TEXAS OIL & GAS ASSOCIATION

TEXAS CHEMICAL COUNCIL

June 20, 2011

Russ Nettles
MC-16
TCEQ Air Quality Division
P.O. Box 13087
Austin, Texas 78711-3087

Submitted electronically to siprules@tceq.texas.gov

Re: 2010 TCEQ Flare Study Project Draft Final Report (TCEQ PGA No. 582-8-862-45-FY09-04, Tracking No. 2008-81)

Dear Mr. Nettles:

Texas Oil and Gas Association (TxOGA) and the Texas Chemical Council (TCC) appreciate the opportunity to provide comments on the Texas Commission on Environmental Quality (TCEQ) 2011 Flare Study Project Draft Final Report.

TxOGA is the largest and oldest petroleum organization in Texas, representing more than 4,000 members. The membership of TxOGA produces in excess of 90 percent of Texas' crude oil and natural gas, operates 100 percent of the state's refining capacity, and is responsible for the vast majority of the state's pipelines. According to the most recent data, the oil and gas industry employs 315,000 Texans, providing payroll and benefits of over $30 billion in Texas alone. In addition, large associated capital investments by the oil and gas industry generate significant secondary economic benefits for Texas.

TCC is a statewide trade association representing 67 chemical manufacturers with more than 200 Texas facilities. The Texas chemical industry has invested more than $50 billion in physical assets in the state and pays over $1 billion annually in state and local taxes. TCC's members provide approximately 70,000 jobs and over 400,000 indirect jobs to Texans across the state. TCC member companies manufacture products that improve the quality of life for all Americans.

Many TCC and TXOGA companies are also members of the American Chemistry Council (ACC), National Petrochemical Refiners Association (NPRA), and/or the American Petroleum Institute (API). TCC and TXOGA collaborated with those national trade groups on these comments, and we also acknowledge our support of the ACC/NPRA/API comments submitted on the flare study project draft Final Report.

Our member companies are generally pleased with the overall strength and scientific rigor of the TCEQ Flare Study and encourage its use as the foundation for further research into flare combustion parameters and operating scenarios that effect a flare's Destruction and Removal Efficiency (DRE). However, we are concerned that TCEQ, the U.S. Environmental Protection Agency (EPA), and others will attempt to simply apply these test results to all industrial flares, without consideration for important differences among flares and different factors affecting DRE. TCC and TXOGA believe additional research is warranted to build upon the foundation of this study, and member companies would be willing to work with TCEQ and others in furtherance of this research.

At the TCEQ Flare Stakeholder meeting, Mr. Torres indicated that several issues that are currently not addressed in the Draft Report would be included in the Final Report. TCC and TXOGA would like the opportunity to review and comment on the complete Draft Final Report before it is finalized and put in the public domain.

TCC and TXOGA offer the following specific comments on the Draft Report. Please note that these comments pertain to the Draft Report itself as well as to the draft Executive Summary. The comments are organized into three groups: technical comments focused generally on the study and its findings, technical comments focused on the remote sensing instruments/performance, and policy-related comments which we believe are relevant to this discussion.

General Comments

1) The Flare Study was well-executed by TCEQ's contractors and subcontractors; however, it is important that the Final Report explain that this study was limited in its scope of parametric variation, and the term "comprehensive" should not appear in the title of the Final Report. The Final Report should include a specific discussion of the limitations of the study, including such things as the limited vent gas composition as compared to the extremely heterogeneous vent gas compositions typically seen in petrochemical processes; the two flare tips employed as compared to the many flare tip sizes, designs, elevations, and assist configurations in use across industry; the very high turndown ratios tested; and the meteorological conditions during the study as compared to the long-term, seasonal variations in which most flares are operated. It is important to highlight these differences to prevent the study results from being broadly applied to all flares operated under all conditions. For example, the following flare operating/design variables were not addressed in the study:
   a) other flare designs,
   b) other combinations of flare head exit velocity and diameter,
   c) other combinations of pilot design, heat release, number and location,
   d) other operating conditions,
   e) steam pressure and its effect
   f) other flare gas compositions, such as
      i) the markedly differing effects of dilution by nitrogen vs. carbon dioxide
      ii) hydrogen-bearing mixtures, which are recognized in 40 CFR §60.18 to behave entirely differently[1]

[1] Demonstration of Hydrogen Use in Steam- and Air-Assisted Flares, Alexis McKittrick, Combustion R&D, Praxair, Inc., June 9, 2009; Link: *http://www.afrc.net/assets/fordownload/flareforum/2009_boston/demonstration_of_hydrogen_use_in_steam-and_air-assisted_fla.pdf*

g) lower turndown ratios or gas flow rates exceeding 1 percent of design capacity

2) The Final Report should address the inappropriateness of applying the results of this study to flares operated under all lower turndown conditions. The Draft Report shows that flare efficiency decreased as the flare turndown increased, and that assist gas quantities and assist gas-to-vent gas ratios to achieve a desired flare efficiency decreased as the flare turndown increased. Flare gas rates tested were at 0.1% and 0.25% of flare design capacity of steam-assisted flares and 0.25% to 0.65% of flare design capacity for air-assisted flares. The Draft Report does not explore the assist gas quantity or assist gas-to-vent gas ratio needed to achieve desired DRE if the flare gas rate increases to higher values, e.g. 1%, 1.5%, 2% or even up to 10% to 20% of flare design capacity for smaller air-assisted flares. The report should caution that it may not be appropriate to apply the same assist gas ratios or combustion zone net heating value calculations in cases where the flow to the flare is at a higher percentage of the design capacity.

3) The Final Report should include a recommendation that additional study on a more diverse set of operating scenarios is needed. The study results show that these particular air- and steam-assisted flares operating under 40 CFR §60.18 conditions can effectively control low Btu vent gas at low flow rates under certain operating conditions. The study results also included instances in which flares operating under low flow conditions (< 1% of their design capacity) and meeting 40 CFR §60.18 conditions did not achieve 98% DRE. This finding requires more study in identifying those critical operating parameters that will ensure the optimal DRE and Combustion Efficiency (CE) for any given operating scenario.

4) The Final Report should recognize that the research findings are not necessarily broadly applicable to the universe of industrial flares. Page 2 of the Executive Summary claims that the flare sizes and design configurations tested were selected because "they represent a large number of flare models currently in the field and the results *will be applicable* to these and similar flare designs when operated under similar conditions". The report, however, has provided no information to substantiate the claim that the flares tested are representative of the industrial population; neither has the testing been repeated to support the opinion that the results "will be applicable". Non-assist flares (*used for gas streams with a low heat content and low carbon/hydrogen ratio*), small flares (operating at less than 10,000 lb/hr), and smaller capacity flares that are operating at 10% to 20% of their design capacity are examples that were clearly outside of the scope of this study. In the operating environment, the actual vent gas to the flare (including composition), the flare design, and overall operating conditions vary in any given case. Therefore, the study is not directly applicable to non-assist flares/small flares or other operating scenarios that fall outside of the bounds of the research.

5) The Final Report should provide actual data on the number of flares currently in use in Texas and the numerous flare tip designs that exist in the industrial community to support the claim

---

Flame Stability Limits and Hydrocarbon Destruction Efficiencies of Flares Burning Waste Streams Containing Hydrogen and Inert Gases, Peter M. Walsh, GE – Energy and Environmental Research Corporation, et al, November 6, 2002; Link: *http://www.afrc.net/assets/fordownload/flareforum/2002_houston/flame_stability_limits_and_hydrocarbon_destruction_efficienc.pdf* that the flare sizes and design configurations were selected to be representative of a large number of flare models currently in the field. Various flare tip designs are selected based on the different fluid characteristics, the pressure available in the collection header, the carbon-hydrogen ratio, and concentration of components. Other typical flare types and designs not tested in this study include pipe flare (subsonic), sonic flare (single tip & multiple tips), coanda tip (single & multiple), enclosed flare, endothermic flare, liquid burner, unique flare designs that use steam/air tubes to reduce the amount of steam necessary to achieve smokeless combustion, and other proprietary tips.[2] For example, flares in the 24" to 48" size that have tubes with a lower stream ring would likely have much different combustion characteristics. The experience with at least one company is that flares of this size would not have only an upper ring, but would also include steam/air tubes.

In addition, the report should emphasize that it is not possible to make conclusions for various other types of flare design which would be expected to behave differently from one another. Some examples include staged elevated flares, annular elevated flare heads, multipoint elevated flare heads, high-pressure sonic elevated flare heads, low-pressure steam nozzles, and high-pressure sonic steam nozzles.

6) In its findings (#3), the Final Report should include a discussion to clarify the differences in how center steam and upper steam affect DRE and steam-to-vent gas ratio. The Draft Report implies that the addition of center steam may be problematic to achieving high DRE. The Final Report should also include a discussion of the purpose and importance of center steam addition to effectively mitigate internal burning to protect the flare tip's mechanical integrity, to ensure smokeless operation, and to prevent steam condensation in the steam header. Otherwise, a reader could misunderstand the report as suggesting, inaccurately, that one option in minimizing steam addition would be to remove or significantly reduce the amount of center steam.

7) The Final Report should provide more information regarding vendor-recommended center steam rates. The Draft Report seems to suggest that 300-500 lb/hr center steam rate is recommended by most flare vendors. However, our experience is that center steam requirements recommended by our flare vendors are usually much higher than this and are based on flare tip size, steam system design, etc.

8) The Final Report should include a key finding for air-assisted flares operating with an excess air factor less than 10. The Draft Report indicates that under these conditions the air-assisted flare achieved greater than 97% DRE.

9) TCC/TXOGA recommend that the tables on pp. 27 and 118 (Tables ES-3 and 9-1) be removed from the report. There are no data provided in Section 9.0 that discuss the analysis of the flare plume and support the constituents listed. Without providing relative concentrations of each species, it could be implied that large quantities of these constituents are being emitted. If the tables remain in the report, information regarding the concentration of each species measured in the plume should be provided either in the report or in the appendices so that readers understand the levels of these constituents that may be present.

---

[2] *http://webwormcpt.blogspot.com/2009/02/flare-tip-quick-selection-chart.html)*

10) TCC/TXOGA recommend that the tables on pp. 28 and 119 (Tables ES-4 and 9-2) be removed from the report. The information as presented can lead to false conclusions that the actual emissions would occur at all flares under all conditions. The report should emphasize that under certain operating conditions DRE can be less than previously expected. If the tables must be included, the report needs to highlight that the currently available technologies, although tested in this effort, have not been demonstrated to be capable or cost-effective in continuously measuring actual flare emissions in the field.

11) TCC/TXOGA recommend that since the Draft Report has limited information about wind effects on flare DRE/CE, the Final Report should state a conclusion that wind did not appear to be a critical factor or there is insufficient data to draw specific conclusions.

12) The Final Report should include an improved discussion and presentation of test results regarding DRE and Combustion Zone Net Heating Value (CZNHV). The Draft Report includes numerous charts depicting DRE vs. CZNHV. These charts seem to draw the conclusion that ~200 Btu/scf CZNHV is necessary for 98% DRE. This is may be true for the conditions and gases tested, but other gases and gas mixtures can have different flammability characteristics that would change this conclusion. The Final Report should include flammability curves for other gases or qualify the existing charts with a statement that a different minimum Btu/scf CZNHV may be necessary for gases other than those tested. In addition, the report should include a brief discussion on hydrogen gas since hydrogen has a net heating value of 51,569 Btu/lb, which is much higher than most hydrocarbons, but has a net heating value of 270 Btu/scf when calculated on a volumetric basis. Thus, concluding that a CZNHV of greater than 200 Btu/scf is required would inhibit the ability to flare hydrogen gas, which burns very well.

13) The Final Report should more prominently highlight that the study reveals there is good agreement between this study and the 1983 EPA/CMA flare study under similar test conditions. This outcome is important since it confirms that current flare operating practices are founded on sound scientific principles developed years ago.

14) All charts included in the report should be reviewed and reformatted as necessary to ensure the data are presented in ranges and are clearly delineated from one another. This will lead to improved understanding of the data, range of accuracy, and potential for error.

15) Finding #6 on pp. 29 and 125 should be eliminated from the Final Report because it inappropriately compares actual emissions to emissions estimated using 99% DRE. There is no need to make this comparison. The real finding could be better described as, "The DRE of propylene has historically been assumed to be 99% based on the 1983 EPA/CMA study, but our study showed that under certain operating scenarios lower DREs were achieved."

16) The Final Report should provide the particle matter (PM) data at the incipient smoke points that were collected during this test or indicate the PM data will be released for review and comment when the data are available. These data will be critical to evaluating the pros and cons of operating a flare near its incipient smoke point, especially in light of EPA potentially lowing ambient air quality standards for particulate matter.

17) <u>The Final Report should include as appendices the raw data on combustion gas compositions</u>. TCC/TXOGA notes that in order to calculate DRE, TCEQ makes an assumption that the ratio of propylene versus CO_2 and CO is constant in the combustion gas. This is roughly the case, but there is uncertainty, especially with high propylene values. TCEQ should release the raw data so we can understand the confidence interval of the ratio of propylene to CO used to calculate DRE. Our concern is that at low DRE, the experimental uncertainty is high. The data in the graphs are shown as single points, so there is a tendency for the experimental uncertainty to get lost.

18) <u>The consequences of operating at very low steam to hydrocarbon ratios for protracted time periods should be reviewed</u>. One advantage of the steam assisted flare is a longer tip life due to the steam's cooling effect. The mechanical integrity risks of operating at very low steam to hydrocarbon ratios should be clearly understood prior to considering policies that might dictate operating in a manner that exposes equipment to higher failure rates.

<u>Remote Sensing Comments</u>

19) <u>TCC/TXOGA agrees with the TCEQ's flare study technical review panel's comment that the limitations of passive measurements should be included in the report</u>.

20) <u>Everything included in the TCEQ slide pack except slide 40 should be included in the Final Report</u>. TCEQ slide #40 from slide pack dated May 18-19, 2011, was not specifically included in the Draft Report. This slide plotted the combustion efficiency measured by the extractive techniques as a function of test points ranked by combustion efficiency. TCC/TXOGA does not agree with Draft Report's premise that 100% of the error should be assigned to passive measurements. Ideally, both techniques should estimate error, assign error bars and be plotted in an unbiased fashion for comparison.

21) <u>The Final Report should include a discussion of the inaccuracies of the various test methods</u>. The standard deviation of the tests varied from 2.2 for steam-assisted to 2.5 for air-assisted CEs greater than 95% (TCEQ Report p. 25). There is no discussion in the report of the inaccuracies of the test methods which are likely the reason for the high standard deviations.

22) <u>TCC/TXOGA questions the statistical analysis comparison of the active and passive FTIR measurements to the ARI extractive measurements</u>. TCC/TXOGA suggests that a more useful statistical treatment would be to calculate the difference of the means of the two technologies and obtain the bias. In addition, TCC/TXOGA suggests a different treatment of the standard deviation would be to calculate the sum of the squares of the individual measurements by its average and then divide by N-1.

23) <u>The Draft Report provides positive feedback on the PFTIR sampling; however, it should provide more discussion on how the instrument was positioned and what improvements were made to the PFTIR since earlier TCEQ trials</u>[3]. Of interest to TCC/TXOGA are how the spectrometer was positioned to get accurate measurements and whether the improved

---

[3] Passive FTIR Phase I Testing of Simulated and Controlled Flare Systems FINAL REPORT, URS Corporation, June 2004, Link: http://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/oth/Passive_FTIR_PhaseI_Flare_Testing_r.pdf

detector design improved the overall sensitivity of the test. The Final Report should also contrast this to the performance of the PFTIR in blind validations conducted by TCEQ in 2004 Phase I trials. The Final Report should acknowledge the other blind validation studies results and note the limitations on use of the PFTIR. In addition, the Final Report should recommend further validation testing on the PFTIR method in the future.

24) The Final Report should clarify that some of the remote sensing technology measuring devices are not commercially available so that readers clearly understand that some devices are research devices.

Policy-related Comments

P1) TCC/TXOGA are concerned that the results of the flare study will form the basis of future EPA and/or TCEQ rulemaking. Flares are first and foremost critical safety devices used to safely and effectively manage emergency scenarios in our processes. We are concerned that future rulemaking could mandate specific flare operating practices which would conflict with this critical function, jeopardizing the safety of our employees and the communities in which we operate.

P2) It is critical that the findings of this study be put into context with existing systems in industry. The Final Report should mention 1) that flare operators have already in many cases actively reduced flows to flares to save gas and reduce emissions through reuse/recycle, and 2) to meet minimum DRE/CE, flammable gas flows (like fuel gas) to flares may have to be purposely increased to meet proper destruction conditions. This may lead to an increase in overall emissions (due to overall increased gas flows) and ultimately higher user cost.

P3) EPA and TCEQ should consider appropriate adjustments to regulatory requirements that will enable industry to make prudent changes to its flare operating practices. The study indicates that large capacity flares operating at low flow conditions can be over-assisted and that controlling flare assist rates is critical to achieving high DRE. The results of this study and various other studies like the mid-80s EPA study indicate that a flare operating slightly above the incipient smoke point appears to be in an ideal range for higher levels of combustion efficiencies, but current regulations do not allow smoking flares. In fact, these regulations provide, at least in part, a driver for the use of more steam than optimal from an efficiency standpoint.

P4) EPA and TCEQ should seek to establish flare operating conditions which maximize the flare's DRE rather than mandating a specific DRE (e.g., 98%) from all flares under all conditions. Regulatory policies should not unduly restrict operating flexibility for equipment that, in many cases, services a wide range of scenarios from the routine to the unexpected operating situation. TCC/TXOGA concur with the TCEQ's flare study technical review panel comment indicating more analysis of the implications of flare measurements and the potential impact on flare operations is needed.

P5) Before any changes are made to regulatory requirements, the relationship between optimum flare steaming to manufacturer's recommended steaming for flare tip cooling needs to be better understood. Specifically, regulations should not drive flare operators into the position of needing to compromise the integrity of their equipment in order to meet compliance requirements. More study may be needed in this area. While the study itself did not show signs or evidence of hot flames that would damage flare tips, the reason for this may simply be the very low flow rates used in the study, i.e., less than 1 percent of design flow rate.

P6) The TCEQ should revisit 30 TAC Chapter 111 concerning visible emissions. These provisions do not allow visible emissions from a process gas flare for more than 5 minutes in any 2 hour period, with certain limited exceptions. A major finding of the TCEQ's flare study suggests the most efficient operation, as measured by the destruction removal efficiency and combustion efficiency, is achieved at or near the incipient smoke point for large flare tips when the waste gas flow to the flare is <0.25% of the design capacity for steam-assisted flares and <0.65% of the design capacity for air-assisted flares. As noted in P2 above, this finding mirrors previous studies. This study provides a new operating paradigm suggesting the need for increased awareness/training for flare operating personnel. TCEQ should consider adding a provision in 30 TAC Chapter 111 that provides some exemption for visible emissions due to efforts to achieve greater flare DRE.

P7) The TCEQ should develop and implement a broad communication plan based on the results of this study. This initiative should educate the public and the media about forthcoming changes to flare operations and what they can expect to see from flares near their communities as operators initiate changes in their flare operating practices. Highlighted in these discussions should be that flares are first and foremost safety devices.

P8) Improved understanding of actual DRE will result in more accurate emission reporting and suggests a need for additional study. Emissions estimating guidance for flares found in AP-42 assumes hydrocarbon DRE is 98% when the flare is operated according to 40 CFR §60.18 requirements based on the results of the 1983 EPA/CMA flare study. The TCEQ study demonstrates that for certain flares operating over the range of requirements in 40 CFR §60.18, DRE's can vary widely. Additional study is needed to understand actual DRE under routine operating conditions so that agencies and industry together can appropriately revise, if necessary, emission estimating methodologies for flares.

P9) The infrared camera continues to be a useful screening tool for evaluating the relative effectiveness of flare DRE, but it is not sufficient for measuring and enforcing a specific DRE requirement. At the flare stakeholder meeting, Mr. Torres discussed the "challenges" in interpreting the infrared camera results. In particular, several photos were reviewed and the "thermal image" (*steam*) versus the "haze" (*unburned hydrocarbons*) was discussed. This suggests that IR camera operators must be skillful users of the device and great care must be taken when interpreting visible images. There are no commercially available instruments to quantify emissions directly from visual images.

P10) TCC/TXOGA encourages TCEQ to continue their dialogue about flares with EPA and to include other stakeholders in these discussions as appropriate. EPA should consider the information in TCEQ's flare study prior to drafting any new regulatory requirements.

We respectfully request your careful and thoughtful consideration of our comments and suggestions. Given the significance of this flare study report and the bearing its results may have on our industry, we would like to suggest a meeting at a mutually acceptable time to further discuss our concerns. To arrange this meeting or if you have any questions regarding these comments, please contact: Deb Hastings at dhastings@txoga.org or 512/478-663; or Christina Wisdom at wisdom@txchemcouncil.org or 512/646-6403.

Sincerely,

Deb Hastings
Vice President Environmental Affairs
Texas Oil & Gas Association

Christina Wisdom
Vice President & General Counsel
Texas Chemical Council