Study: BWON Compliance Benchmarking

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Abstract

40 CFR 61, Subpart FF - Benzene Waste Operations NESHAPs (BWON) is one of the more complex Federal regulations affecting US refineries. Sustaining compliance with this regulation is challenging, which is apparent from the fact that the BWON is one of the marquee regulatory standards incorporated into refinery global settlements with the United States Environmental Protection Agency (US EPA).

A benchmarking study was performed to evaluate certain characteristics of affected facilities and compare those characteristics to BWON compliance metrics. The study identified several common programmatic compliance deficiencies that BWON program coordinators and management should be aware of and understand. Tools and suggestions are provided to assist in correcting these common BWON compliance issues.

In addition, publically available BWON reporting data were compiled to provide insight into how a facility's BWON-related operating parameters might compare to other refineries of similar size or complexity. The parameters evaluated included Total Annual Benzene Quantity (TAB), uncontrolled benzene quantity, and number of waste streams versus refinery throughput. Also presented are comparisons of the managerial dimensions of BWON compliance, such as staffing level and workload versus facility throughput, complexity, and TAB.

Introduction and Purpose

The BWON rule is one of the more complex and commonly misunderstood regulations affecting refineries, as evidenced not only from the litigious history of the rulemaking, but also the past and recent enforcement history on the rule. Not only have there been several historic civil cases regarding BWON, but the BWON rule was also the genesis of multiple criminal environmental enforcement cases.

Petroleum refiners are very aware of this history and US EPA's refining enforcement initiative has defined BWON as one of the marquee areas covered by global settlements. In fact, since March 2000, the US EPA has entered into 24 settlements with companies that operate nearly 88 percent of the Nation's petroleum refining capacity covering 99 refineries in 29 states. US EPA contends that they are negotiating additional settlements that will increase the percentage of the covered refining capacity to 95 percent. Notwithstanding this enforcement initiative, the US EPA and US Department of Justice (DOJ) are continuing to evaluate BWON compliance at refineries through ongoing Consent Decree compliance audits and have initiated similar enforcement initiatives in the chemical and petrochemical industry. US EPA is continuing to find alleged BWON compliance issues during these inspections. In addition, with the focus on the BWON rule, the refining industry is internally evaluating BWON compliance and self-

disclosing compliance issues. Table 1 presents a summary of refinery enforcement initiative actions that included BWON terms and the associated penalty assessed to the company.

Table 1 – Refinery Enforcement Initiative History[1]

Company Name	Facility	Penalty ($)	Date
Koch Petroleum Group	Corpus Christi, TX St. Paul, MN	$ 4,500,000	12/22/2000
B.P. Amoco and Arco	All Facilities	$ 9,500,000	1/19/2001
Motiva, Equilon, Shell Deer Park	CA, WA, LA, DE, TX	$ 9,500,000	3/21/2001
Marathon Ashland Petroleum	KY, TX, IL, LA, MI, OH, MN	$ 3,800,000	5/11/2001
Conoco, Inc.	Lake Charles, LA Ponca City, OK Billings, MT Commerce City, CO	$ 1,050,000	12/20/2001
Navajo Refining Co. & Montana Refining, Co	Artesia & Lovington, NM Great Falls, MT	$ 750,000	12/20/2001
Lion Oil	El Dorado, AR	$ 348,000	3/11/2003
Coastal Eagle Point Oil Co (CEPCO), CHS Inc (Cenex), Ergon	Vicksburg, MS Laurel, MT Westville, NJ Newel, WV	$ 2,900,000	10/1/2003
Chevron USA	HI, MS, UT, CA	$ 3,500,000	10/16/2003
CITGO	IL, LA, NJ, GA, TX	$ 3,600,000	10/6/2004
Conoco Phillips	IL, LA, NJ, PN, WA	$ 4,500,000	1/27/2005
Sunoco Petroleum	PA (2), OH (1), OK (1)	$ 3,000,000	6/16/2005
Valero Petroleum Refining	CA (3), CO (1), LA (2), NJ (1), OK (1), TX (6)	$ 5,500,000	6/16/2005
Giant Petroleum Refining	Bloomfield & Gallup, NM	$ 250,000	8/4/2005
Exxon Mobil	CA, IL, LA, MT, TX	$ 8,700,000	10/11/2005
Williams Refining	Memphis, TN	$ 2,200,000	3/14/2007
TOTAL Petrochemicals	Port Arthur, TX	$ 2,900,000	5/1/2007
Valero (Premcor) Refining	TN, OH, and TX	$ 4,200,000	8/16/2007
Hunt Refining Co & Hunt Southland Refining Co	Tuscaloosa, AL Sanderson & Lumberton, MS	$ 400,000	9/28/2007
Sinclair Oil Corporation	Casper & Sinclair, WY Tulsa, OK	$ 2,400,000	1/16/2008
Holly Refining & Marketing	Woods Cross, UT	$ 120,000	4/21/2008
Frontier Refining	Cheyenne, WY El Dorado, KS	$ 1,230,000	2/10/2009
Wyoming Refining Company	Newcastle, WY	$ 150,000	2/10/2009
B.P. Products North America	Texas City, TX	$ 12,000,000	2/19/2009

[1] http://www.epa.gov/compliance/resources/cases/civil/caa/oil/index.html

The refining industry is highly regulated and generally has sophisticated environmental management systems, but it seems that BWON remains an industry-wide compliance challenge. Why is compliance with the BWON so challenging? The rule is certainly complex, but the BWON challenge is made greater by the perception that rule interpretations have shifted and state-of-the-art BWON program management has changed over the past sixteen years since rule promulgation. Additionally, as the refining industry further understands refinery benzene emissions management and BWON rule complexity, the manpower and management systems necessary to sustain compliance needs to progress accordingly.

Many petroleum refineries make an initial investment in capital projects, managements systems, training, and staffing to implement BWON compliance solutions that are intended to be sustainable for the long term. The amount of investment varies widely, and future compliance hinges greatly on the discretionary investment each refinery chooses to make to achieve a sustainable compliance program. This initial investment typically occurs as a result of a triggering event, such as the promulgation of the rule, entry into Consent Decree, or following an enforcement action.

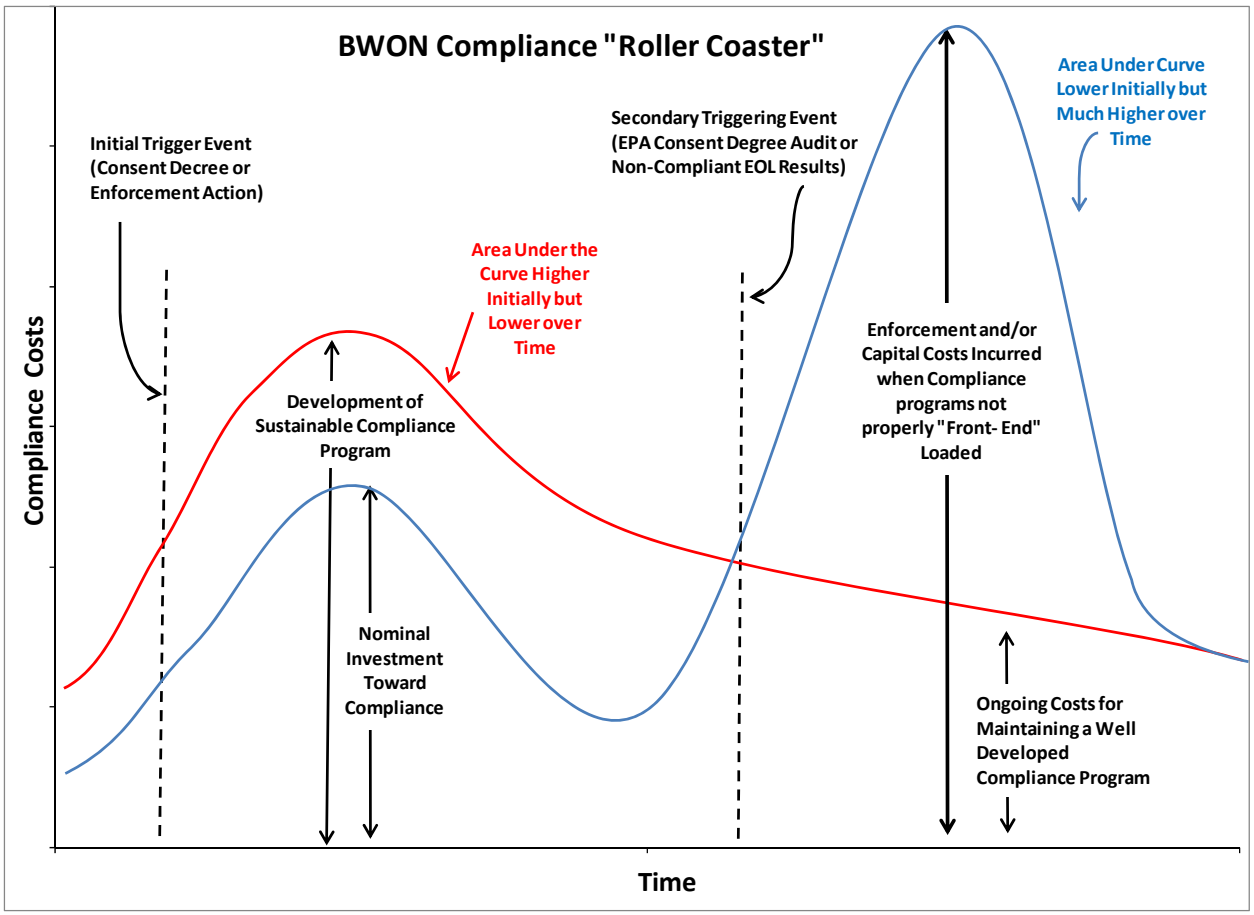
Unfortunately, in today's environment of a strained economy and limited budgets, cost concerns tend to reduce spending for sustaining BWON compliance over time, often resulting in increased compliance challenges and/or compromised compliance. This lack of attention toward BWON typically continues until sometime in the future when a second triggering event occurs (i.e., US EPA compliance enforcement audit) and results in yet another substantial investment in the BWON rule compliance program. Corporate self-reporting and/or this multi-year cycle of investment and decay continues, giving rise to the "BWON compliance roller coaster". Consider the graphical representation in Figure 1 presenting compliance costs as a function of time. For the purposes of this chart compliance costs qualitatively include manpower, capital, and enforcement penalties. Two types of facilities are represented in the chart below. The blue line represents facilities with an unsustainable or reactionary BWON program and the red line represents facilities with a sustainable BWON program.

Examining the blue curve on the chart below, the first peak shown in compliance costs is generally caused by a triggering event such as an enforcement action. The peak represents the initial investment required to address the compliance issues. After this investment, the resources placed into the program typically fall to pre-event levels. At some point in the future, a subsequent triggering event causes a second investment in the program. The compliance costs in this case are often much higher, and at times exponentially higher, than those incurred during the initial peak. This cyclical program management is typical of the "firefighting" behavior observed in an economically and resource-strained facility.

The initial peak of the red curve, representing a sustainable BWON program, is higher than that of the blue, reflecting a larger initial investment in the program. The continuous costs of managing sustainable compliance under BWON are higher than those of the blue curve. However, once the second triggering event occurs, the blue line crosses above the red line for an extended period. Most notably, the total area under the blue curve is actually much higher than the area under the red curve. This indicates that, despite the higher initial investment and

ongoing cost of sustaining the BWON program, the total cost of managing a sustainable BWON program is much lower than that of the "roller coaster" refinery.

Figure 1 – BWON Compliance Roller Coaster



The question arises how one particular refinery may stand up to others from a BWON compliance and management perspective. Refinery management should know whether industry peers are experiencing similar difficulties with sustaining compliance with BWON and should understand how pervasive problems are in order to mitigate enforcement risk. Refinery management should also understand potential solutions - What can be done to manage risk? What enforcement trends are ongoing? What type of staffing do other facilities have to manage BWON compliance?

This paper intends to provide insight into the above points. Presented are findings from several months of research regarding historical BWON compliance in the petroleum refining industry. The data used in this study was gathered through a deliberate series of Freedom of Information Act (FOIA) requests from US EPA including: lists of affected facilities, TAB and uncontrolled benzene quantity reporting histories, enforcement histories, rule interpretations, agency correspondence, and numerous Consent Decree-related reports including BWON Review and Verification (R&V) reports and End-of-Line (EOL) benzene quantity reports.

This extensive FOIA data was analyzed and organized such that it could be used to benchmark certain elements of a refinery BWON program. In some cases, general data gained directly from refineries through interviews and site knowledge was also incorporated into the results. Finally, discussions are presented related to managing a sustainable BWON compliance program and notable enforcement trends on BWON and common BWON deficiencies.

Technical BWON Benchmarking

The benchmarking study evaluated a total of 88 refineries including 68 Review and Verification Reports (R&V) and 74 facilities' EOL quarterly reports for the past five years. Benchmarking data may be of significant usefulness to the audience as it provides insight into how one facility may compare another facility on various dimensions of BWON compliance. Subsequent sections will provide an in-depth focus on selected parameters that have been benchmarked at multiple facilities with respect to BWON, including: TAB, EOL and other parameters versus refinery throughput, uncontrolled benzene quantity consumption, BWON staffing, and BWON coordinator workload.

Table 2 – Selection of Compliance Options

Compliance Option	No. of Facilities	Percentage	Refining Capacity (KBPD)
< 10 Mg/yr	19	22%	822
2BQ	20	23%	4,432
6BQ	46	52%	7,572
Undetermined	3	3%	Undetermined
Total Evaluated	**88**	**100%**	**12,826**

Out of the 88 facilities evaluated, the vast majority of facilities with a TAB of greater than 10 Megagrams per year (Mg/yr) were electing to comply with the 6 Mg/yr "treat to target" compliance option. This compliance option is described under 40 CFR 61.342(e) and is herein referred to under its commonly used name "6 BQ". The remainder of the facilities with a TAB greater than 10 Mg/yr selected the 2 Mg/yr compliance option described under 40 CFR 61.342(c) and herein referred to as the "2 BQ". None of the refineries evaluated reported the use of the 1 Mg/yr compliance option in 40 CFR 61.342(d).

As an indication of compliance, Consent Decree R&V reports received as part of the FOIA request were reviewed. The reported R&V uncontrolled benzene quantity was compared against the chosen compliance option limit for facilities with a TAB of greater than 10 Mg/yr. The data showed that for facilities selecting the 2 BQ compliance option, a relatively high percentage reported uncontrolled benzene quantities greater than 2 Mg/yr during the R&V process. Ongoing compliance was evaluated based on the annualized EOL results compared to the chosen compliance option limit. Notably, facilities using the 2 BQ compliance option and that reported

initial uncontrolled benzene quantities greater than 2 Mg/yr as part of the R&V process appeared to struggle with meeting the 2 Mg/yr limit after the R&V process was completed.

In contrast, most of the facilities opting for the 6 BQ compliance option reported uncontrolled benzene quantities less than the 6 Mg/yr limit in R&V report. A few of the 6 BQ facilities that reported an uncontrolled benzene quantity greater than 6 Mg/yr in the R&V still reported uncontrolled EOL benzene quantities greater than 6 Mg/yr. However, very few of the facilities whose R&V reports indicated uncontrolled benzene quantities less than 6 Mg/yr subsequently reported uncontrolled EOL benzene quantities greater than 6 Mg/yr. Even though these findings suggest the 6 BQ as the preferred compliance option, certain facility configurations and control strategies precludes the use of the 6 BQ option and this paper is not intended to advocate the 6 BQ compliance option in all cases.

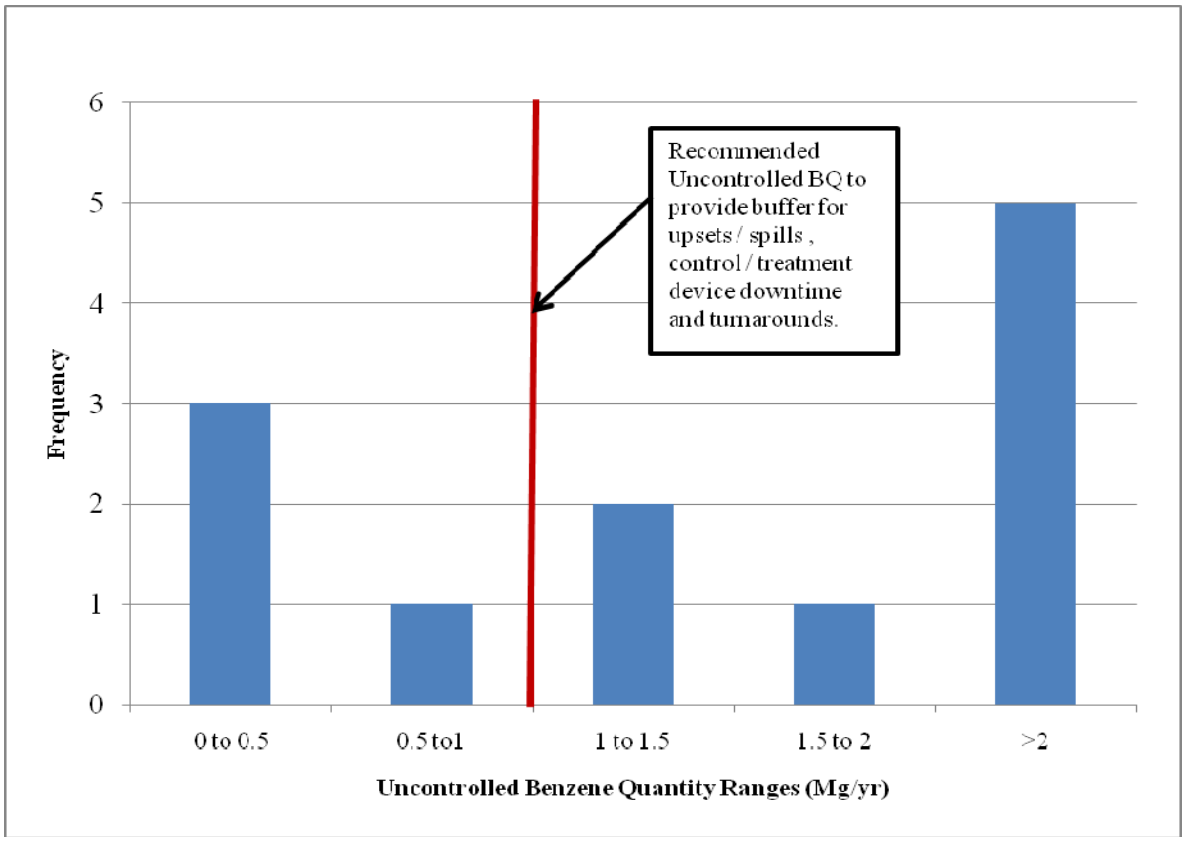
Certain facilities that had a TAB less than 10 Mg/yr and were not required to choose a compliance option have also undergone the Consent Decree R&V process. The data analysis showed that the majority of these facilities were confirmed by the R&V process as having TABs less than 10 Mg/yr and very few experienced subsequent EOL results that indicated a TAB of greater than 10 Mg/yr. Experience indicates that many facilities that historically reported a TAB of less than 10 Mg/yr, and subsequently entered a settlement as part of the refining enforcement initiative, concluded that they were greater than 10 Mg/yr prior to or during settlement negotiations. Therefore, that fact that few facilities with a historical TAB of less than 10 Mg/yr were later determined to have a TAB greater than 10 Mg/yr during the R&V process, does not necessarily indicate that facilities that historically reported a TAB below 10 Mg/yr were accurately reporting.

Histograms

The following histograms reflect, by frequency, how much of the 6 Mg/yr or the 2 Mg/yr allowed under the 6 BQ and 2 BQ compliance options, respectively, are consumed by the petroleum refineries included in this benchmarking analysis. The data originated from each refinery's R&V report. The columns reflect the number of facilities that had uncontrolled benzene quantities within a certain range.

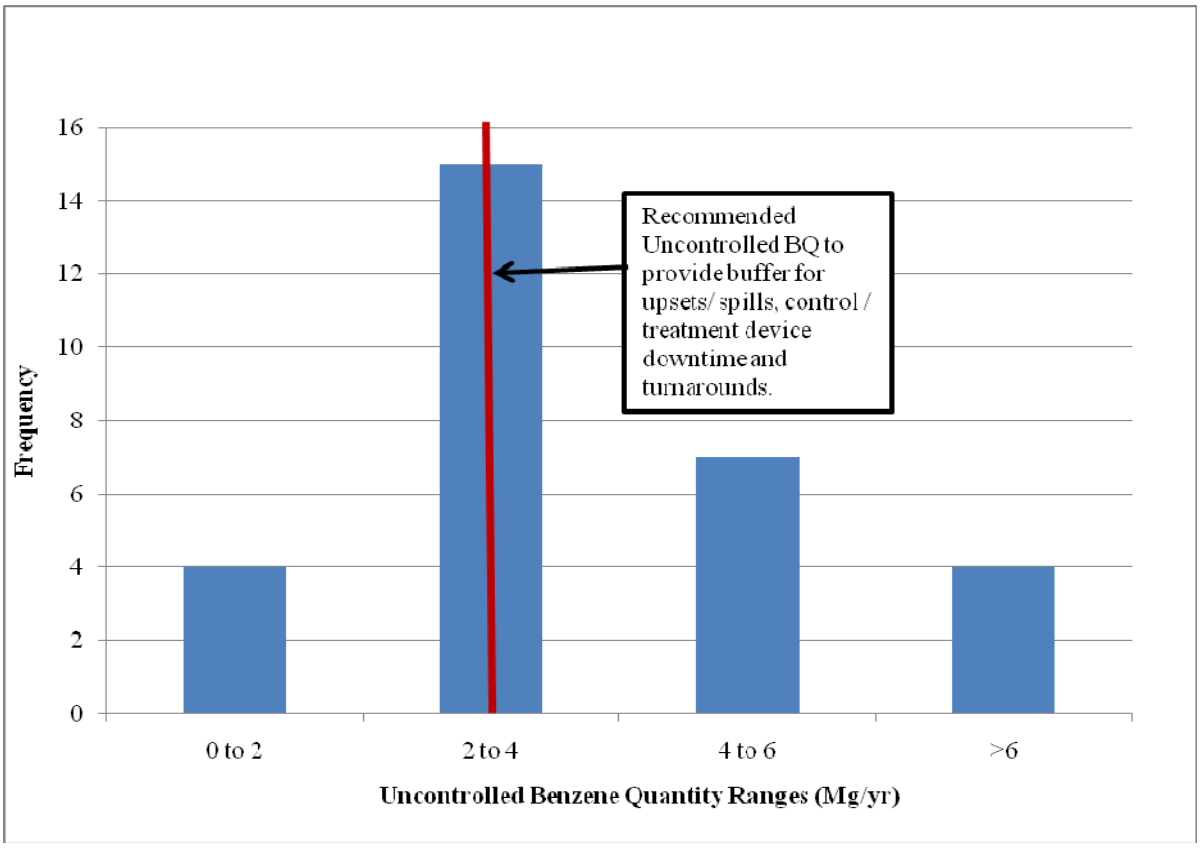
The 2 BQ histogram shows that 42 percent of the facilities evaluated reported an uncontrolled benzene quantity greater than 2 Mg/yr during the R&V process and two-thirds of the facilities evaluated reported uncontrolled benzene quantities greater than 1 Mg/yr. It is recommended that facilities under the 2 BQ compliance option target a design uncontrolled benzene quantity of 1 Mg/yr to allow for unplanned releases, spills, and other eventualities that may impact the 2 Mg limit.

Figure 2 – 2 BQ Histogram



Typically, for facilities operating close to or above the 2 Mg/yr limit under the 2 BQ, the corrective actions are limited to the optimization of existing controls, the addition of new controls, or to change to the 6 BQ compliance option if the refinery configuration allows. The 2 BQ facilities that do not exempt a significant portion of their overall uncontrolled benzene under the less than 10 ppmw exemption can often effectively use the 6 BQ option for compliance, especially when the facility uses an enhanced biodegradation unit for treatment.

Figure 3 – 6 BQ Histogram



The 6 BQ chart indicates that almost 60 percent of the facilities included in the benchmarking analysis used more than 3 Mg/yr of the allowable 6 Mg/yr. This graph also shows that about 25 percent of the facilities evaluated are operating very close to the 6 Mg/yr limit. However, it is recommended that facilities under the 6 BQ compliance option target a design uncontrolled benzene quantity of 3 Mg/yr to allow for unplanned releases, spills, and other eventualities that may impact the 2 Mg limit. It is worth noting that the US EPA's preferred compliance option is the 6 BQ compliance option since the amount of allowable uncontrolled benzene is fixed, whereas the 2 BQ compliance option allows less than 10 ppmw benzene waste streams to be exempted without counting them toward the 2 BQ limit. This fixed uncontrolled benzene quantity facilitates the US EPA's EOL check for assessing "compliance" with the 6 BQ.

As part of the benchmarking study, the difference between the reported R&V uncontrolled benzene quantities and EOL uncontrolled benzene quantities were determined to assess how distant the EOL results were from the reported uncontrolled benzene quantities. These results were further categorized by compliance option.

Figure 4 – Comparison of EOL Benzene Quantities to 2 BQ Reported Benzene Quantities

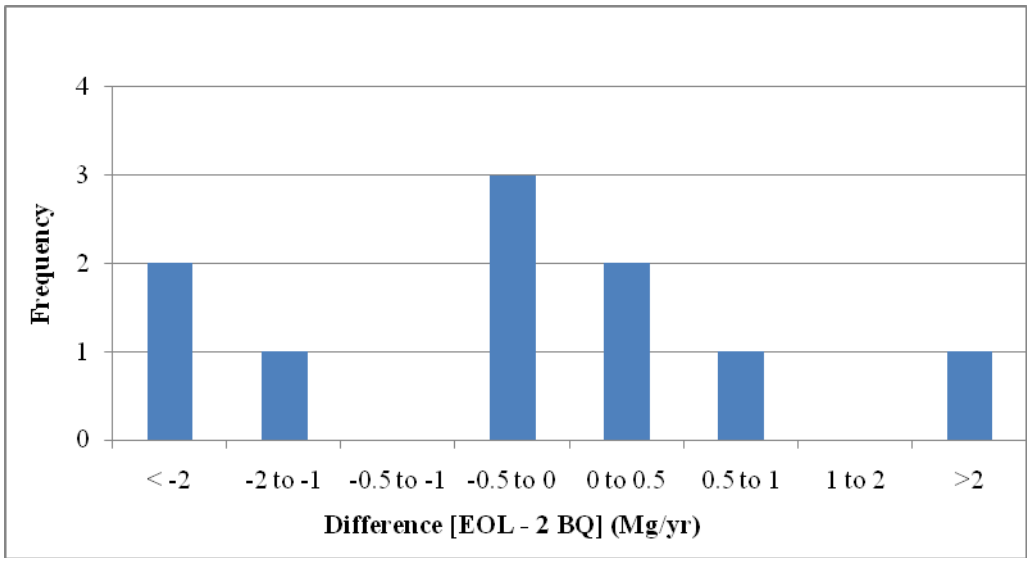
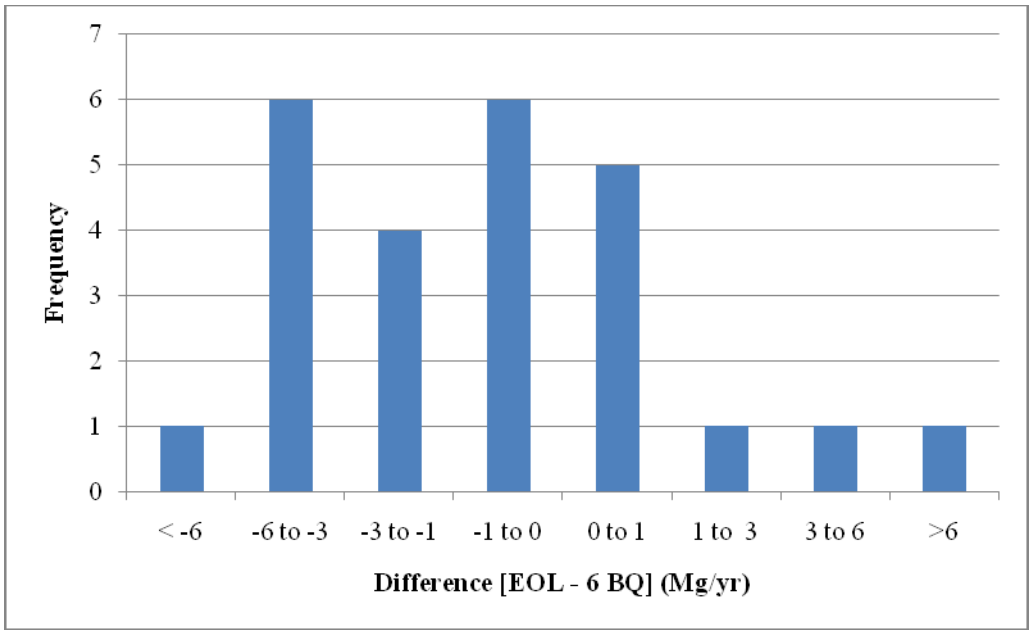


Figure 5 – Comparison of EOL Benzene Quantities to 6 BQ Reported Benzene Quantities



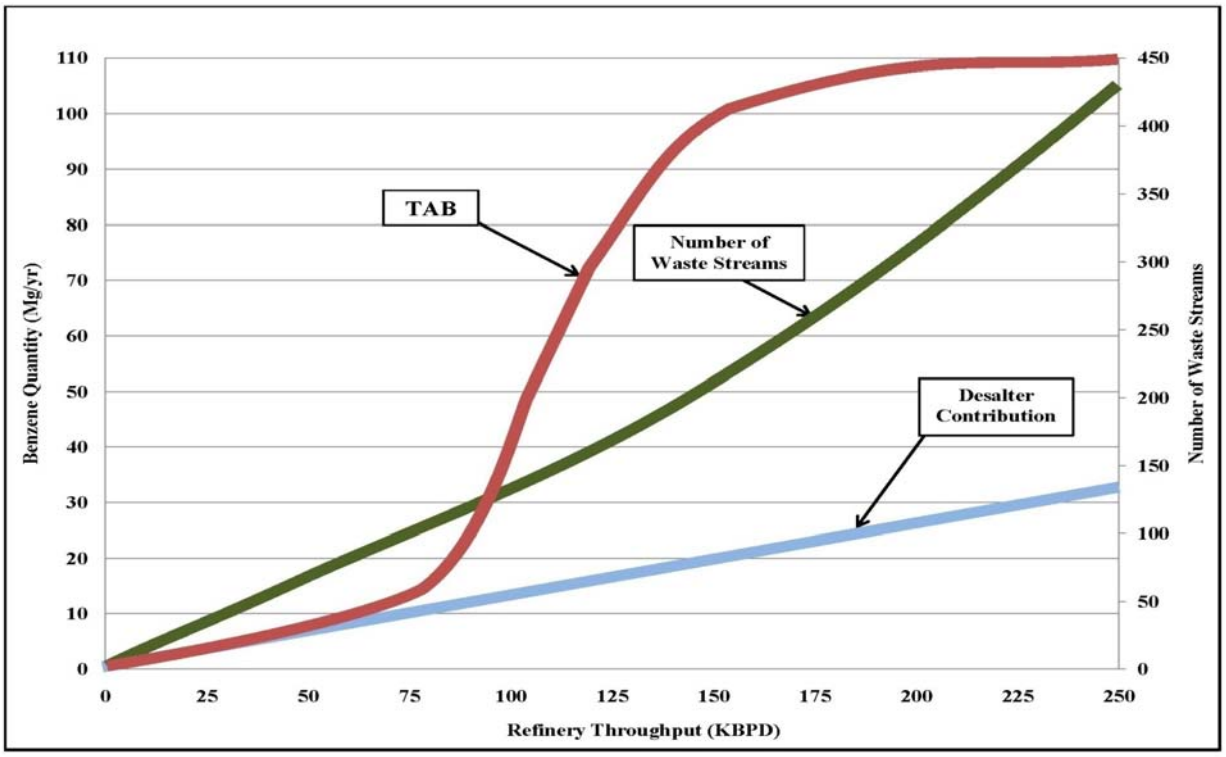
The differences between the EOL results and the reported R&V uncontrolled benzene quantity appear to indicate that some refineries are over reporting and some refineries are under reporting the "paper" uncontrolled benzene quantity. Where a facility experiences these differences a further review of the discrepancy is warranted.

Several reasons exist why facilities' EOL numbers are lower than the reported compliance option. One potential reason is that the refinery may be conservative on the calculations for the "paper" uncontrolled benzene quantity. Another explanation might be that there are benzene

losses upstream of the EOL sampling locations. EPA has indicated that between 20 and 40 percent of the benzene present at the point of waste generation may be lost as the waste is managed en route to the wastewater treatment plant[2]. A third explanation may lie in a facility not using the proper sampling methodology as described under 40 CFR § 61.355(c)(3)(i); where the rule states that BWON samples must be taken with a sample coil at less than 10°C to avoid benzene vaporization into the atmosphere.

Facilities where the EOL numbers are greater than the selected compliance option could indicate that the facility is out-of-compliance, and potentially trigger a third-party review to investigate the problem. Typically under Consent Decrees, when more than two consecutive quarters show that the projected EOL uncontrolled benzene quantity surpasses the allowable uncontrolled benzene quantity, a third-party review may be mandated to investigate the problem. In some Consent Decrees, action items are mandated if results from only one quarter extrapolate to an annual number that has the potential to exceed the compliance option limit. These action items involve additional sampling drawn on separate days during the subsequent calendar quarter for EOL points, as well as for specific uncontrolled points of waste generation with over 0.05 Mg/yr as identified in the most recently submitted TAB report.

Figure 6 – TAB, Desalter, and Waste Stream Chart



[2] Volume 55, No. 45, Federal Register, Page 8326, March 7, 1990

The above chart represents the minimum expected TAB, the desalter contribution to the TAB, and the number of TAB waste streams expected to be found at a facility with respect to the facility throughput. A facility TAB is notable because it often indicates the amount of rigor that the facility has placed on their waste stream review and EPA uses the TAB as a high-level metric. However, it should be noted that a facility TAB may vary depending on the types of process units and the facility control or waste management strategy with respect to BWON.

The following examples indicate the variability and possible deviations from the chart. The first case is a petroleum refinery that may have a TAB lower than the one exhibited on the chart. Consider a facility configured such that it does not have a slop oil system, but instead deinventories their equipment during routine and turnaround maintenance to crude tanks without any intervening waste management vessel. A petroleum refinery such as this would be expected to have a lower TAB than a facility that utilizes a robust slop system since the slop oils sent to crude tankage directly would not meet the definition of a waste under BWON. Additionally, if a facility primarily runs sour crude and sends a significant portion of the wastewater to the sour water stripper, then the facility TAB will also be lower than the anticipated TAB. This is because the rule allows for the benzene quantity for waste streams sent to a sour water stripper to be counted at the outlet of the sour water stripper instead of the prototypical point of waste generation.

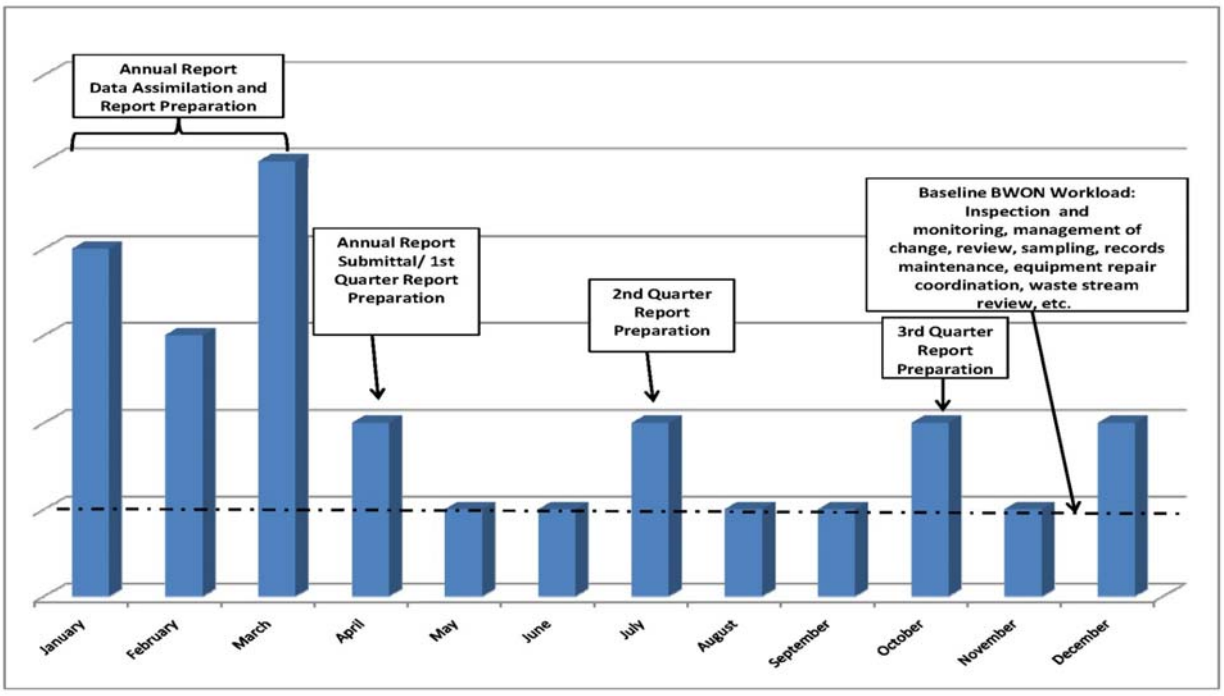
In contrast, a petroleum refinery that has chemical units, such as a benzene extraction unit, could have a much higher TAB than a facility without such units. Generally, the refineries that do have these types of units or have reformers, have a steep curve of the TAB plot when you reach approximately 100 thousand barrels per day of crude charge since large refining complexes also have chemical units.

These same considerations can also affect the number of waste streams in a facility's TAB. Other items that affect a facility's number of waste streams in their TAB include how a facility represents individual waste streams in their TAB. Many TAB waste stream lists appear very lengthy; however, upon further evaluation, 80 plus percent of the waste streams in the TAB are items such as pump and exchanger maintenance or filter change outs. The qualitative number of waste streams reflected in Figure 6 discounts these types of maintenance waste streams.

Managerial BWON Benchmarking

The chart below provides insight as to the rise and fall of the BWON workload at an affected facility. This chart is intended to qualitatively reflect the BWON rule workload at a facility whose TAB is greater than 10 Mg/yr; meaning the facility is subject to BWON control and treatment standards and required to demonstrate that the facility uncontrolled benzene quantity is less than either 2 Mg/yr or 6 Mg/yr, depending on the compliance option selected. The actual work load may vary depending on the facility size and whether or not the refinery is under a Consent Decree. This workload will increase for facilities under a Consent Decree due to the additional quarterly or semi-annual reporting and related tasks. The occurrence of the peaks may also change relative to each other because facilities may report on alternate schedules.

Figure 7 - Staffing and Workload

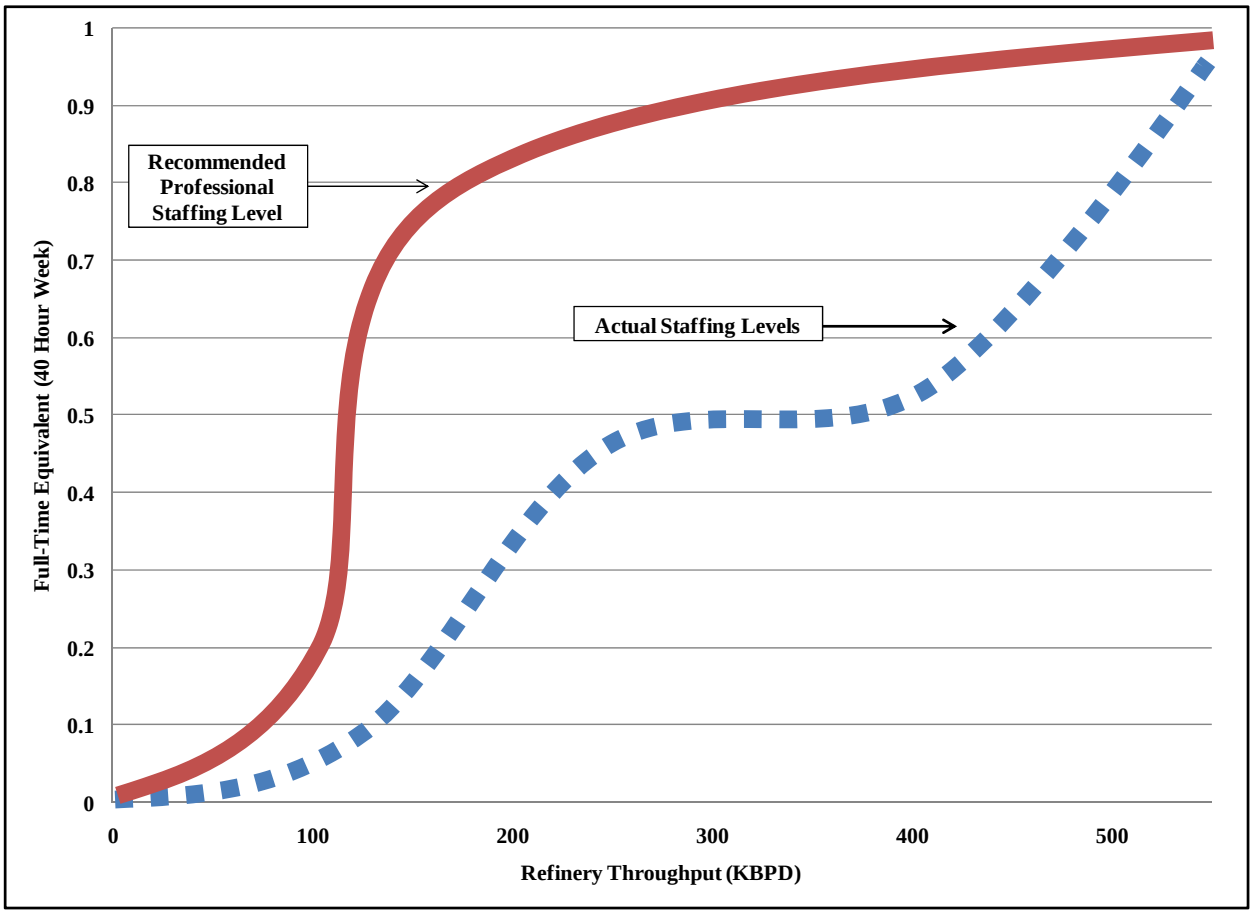


As shown, three or four major peaks in BWON workload are typical over the calendar year. These peaks reflect the effort to prepare both the annual TAB report, as well as the quarterly reports that must be submitted per BWON when a facility TAB is greater than 10 Mg/yr.

Even during the non-peak workload periods, a notable baseline work load still exists. This baseline workload reflects the needs to perform inspection and monitoring of BWON affected waste management units, assisting in management of change reviews, maintaining BWON records, performing BWON sampling, verifying waste stream inventories, BWON equipment repair coordination, etc. This baseline workload will also be affected by whether the facility uses contractors to perform equipment inspections, Method 21 monitoring, or sampling; and the configuration and complexity of the facility wastewater collection and treatment system.

The chart below plots the number of full-time-equivalent (FTE) staff to manage a BWON program with respect to refinery crude oil throughput. This chart depicts internal professional staffing needs and does not include outside contractors that may be used for equipment inspection, monitoring, and/or waste stream sampling.

Figure 8 - Full-Time Equivalent Chart



The blue dotted line displays the actual staffing observed at petroleum refineries and the solid red line represents the recommended staffing for the same facilities. The graphical representation demonstrates that both plots increase with respect to the refinery throughput.

An inflection point occurs in the vicinity of the 70 thousand barrels per day crude throughput; from this point the curve begins to increase exponentially. The sudden rate of change in curvature occurs at this point because this is where a facility's TAB is expected to surpass the 10 Mg/yr threshold. The 10 Mg/yr applicability threshold requires facilities to install controls to treat the benzene-containing wastewater and therefore, the regulatory and workload burden increases substantially. The recommended staffing increases at a much greater rate than that for the actual staffing at this point. This is due to the observation that at smaller petroleum refineries the environmental department is smaller and various programs might be assigned to one person. A BWON coordinator may not only be managing BWON, but also other programs such as LDAR, NPDES, air permitting, etc. This gap is of concern because even a small facility that is subject to the BWON rule has the same relative requirements as a larger one, except the amount of equipment subject to BWON inspection and monitoring requirements may be smaller. At larger facilities, the curves begin to converge again, due to generally larger budgets and staffing available.

A specific staffing case study was performed at a refinery under Consent Decree with a crude charge rate of 65 KPD and a TAB greater than 10 Mg/yr. The staffing needs to implement the BWON rule program at this facility were determined to be about two-thirds of a full-time equivalent or approximately 45 days per quarter. This estimate includes administrative aspects of BWON such as recordkeeping and reporting as well as field aspects such as inspection and monitoring. The staffing estimates were based on the following compliance tasks:

- BWON Sampling including EOL, quarterly point of generation and product and intermediate sampling, and at least monthly treatment system sampling. ***(8 days/qtr)***
- BWON quarterly visual inspections (QVIs) and no-detectable emissions (NDE) LDAR monitoring and associated recordkeeping along with job orders and repair tracking. ***(6 days/qtr)***
- Vacuum truck NDE LDAR monitoring and QVIs and associated recordkeeping ***(2 days/qtr)***
- Vacuum truck log management including reviewing and populating of TAB spreadsheet with waste movements ***(6 days/qtr)***
- Quarterly waste stream review with operators including field review and updates to TAB spreadsheet ***(5 days/qtr)***
- BWON advocacy and training (sampling training, standard operating procedure training, general operator training) ***(8 days/qtr)***
- File population and records management ***(4 days/qtr)***
- BWON quarterly report preparation ***(1 day/qtr)***
- BWON Annual report preparation ***(2 days/qtr)***
- CD quarterly report preparation, including EOL calculations ***(3 days/qtr)***

Managing Culture and Change

One of the fundamental components of a sustainable BWON compliance program is integrating functional and operational groups within the refinery into the BWON program. Many of the deficient programs struggle to cross the boundary and remove cultural barriers between the environmental department and operations personnel; this causes weakness in the field aspects of a BWON compliance program.

Hundreds of hours and tens of thousands of consulting dollars are often spent preparing a well documented waste stream inventory (or TAB) and uncontrolled benzene quantity at some point in a refinery's life-time; only to discover that the waste stream inventory is poor or obsolete years later. Some refineries have not updated their waste stream inventory since the rule was promulgated. The waste stream inventory is of concern given the fact that most refineries have numerous capital projects a year that may impact benzene waste streams and may have many "routine" small operational changes that may affect benzene waste streams. A few examples are provided below that have particularly impacted BWON compliance.

One example is a facility that changed ownership, and as part of that change in ownership, increased shipments of benzene across their marine terminal. The operating procedures at that

facility called for draining the residual product from the loading lines into an uncontrolled sump at the docks. This benzene quantity was estimated to be relatively minor when the previous owner operated the facility, resulting in less than 0.25 Mg/yr to the uncontrolled benzene quantity. However, when the new owner increased the benzene throughput by over an order of magnitude in order to ship the benzene to a chemical plant, the resulting uncontrolled benzene quantity also increased to several Megagrams per year. This stream in and of itself put the facility out of compliance.

A second example is a facility that went from using predominately purchased feedstock to a feedstock that was produced by one of their new units. The produced feedstock turned out to be of lower quality and fouled the feed filters to the unit much quicker than the purchased feedstock. This resulted in a significant increase in the frequency that the filter elements had to be replaced. As had been standard operating procedure in the past, the filters were drained to an uncontrolled sewer to replace the filter element. This change in feedstock and increase in filter draining resulted in an increased uncontrolled benzene quantity that, in and of itself, resulted in the facility exceeding their uncontrolled benzene quantity limit.

A third example is a facility that changed their procedures for performing water draws on product tanks due to product quality issues (water in the product shipped to customers). Subsequently, operations personnel began to water draw tanks for a longer period of time until they observed oil in the water draw to ensure the tank was free of water. The waste stream that was originally primarily water now had a significant contribution to the uncontrolled benzene quantity due to the oil that was drawn off the tanks. As in the previous two examples, this change in procedure resulted in increasing the uncontrolled benzene quantity beyond the allowable limit.

These examples provide a perspective on how changes that are relatively benign can impact BWON compliance significantly since prior to the change the waste streams involved did not compromise the uncontrolled benzene quantity. Hardly any MOC program would capture these changes. None of these “changes” in and of themselves were even a result of any type of capital project.

One fundamental concept that facilitates sustainable BWON compliance is having a relationship with the other functional and operation organizations within a facility. What can be done do to force or facilitate this interface? How can a facility ensure that the accountability for BWON extends beyond the environmental department to other groups within the organization?

The recommended ideas to manage this relationship gap include team work and are a function of communication, more extensive and repetitive training, and spreading increased accountability. First, operations must be accountable for their waste stream inventory. Depending on the organizational structure, this concept can be achieved in two ways. One way is routine reviews of the waste stream inventory with operations, which means sitting down with the persons operating the units on a regular basis (e.g., quarterly) to review the waste streams in their unit in an attempt to capture changes. Another option is for operations to be directly accountable for their waste stream inventory and productively communicate with the environmental department. This second option is challenging since operations must have a good baseline knowledge and

understanding of the BWON rule and field implications of the BWON rule to truly understand how to identify issues or operational changes that may impact BWON compliance.

The execution part of these recommendations is vital to BWON compliance. In order for these situations to be effective, there needs to be a strong relationship between environmental and operations to ensure that there is an awareness of BWON. Too often, process personnel disregard, intimidate, or otherwise not support plant environmental personnel. This cultural gap in the integration of environmental and process personnel is often culturally supported by operations and plant management personnel, directly and/or indirectly. Suggested methods to increase awareness, knowledge and skill levels include: formal training programs, propaganda, and general "face-time" with operations. Suggested methods to improve integration between operations and environmental are inclusive and unique to corporate culture, and are not addressed by this paper.

BWON training programs are recommended to include classroom-type training. Computer based training (CBT) can be a weak reinforcing tool given that there is not an opportunity for dialogue nor to truly ensure that the knowledge is adsorbed.

The use of propaganda as an awareness tool can be quite effective. This "propaganda" includes ideas such as control room posters, hard hat stickers, email newsletters, and team building awareness exercises that keep BWON at the forefront of the mind. The propaganda is essentially internal marketing materials that drive mind-share and awareness of BWON on a day-to-day basis. A good example is a facility that created "Oil to the Drain is a Pain" catch phrase and created hard-hat stickers to support the initiative. Another idea is a picture of the animal a "seal" to remind personnel of BWON drain and water seal inspections.

The authors believe that face-to-face time with operations is the most important awareness method. This technique encompasses performing field reviews in process units, reviews of operator rounds, interviewing operations, attending morning meetings, sponsoring brown bags, and generally creating opportunities to communicate concerns, instill BWON knowledge, and market BWON compliance within an organization and the operations thereof.

To a large extent, the concentration has been on operations in these discussions, but there are several other fronts within the facility organization that these same concepts must be implemented, including: engineering and projects groups, purchasing, maintenance, the economics and scheduling group, and plant management.

A 360^{o} leadership focus from environmental personnel throughout the organization will help ensure personnel are listening, communicating and taking actions. This culture is critical to BWON success and sustainability as people and their roles change in an organization, and is less costly than enforcement defense and settlements.

Enforcement Initiatives/Emerging Issues/Common Programmatic Deficiencies

Interpretation and application of the BWON rule regulation has changed noticeably since first promulgated in the 1990's. An example of this phenomena is to compare a facility TAB report

as submitted in 2009 versus what many facility TAB reports looked like as part of the initial submittals in the early 1990s. Early TAB reports typically had far fewer waste streams (often less than a dozen) than today's reports, which typically include several hundred individual waste streams.

Reflecting this change in the complexity of TAB reports, the industry standard for compliance with BWON has also become higher and more inclusive as a result of enforcement actions and rule interpretations. US EPA considerations to be addressed in a modern BWON compliance program, emerging issues, and some potential programming deficiencies at regulated facilities are discussed below in no particular order.

Unburied Sewer Line Inspections

Unburied sewer lines are required to be visually inspected on a quarterly basis per 40 CFR 61.346(b)(4)(iv). This requirement is often missed by facilities, which as a result do not properly identify and perform the inspections of aboveground sewer lines. Unburied sewer lines are defined as piping that is used to manage benzene-containing waste either between a point of generation and a waste management unit or between waste management units subject to BWON. Examples of unburied sewers include forced wastewater mains and piping used to deinventory equipment into storage drums. Oftentimes, regulated facilities fail to understand that such lines are subject to quarterly visual inspections. Complex networks of aboveground piping can be challenging to identify and an even greater challenge is to develop a system to verify that this piping is being properly inspected.

Several methods have been observed for successfully rolling this equipment into a BWON inspection and monitoring program. The methods range over a wide spectrum, including tagging these systems and using tools typically used to track Leak Detection and Repair (LDAR) monitoring to documenting generic Audio Visual Olfactory (AVO) inspections performed by operators on routine rounds using paper and pencil. The key is to ensure that, in one way shape or form, the facility can demonstrate that these lines have been identified and are inspected according to the requirements of BWON.

Control and Treatment Device Design Documentation

The second deficiency that has been frequently observed is the lack of documentation demonstrating that BWON control and treatment systems meet BWON requirements. 40 CFR 61.356 (d) and (e) require that engineering design documentation be prepared and maintained for the life of all control and treatment equipment in BWON service. The most prevalent compliance gap observed is the failure to maintain control device design documentation for carbon adsorption systems. US EPA has unofficially commented that compliance with this requirement is currently of particular concern during facility audits.

Each type of control or treatment device requires different information be included as part of its design documentation. For example, in carbon adsorption units, the design analysis is required to consider such factors as vent stream composition, constituent concentration, flow rate to carbon systems, relative humidity of the vent gas to the carbon, and temperature of the vent gas

to the carbon. Furthermore, the design analysis for carbon systems must establish the following design parameters: design exhaust vent stream organic compound or benzene concentration level (or breakthrough concentration), capacity of the carbon bed, type and working capacity of activated carbon used for carbon bed, and design carbon replacement interval based on total carbon working capacity and operating schedule. Refineries may have dozens of such carbon adsorption units in operation at any one time, as well as numerous other control or treatment devices, each requiring design documentation of similar complexity.

Off-site Waste Shipment Notifications

40 CFR 61.342(f)(2) requires that a notification be included with each offsite shipment of BWON waste for treatment or management, stating that the material is a benzene-containing waste and is required to managed in accordance with BWON. Refineries typically generate hundreds of tons of such waste on an annual basis, and may ship the wastes to multiple offsite receiving facilities to undergo a wide variety of treatment or disposal methods. If these wastes shipped offsite are to be considered controlled according to the BWON rule, each shipment must be accompanied by the referenced notification. This requirement can be particularly challenging for facilities under the 6 BQ compliance option that must control all benzene-containing wastes that contain less than 10 percent water. Several cases in which wastes that were considered controlled by the generating facility, but for which the notifications were not included with the manifest, were the subject of enforcement actions.

Missing BWON Waste Streams

Industry standards for waste stream inclusion in a facility TAB and uncontrolled benzene quantity has become much more rigorous since the rule was promulgated. TAB and 2 BQ or 6 BQ waste stream inventories now contain many more streams, and of a much wider variety, than was typically observed in the 1990s. Certain streams that meet the definition of BWON wastes, and are commonly recognized as such by industry, may still be consistently missed as part of many facility TAB reports. Many of the areas where waste stream are missed are associated with outside battery limit operations and infrequently generated wastes. Some notable examples include the following:

- Waste streams associated with marketing terminals, barge and ship loading operations, and co-located tank farms.
- Waste streams associated with knock engine labs and blending operations.
- Laboratory sample wastes including product and quality assurance samples.
- Waste streams associated with pipeline operations at a refinery including pigging stations, thermal pressure reliefs, and sampling waste.
- Waste streams associated with compressors in particular those compressors in recycle hydrogen service which may contain high concentrations of benzene.

Waste Stream Updates

The need to perform routine waste stream reviews is critical to sustaining compliance with the BWON rule. In many cases, it has been observed that a Management of Change (MOC) program, in and of itself, is not an effective way to find new waste streams or find changes to existing waste streams. Any MOC program, no matter how robust, must be augmented by routine reviews of the waste stream inventory to verify its completeness and accuracy. The review if performed properly is an opportunity to impact and manage BWON culture along with compliance.

As discussed previously, the methods by which such a review may be undertaken vary widely, and may range from performing routine interviews with operations and engineering personnel to review the waste stream inventory to properly training those same people to perform the same tasks as part of their routine duties and making them accountable for their waste stream inventory. In most cases, however, it should be noted that the inclusion of additional resources, often from a variety of disciplines within the refinery, is a prerequisite to a successful waste stream review.

Reviewing a facility waste stream inventory regularly is far more effective, both from cost and compliance standpoints, than reviewing a program only once every several years. As discussed previously, many facilities have been observed that follow a sine-type function where the BWON rule reviews occur in waves with each peak in program review generally triggered by a compliance issue in one of the valleys. Routine reviews are easier; infrequent reviews are difficult or painful.

In addition to reviewing the waste stream inventory for inclusivity, it is also important to routinely review benzene concentration data used for waste streams including the benzene concentration in both the water and hydrocarbon phase of waste streams. Oftentimes, the concentration data used to characterize a waste stream is several years old and has not been reviewed to ensure it is representative of current operations. Although the rule does not require that each waste stream be sampled on a certain frequency, it is recommended that some sampling be performed and, at a minimum, a periodic review of the concentration data be performed and the results documented to ensure that the benzene concentration data is still appropriate.

Vacuum Trucks

Vacuum trucks are used very commonly throughout refining to manage solid and liquid wastes as part of maintenance, housekeeping, or other activities. Due to the sheer number of movements such trucks make annually, the wastes managed in these containers presents a tremendous challenge to track. Adding to the complexity is the fact that vacuum trucks often manage wastes that have not, or cannot, be easily characterized. Under the BWON rule, vacuum trucks can be considered affected waste management units and fall under the container standards under 40 CFR 61.345. To be considered controlled, wastes managed by vacuum trucks must undergo inspection and monitoring similar to that required for other BWON-affected waste management units.

Simply performing proper inspection and monitoring of vacuum trucks in accordance with the BWON rule container requirements does not mean that all wastes managed in these trucks may

be considered controlled. The features of the location the waste is collected from and where the waste is discharged to must also be evaluated. If either the point of collection or the point of discharge do not meet control the control requirements then the waste must be deemed uncontrolled.

Understanding how the waste is managed from point of collection to disposal or discharge, having system in place to track such movements, and properly training vacuum truck operators to ensure that wastes are discharged in locations that meet BWON control requirements, are crucial elements of BWON compliance. The elements are oftentimes a challenge since there can be multiple locations where vacuum trucks are discharged, including everything from open systems such as washout slabs to controlled systems such as BWON-compliant slop tanks. Based on the frequent use of vacuum trucks to manage wastes in refineries, and the fact that even a single truck load of improperly managed waste is sufficient to render a facility non-compliant, a robust vacuum truck management program is critical to a sustainable and compliance BWON program.

Waste Management Unit Equipment Integrity/IR Camera

Infrared (IR) leak-detection cameras are being used more and more often by regulators as tools to find hydrocarbon leaks in process equipment as part of LDAR programs. Regulators have also been observed using IR-type cameras to find BWON-affected waste management units that may have integrity issues. As the application of this technology becomes more widespread, such inspections of BWON equipment using IR technology are anticipated to become more frequent. In certain cases, IR camera "leaks" found during agency inspections on BWON-affected waste management units may indicate that the BWON rule waste management unit inspection and monitoring program is not effective, or create required industry response to agency inquiry.

Another area of recent focus related to waste management unit integrity is with regard to water seals on drains and what may be considered "bad actor" drains that will not hold a water seal for a reasonable period of time. US EPA has recently focused on this during several site audits reviewing water seal inspection logs, identifying such drains, and questioning their integrity.

Sour Water Systems/Streams

Sour water waste streams are defined in 40 CFR 61.341 as streams containing greater than 10 ppmw sulfur or ammonia and are managed in enclosed systems en route to management in a sour water stripper. The point of TAB accounting for such streams is the outlet of the sour water stripper. Currently, US EPA is interpreting "enclosed" to mean controlled. Nominally, this interpretation means that sour water equipment (i.e., surge tanks etc.) en route to from the point the sour water is generated to the sour water stripper must be equipped with BWON-compliant controls. These systems should be evaluated to determine if they are "enclosed" or controlled up to and including the sour water stripper.

Co-located Facilities "Double-Dipping"

US EPA has observed that refining and petrochemical complexes have been through restructuring and/or divestitures since the original risk-based BWON rule making was performed in the late-80s and early-90s. Complexes that were once under common ownership and control are now owned by distinctive companies and submit separate TAB reports and uncontrolled benzene quantities. US EPA has a concern that this has resulted in a backslide on the amount of uncontrolled benzene allowed at this complexes and has plans to address this perceived issue in the future. Consider that a facility that was once allowed an uncontrolled benzene quantity of 6 Mg/yr that is now owned by three separate companies submitting separate TAB reports and uncontrolled benzene quantities and could conceivably have an "allowable" uncontrolled benzene quantity of 18 Mg/yr.

BWON Waste Management Unit/Individual Drain System Identification

Through inspections and enforcement actions, US EPA has expressed concern that regulated facilities are not properly identifying all of the components of an individual drain system (i.e., drains, manholes, junction boxes, etc.) that are required to be inspected and potentially monitored under BWON. The US EPA has observed drains in inspection records that are not found in the field and drains in the field that are not found in the inspection records. A parallel may be drawn between the individual drain system component identification issue and a deficient LDAR tagging program where the regulated components have not all been properly identified. Such inconsistencies may indicate a systemic issue that casts doubt on the compliance of the inspection and monitoring programs as a whole. All individual drain systems and waste management units in BWON service should be reviewed to ensure that affected equipment are included in the BWON waste management unit inspection and monitoring program.

Conclusion

The petroleum refining industry is experiencing a second wave of enforcement initiatives through CD implementation audits and BWON issues continue to surface and result in penalties. To add to the problem, penalties are substantial for refineries that were unable to comply with the original CD citations and action plans.

Sustained BWON compliance is a matter of diligently following a comprehensive BWON compliance plan, which requires maintaining and training sufficient personnel resources. Commonalities amongst sustainable BWON programs include the successful integration of all functional and operational groups within the refinery into the BWON rule program and 360° leadership from environmental department throughout the organization is essential for ensuring people are listening, communicating and taking compliance actions. A corporate culture promoting this integration is critical to BWON success and sustainability as people and their roles change in an organization.

Other commonalities include a sufficient initial investment to address compliance and build compliance programs and appropriate ongoing investments to maintain the programs. Despite higher initial investment, the total cost of managing a sustainable BWON program is usually

much lower than when compared to refineries that had a lower initial investment and/or lower allocated continuous BWON compliance costs.

Benchmarking studies revealed that refineries are moving from the 2 Mg/yr compliance option to the 6 Mg/yr "treat to target" compliance option. This finding reflects the fact that the 6 BQ has historically been US EPA's favored compliance option, based on language included in many Consent Decree BWON provisions limiting selection of the 2 BQ by covered facilities.

The study revealed that facilities reporting under the 2 BQ compliance option, showed a relatively high percentage of apparent non-compliance during the R&V process; notably, the same 2 BQ facilities struggled to maintain compliance after the R&V process was completed. In contrast, most of the facilities opting for the 6 BQ compliance option were initially determined to be in compliance with the 6 Mg/yr limit. A minimal amount of 6 BQ facilities were found out of compliance after the R&V process. Nonetheless, both compliance options showed that the vast majority of refineries consume more than 50 percent of their allowable limit and struggle to maintain a high enough margin for error allowing for unplanned benzene wastes.

As the refining industry endures BWON evolving, understanding, interpretation and enforcement; the manpower and management systems necessary to sustain compliance must progress proportionally. The recommendations to manage this BWON compliance gap are a function of communication, training, and spreading accountability. First operations should be accountable for their waste stream inventory. Management promotion of formal training programs, propaganda, and "face-time" interaction with operations will increase awareness and the effectiveness of the BWON program.

Biographies

Larry G. Darcey, P.E. is a Vice President and Client Service Manager out of Sage Environmental's Houston office. He has more than a decade experience in environmental and management consulting and additional experience with the TNRCC and as the Environmental Solutions Manager for a Texas gulf coast refinery. Mr. Darcey specializes in air quality permitting and compliance and has extensive knowledge and experience with the BWON rule. He has worked BWON compliance issues at more than two-dozen refineries including wholesale re-development of a several large refinery's TAB and BQ, assistance with Consent Decree BWON requirements, and development of BWON compliance programs. In addition, Mr. Darcey has assisted several refiners in BWON enforcement negotiations with State agencies and the Environmental Protection Agency. Mr. Darcey is a graduate of Texas A&M University and is a registered professional engineer in six states.

Ruth Jimenez-Benning, MBA is a Project Manager out of Sage Environmental's North Austin office. Mrs. Benning has seven years of environmental consulting field. Mrs. Benning has managed development and/or enhancements of benzene waste compliance programs for the NESHAP FF rule for numerous petroleum refineries, including projects required by "Global Settlement" Consent Decrees. For some of these projects, Mrs. Benning developed complex spreadsheet-based compliance tools for calculating, recordkeeping and reporting Total Annual Benzene (TAB) values for the NESHAP FF rule. Ms. Jimenez-Benning holds a B.S. in chemical engineering from the University of Arkansas and an MBA from the University of Texas at Austin.