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 nine 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. The use of a transparent and open system will also allow them to justify the supplied data should it be necessary.

In preparation for the incoming NO_x mass emissions cap and trade program, it is also critical to have an accurate accounting of those NO_x emissions. Due to the current market value of NO_x, it is of economic significance to have a handle on buying credits, potential areas for emissions reductions and the current actual emissions as well as projected future emissions.

The Flex Air phase of the project 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, the implementation of such a system will ease future audit processes and agency inspections. The system provides one source which meets the full record keeping requirements including documentation, record keeping, and compliance assurance of calculations. The open architecture of the E!CEMS software will also allow

for future integration with other higher-level compliance systems, or export of data into specified formats for governmental reporting.

Challenges

Coordination with other internal projects provided both benefits and challenges. Delays in schedule of prerequisite efforts such as Program Clear Skies (due to the extended shutdown resulting from Hurricane Rita) impacted the efficiency of the commissioning of the E!CEMS calculations.

Since this project was not directly sponsored by the BP Digital Communications and Technology (DCT) group, it was difficult to identify resources to troubleshoot or perform routine maintenance on the server. As we encountered performance issues with the server, we 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 currently in progress at the site and other future applications of the AEMS system.