

The University of Texas at Austin
Responses to
TxOGA & TCC Comments (Dated August 16, 2010) on the
Comprehensive Flare Study Project
Quality Assurance Project Plan (Rev. 0, Dated July 2010)

TxOGA & TCC Letter of Transmittal

Page 1, Paragraph 4

Comment: *Our member companies have a number of general concerns regarding the study plan including the fact that a number of the comments from the TCEQ's own Technical Review Panel appear to have been overlooked or not adequately addressed. Therefore, prior to implementing the Flare Study, we urge TCEQ to fully address the Panel's concerns.*

Response: UT Austin appreciates the comments provided by the TCEQ Technical Review Panel and made every effort to understand and address the comments of the TCEQ Technical Review Panel. UT Austin will revisit those comments and address any that may have been overlooked, paying particular attention to any identified in the specific comments provided in the TxOGA & TCC detailed comments of August 16, 2010.

Quality Assurance Project Plan

Section A4 Project/Task Organization

Comment: *Each subcontractor should provide a detailed organizational chart and specific descriptions of the functions of its staff so that the QAPP clearly delineates who will be doing what during the Flare Study. In addition, the QAPP does not specify what individual has responsibility for assembling and reviewing all of the data generated as a single dataset. It appears that Zephyr Environmental is providing data management and validation services as well as statistical support to the project. If Zephyr will be on site with any instruments and/or analytical tools, the consultant should also appear in Sections B6 (Instrument/Equipment I/M) and B7 (Instrument/Equipment Calibration and Frequency).*

Response: In lieu of a detailed organizational chart for each subcontractor, UT Austin elected to follow the format used by the TCEQ which provides a detailed listing of project responsibilities in Sections A4.1 to A4.12. In addition UT Austin has included an overall organizational chart for the project, Figure A4.A, and Table A4.1, which shows specific roles and responsibilities during the flare tests. This approach met with approval from one the reviewers of the TCEQ Technical Review Panel, EPA, who stated:

Edward:

I just went through the latest version of your TCEQ QAPP – GREAT improvement. I can actually read through it and tell what you're going to do, who's going to do it, how you plan to do it, and when you're planning to do it. QA/QC information was more complete and better organized. Great job. If I had anything to complain about, I would complain about the fact that the current version is still labeled "Revision 0," which it is not.

Good luck on the project. It will take a Big Whistle and a huge bullwhip to coordinate everybody in their on-site operations and then, later, in spite of everybody's promises and great intentions, prying data out of everybody so that a report can be produced.

Joan

UT Austin (Vincent Torres and Ed Michel) has responsibility for assembling and reviewing the final data sets as specified in Sections A4.3 and A4.5.

Zephyr will not be on site during the testing or providing any equipment for the testing. UT Austin will further clarify their role in the QAPP to make their role and responsibilities clearer.

Section A4.11 Data Validation

Comment: *The data validation protocols to be used are not clearly spelled out. Also, third party, independent data validation is not called for and should be considered.*

Response: As planned, the project funds and schedule do not support third party data validation.

Comment: *We also note that IMACC will be validating the data generated from both the active and passive Fourier Transform Infrared Spectroscopy (FTIR) instruments. We are concerned that having the same subcontractor employing both instruments and validating both sets of data will compromise the integrity of the data. How will TCEQ ensure that the Passive FTIR (PFTIR) instrument is not calibrated using data from the Active FTIR (AFTIR) instrument with the intent of "truing up" the PFTIR results? This study provides an opportunity to evaluate the PFTIR instrument on an independent basis, but having the same subcontractor running both this instrument and the AFTIR instrument puts into question the validity of the*

PFTIR results. In short, we believe the active and passive FTIR instruments should be validated independently.

Response: UT Austin is well aware of the concern related to the PFTIR and AFTIR relationship and appreciates the concern. IMACC will be supplying the algorithm to UT Austin prior to any field testing so that UT Austin may validate any data generated by IMACC at a later date to verify that the algorithm has not been changed.

Sec. A6.2 Sampling and Measurement

Comment: *The QAPP should explain the basis for the selection of the flows at 0.25% and 0.1% of rated design. We are concerned that these are extremely low flows that may not be representative of low-flow conditions at most flares throughout industry. Additional concern has to do with the test matrix presented in Appendix D which is summarized below. The steam-to-fuel ratios proposed for testing are at or near the smoke point and at or near the snuff point. Flares are not normally operated at these steam-to-fuel ratios. They are operated in between these ratios. The testing needs to be conducted at an intermediate steam-to-fuel ratio in order to be representative of how flares are operated.*

Response: Please also refer to the TCEQ response to this comment. **Emergency flares controlling routine emissions are expected to be operated at very high turndown ratios. The current testing plan would put the turndown to be around 500 for the 2,300 lb/hr flow and around 1000 for the 1,000 lb/hr flow. In industry, this flare tip would be expected to operate between 0 and 1,000,000 lb/hr. Information from industry on actual routing flow to emergency flares is very limited. If these waste gas rates are not representative of the wide range of flow expected at emergency flares controlling routine emissions, then TCEQ would welcome any available data on actual operating conditions of emergency flares controlling routine emissions.**

The Test Plan in Appendix D includes two intermediate steam/air test points for each test series except Test Series S1 and A1, which are baseline tests using all propylene.

Comment: *EPA has recently introduced a new concept related to flare operation, i.e., the flare combustion zone heating value. It appears that EPA wants to set a lower limit combustion zone heating value of 200 Btu/scf based on the recent test data. It appears that the flare combustion zone heating value will be very low during Runs S3 - S6 (potentially 100 and 200 Btu/set). TCEQ should consider exploring this new parameter in some manner during the test.*

Response: This project will calculate a combustion zone heating value during each test and report the results in the final report. Please see the TCEQ response to this comment. **The formula to determine the combustion zone BTU value will likely be the same formula used in the recent Marathon Texas City and Marathon Detroit flare testing unless a more accurate formula can be determined.**

Comment: *Furthermore, TCEQ should also consider exploring the 40 CFR §60.18(f)(6) v_{max} equals $k_1 k_2 h t$ equation and assumptions during the study.*

Response: Please refer to the TCEQ response to this comment. **Can not find equation $k_1 + K_2 h t$ identified in the comment. Maximum velocity of a flare tip falls outside of the scope of this project.**

Section A7.1 General Project Objectives

Comment: *A stated data quality objective is to "Guide in the use of remote sensing technologies". We believe that the objective should be to explore the validity of these remote sensing technologies for use in evaluating flare emissions. We believe exploring the validity is more appropriate based on the 2004 URS study report for TCEQ that states the relative reported accuracy to be about +/-50% for CO₂, CO, and ethylene. Further to this point, this same report stated that comparisons of PFTIR and extractive FUR (EFTIR) concentrations indicated that significant bias was seen for certain compounds in specific tests.*

There have been no successful blind-validation comparisons with reliable extractive-sampling tests of any remote sensing technology. Thus, while 'point-and-shoot' measurement technology is needed and desired by operators and regulators, a blind-validation comparison should provide quantification of speciated mass emissions of today's highly-reactive volatile organic compounds of interest (e.g., ethylene, propylene, butadiene) or the class-archetypal carcinogens of interest (e.g., formaldehyde, benzene, benzo(a)pyrene).

Response: Please also refer to the TCEQ response to this comment. **TCEQ is aware the proposed remote sensing equipment, specifically the passive FTIR tool (PFTIR) has not been blind validated.**

The design in the test program prevents the remote sensing technologies to view the extractive sampling measurement results until

publication of the final report. This process will provide a blind-validation comparison.

Section B1.1 Study Site Design

Comment: *Although an extensive description of the John Zink facility and flare test equipment is provided in this section, the QAPP fails to provide a Quality Management Plan for the John Zink facility. We believe this document is needed to complement and complete the other information provided.*

This section describes the two flare tips that will be used in the study but does not justify their selection. The justification for each should be provided. Also, this section states that drawings of the steam-assisted flare tip (John Zink Model QSC) and the air-assisted flare tip (John Zink Model LHTS) are included in Appendices L and Ll respectively. There is no Appendix Ll in this version of the QAPP and a drawing of the air-assisted flare tip should be included.

In addition, this section should better define the combustion zone and ensure consistency of its use throughout the body of the QAPP. Reference is made to the location of the sampling probe and the logic for its location. A more definitive discussion is needed of the parameter choices to be used along with justification for the selection of the parameters that define the location. Furthermore, the remote sensing instruments should be located and directed such that the sampling probe does not interfere with their ability to take accurate remote measurements. The probe needs to be placed in a manner that will not interfere with the aiming point used for the remote sensing equipment.

The method of steam injection should be defined for different flare tip configurations and manufacturers. Steam injection can range from simple high-pressure nozzles around the perimeter of the flare tip, to multi-level exterior nozzles, internal steam addition, coanda effect, and in many variations. The technology of steam addition is clearly important, but discussion of how these details of several design configurations affect the definition of combustion zone BTU/SCF is not addressed in the QAPP. Will these design variations affect this QAPP's purpose, and objectives to determine the relationship between flare design, operation, and DRE?

Finally, this section devotes a half page of text describing the sampling probes depicted in Appendices J1 and J2. To provide much needed clarity, the drawings provided in Appendices J1 and J2 should include extensive labeling and detail so that the discussion in this section can be clearly related to the pictures of the sampling probes. Further, how the sampling systems that route the gases to the analytical

equipment is not described. Please provide a description of how this will occur. This concern is also addressed in our comments on Sections B2.1.2 and B 2.1.1 below.

Response: Paragraph 1: UT Austin has a QMP but has not required any of the sub-contractors to provide one.

Paragraph 2: Please also refer to the TCEQ response to this comment. **A flare tip with center and upper steam tip was selected due to being a very popular steam tip design in industry. Based on available data, a 36 inch tip is considered a medium-large diameter tip. TCEQ understands this design of this type of tip (center and upper steam) does not vary much between manufacturers. The 24 inch air assisted tip was selected as being an average medium-large capacity tip.**

The QAPP does contain Appendix L1. UT Austin supplied an Appendix L1 in the copy submitted to the TCEQ. It must have been inadvertently lost in posting to the Internet. Please see copy of Appendix L1 attached to this series of responses.

Paragraph 3: The goal of the extractive sampling is to measure emissions post the combustion zone to ensure that all combustion due to the flare process has been accounted for in calculation of the DRE. So the emphasis is to ensure that sampling occurs at a location after the point where all reactions due to the flare combustion process have ceased. Section B1 describes in detail why the parameters that will be used in defining this location were chosen, and why these parameters help position the extractive sampling device.

The remote sensing technologies will have an unobstructed view of the flare tips and will not be obstructed by the extractive sampling device from making measurements of the flared gas.

Paragraph 4: These are important and valid points in considering how steam injection influences flare performance but they are beyond the scope and budget of this project. A future flare research project may wish to focus on this topic.

Paragraph 5: As suggested, UT Austin will add labeling detail to the drawings in Appendices J1 and J2 to facilitate understanding of the related narrative.

Appendix C depicts how the gases are routed to the analytical equipment. This comment is similar to the comment on Section B2.1.2. The response is included in the response to that section.

Section B1.3 Measurement Validation

Comment: *We are concerned that the Aerodyne meteorological data validation process will use the John Zink Co. and Tulsa airport met data for comparison, but in the case of differences in the data, the Aerodyne met data will be used and the conflicting data ignored. This seems contrary to a true measurement validation process. Also, the QAPP does not describe how the meteorological data, in particular the wind speed data and crosswind effects will be used and analyzed as the study proceeds. The QAPP also does not describe how the meteorological data will be used to disqualify test results.*

Response: UT Austin will provide clarification to the section related to the meteorology measurements and data validation process. Only the Zink and Aerodyne meteorological data will be applicable due to the microenvironments in vicinity of the flares. Of the two, Aerodyne's meteorological data, which is of known quality, will be the project standard. Meteorology data will not be used to disqualify test results. The following detail is provided for information purposes in this response and will be incorporated into the next revision of the QAPP.

During the John Zink flare tests Aerodyne Research, Inc (ARI) will be using the Davis Anemometer #7911 for wind speed and direction measurements. Wind speed is derived using the following formula:

$V = P(2.25/T)$, where

V = Wind Speed in mph

T = Sample speed in seconds

P = Number of pulses in the sample period

ARI will be using a sample speed of 1 second; therefore the simplified formula is,

$V = P(2.25)$

Every rotation of the anemometer generates one pulse, and the number of pulses is recorded digitally, ARI will then take that number and multiply it by 2.25 to obtain the wind speed. In conjunction with that, Davis provides a wind speed look up table, which ARI will refer to once ARI calculates a wind speed. This table provides the true wind speed and accounts for any offset error which may be present.

Wind direction is calibrated by manually. An operator will adjust the anemometer so that the dead-band of the sweep is pointing directly at the flare. ARI then will find true north and record that digital output. The #7911 anemometer has a 10 bit digital output. A full-scale output would equal 1024 bits. Therefore,

$$(360^{\circ})/(1024 \text{ bits}) = 0.3516 \text{ degrees/bit}$$

ARI will then take the given output from the anemometer and multiply it by 0.3516 to obtain the direction in degrees.

Furthermore, ARI has designed the electronics associated with the anemometer to record Relative Humidity (RH) as well as ambient Temperature (T). This is done using the Sensirion SHT1x RH and T sensor. ARI will use the high resolution mode of this device; therefore, ARI will use the following RH formula:

$$RH_{\text{Linear}} (\%) = -2.0468 + (0.0367 * SO_{\text{RH}}) + (-1.5955e-6 * SO_{\text{RH}})^2$$

Where, SO_{RH} is the RH output from the Sensirion SHT1x.

For temperatures much different than 25°C the RH sensor requires temperature compensation. This is done with the following formula:

$$RH_{\text{True}} = (T_{\text{C}} - 25) * (0.01008 * SO_{\text{RH}}) + RH_{\text{Linear}}$$

The output for temperature from the SHT1x is much more linear. To calculate the true temperature from this device we will use the following formula:

$$T = -39.69 * SO_{\text{T}}$$

Where SO_{T} is the digital output from the SHT1x.

Section B2 Sampling Methods Requirements

Section B2.1.1

Comment: *John Zink Company, Inc. indicates the measurements it will make to ensure the flare system is producing the predetermined flare conditions, but there is no mention of whether John Zink is going to analyze the fuel. It appears that the only mechanism to assess fuel composition is by calculation from the flow instruments. John Zink Company, Inc. should include a provision for collecting and analyzing a sample of the waste gas mixture. Prior experience with flare testing indicates that sole reliance on flow control devices and flowmeters on the individual gas streams may not provide an accurate accounting of the waste gas mixture.*

Response: TRC will be analyzing the waste gas composition for this project.

Section B2.1.2

Comment: *Aerodyne Research Inc. does not describe how its sampling equipment will be connected to the sample probe depicted in Appendices J1 and J2. It is also not*

clear whether and how any sample conditioning will take place. We are concerned about how sample conditioning will be handled due to cooling, how that may degrade the sample, and how the high sample line temperatures will be handled. Also, Table B2.A in this section needs to provide for each instrument to be used by Aerodyne the specific manufacturer, model number and sample location. Furthermore, the list of instruments does not include the equipment Aerodyne will use to collect meteorological data. These should be added to the table along with the manufacturer, model, and location information.

Response: See Appendix C in addition to this response.

There will be three sample lines used in this test. The plume sampler will draw and mix a large volume of air and two of the sample points will draw sample from this mixed flow. As the test matrix proceeds, a third probe, which does not ‘premix’ portions of the plume may be sampled in order to address the scale of combustion dynamics.

Sample Locations

Sample probe after mixing, *non dilution tip*

Sample probe after mixing, *dilution tip*

Sample probe before mixing, *dilution tip*

The non-dilution probe tip refers to whole sample being drawn through a temperature-controlled manifold to the instrument packages. The temperature will be kept high to prevent combustion water or added steam from condensing.

The dilution tip probes add nitrogen within 1 mm of the sample entrainment in the probe. The dilution ratio will be adjusted to keep the sum of the measured CO and CO₂ less than 2000 ppm by volume. Based on the anticipated C:H ratio in the fuel stocks for this test, this will keep the level of H₂O below the condensation point for the anticipated ambient temperatures. *The level of dilution by nitrogen will not affect the calculated DRE based on carbon mass balance.* The dilution ratio will be measured by the difference between the total flow (in-line venturi flow meter) and the added nitrogen. The dilution level estimates will be corroborated by flow calculated dilution factor to the effect of dilution on stable atmospheric species such as CO₂ and CH₄.

Past experience with the dilution system suggests it is an effective way to arrest trace combustion and preserve the hydrocarbon speciation (particularly oxygenated compounds such as formaldehyde) through the sample lines.

The equipment manufacturer and model number will be added to Table B2.4 and the equipment Aerodyne will use to make meteorology measurements will be incorporated in the next revision of the QAPP.

Section B2.1.4

Comment: *Industrial Monitor and Control Corporation (IMACC) references Appendix B 10 for its PFTIR and AFTIR measurement procedures. Appendix B 10 does not describe how the FTIR instruments will be aimed relative to the sample probe. Will measurements be made at multiple points in the flare plume to determine that the flare plume is or is not homogeneous? In addition, in the 2003 TCEQ work evaluating the PFTIR instrument, the need for an additional wave length detector was identified. How is this issue to be handled, given, to our knowledge, that such a detector was not developed?*

Response: As explained in Section B1.1, should the carbon fraction method and other observations/data determine an inhomogeneous flare plume, multiple points in the flare plume will be sampled. It is up to IMACC to determine which detector they believe will provide the best measurements of flare emissions given the composition of the waste gas that will be used for this flare study.

Sec. B2.2.1

Comment: *It is not clear how the TRC equipment will be connected to the sample probe depicted in Appendices J1 and J2. It is also not clear whether and how any sample conditioning will take place. We are concerned about how sample conditioning will be handled due to cooling, how that might degrade the sample, and how the high sample line temperatures will be handled. Furthermore, the QAPP states that TRC will use a modified EPA Method 19 (in Appendix B2) to calculate mass emissions rates. The cover page to Appendix B2 should explain the differences between EPA Method 19 and the TRC modified method.*

Response: Please refer to the diagram contained in Appendix C for the visual aid showing the heated sample transfer line that begins in the body of the flare flue gas sampling device, traverses to and terminates at the TRC sampling van. Appendixes J1 & J2 show the access port for the TRC sampling probe on the flare flue gas sampling device, as a round cover on the back 1/3rd of the sampling device body just before the external fins.

The transfer line will be positioned through this cover into the middle of the 12" sampling device where the sample will be drawn. This transfer line is heated to 110° C to minimize water from condensing prior to the gas chromatographic analysis. The management of water improves the accuracy and reproducibility of the analysis.

The difference between EPA Method 19 and the TRC modified method will be explained in Appendix B2 (cover page) in the next revision to this QAPP.

Section B2.3 Corrective Action

Comment: *The QAPP fails to describe the priority ranking system for instrument failures that would postpone or cancel the testing until a correction is implemented. In addition, the last sentence dealing with what happens if one of the remote sensing systems fails, stands in stark contrast to the uses of data listed in A5.3 and the data quality objectives stated in section A7.1. The QAPP should be clear on the weight being given to the remote sensing technologies employed in the study related to postponement decisions.*

Response: The priority and weight of the remote sensing technologies with respect to obtaining data on flare performance will be clarified in this section to make it consistent with Sections A5.3 and A7.1. Flare testing will not be terminated if a remote sensing technology is unable to continue making measurements representative of its capabilities. The following section will be added to the next revision of the QAPP to address equipment failure.

B2.4 Equipment Failure

In the event that one of Aerodyne's, Zink's, TRC's, or LSI's measurement instruments fail the UT project manager will consult with the project sponsor to determine whether to continue the flare test series, postpone, or cancel the testing until a correction can be implemented.

Section B3 Sample Handling and Custody

Comment: *This section should provide a sample handling procedure and an appropriate chain of custody form to be used if samples are collected for off-site analysis.*

Response: The COC's and sample handling procedures that will be used for collection of canister samples will be incorporated into the QAPP.

Sections B5 – Quality Control (QC), B6 – Instrument/Equipment Testing, Inspection, and Maintenance Requirements, and B7 – Instrument/Equipment Calibration and Frequency Quality Control (QC)

Comment: *These sections do not adequately describe the process to be followed when problems arise. Also, there are numerous references to Appendix H. Please see the comments on Appendix H that are included later in this document.*

Response: For problems with equipment failure, please refer to Section B2.3. This section will be modified to address equipment failure that prevents further operation of critical measurement equipment during the remainder of the test series. Issues related to problems with the Test Plan are addressed in Appendix E.

Section B5.1

Comment: *John Zink Company, Inc. (QC) describes the steps to be taken to achieve and quantify the specified test conditions. We believe that there should also be a qualitative step that ensures a stable flame is present for each specified test condition.*

Further, a discussion is needed on how a stable flame is to be defined. It appears that the determination of stability will be done by visual observation of the flame which depends on the luminosity of the flame and may be subjective. Flare tip design affects the stability curve. Flames near the stability limit are very sensitive to perturbations, and, when perturbed, can produce high emissions of unburned material. Flare efficiency depends on flame stability, which in turn depends on flare head design and flare gas exit velocity, heating value, and composition. Stable flare flames and high combustion and destruction efficiencies are attained when the flares are operated within operating envelopes specific to each flare head and gas mixture tested. Operation beyond the edge of the operating envelope results in rapid flame de-stabilization and a decrease in combustion and destruction efficiencies. There are practically as many different combinations of these variables as there are industrial flares.

Response: Please also refer to the TCEQ response to this comment. **Due to the low velocity of the waste gas, the flame is anticipated to be stable during the smoke point test. The flame may become unstable as the ratio of assist is added to the tip.**

A stable flame may not be achieved for test conditions proposed. If so, that will be noted for that test condition and the procedure in Appendix E will be employed to determine how that test condition will be modified to achieve beneficial data at or near the same operating point. Some of the operating points will be at or near the edge of the envelope of stable operation, one of the types of data sought by this study. A qualitative step will be created and included in Protocol 5 of Appendix N of the next revision that defines a stable flame.

Section B10.5 IMACC Data Management

Comment: *IMACC uses certain analytical algorithms that have not been independently verified. Considering the amount of data to be collected using both the active and passive FTIR instruments and the potential reliance on these data for the conclusions of the study, these algorithms must be independently verified and this verification included in the QAPP. In each of the previous TCEQ studies, referenced above, there were questions raised concerning the algorithms.*

Response: UT Austin will not be relying on these data for its determination of flare emissions. UT Austin will be provided the IMACC's analytical algorithm prior to any testing. It will be required to use these same algorithms to process its data. Please refer to the IMACC algorithm policy contained in Appendix B10.

Section C1.2 Performance Evaluations

Comment: *The plan states that performance evaluations are not planned. Specifically, what is/was intended to be included in the performance evaluations? How are the critical aspects of the performance evaluations to be handled? How does the lack of performance evaluations affect the ability to achieve the project objectives stated in A7.1?*

Response: Performance evaluations are a quality control process in which the qualitative data generated in a measurement system are obtained independently and compared with routinely obtained data to evaluate the proficiency of the analyst or laboratory. (40 CFR Part 58, Appendix A)

The monetary impact on this project for independent assessment of all the measurements systems through performance evaluations is too large for the sponsor to incur. With the use of the routine zero and span quality control checks, The University of Texas at Austin feels that the data generated in this project will be of sufficient quality to be used for its intended purpose without performing performance evaluations.

Appendix A1 Satellite Photo of Flare Operation Facility Area

Comment: *The QAPP should provide a narrative discussion of the satellite photo. Also, the locations of the boiler and the propylene storage facilities need to be shown on the satellite photo.*

Response: This suggestion will be incorporated in the next revision of the QAPP.

Appendix B TRC Modified EPA Method 3A (O₂ and CO₂)

Comment: *The description of the TRC Modified EPA Method 3A (O₂ and CO₂) should include how the TRC modified method differs from the EPA method. Also, the method description should describe how and where the TRC sample*

probe connects to the John Zink sample probes shown in Appendices J1 and J2.

Response: A description of the differences between the two methods will be included in the next revision. Please refer to Appendix C for a diagram depicting how the TRC probe connects to the John Zink sample probe.

Appendix B1 TRC Modified EPA Method 18 GC Analysis

Comment: *It appears that the Technical Review Panel's comments have not been addressed. We agree that these issues need to be addressed in the QAPP.*

Response: UT Austin believes that it did address the TRP's comments that it submitted to the TCEQ related to this item. Can you be more specific about what you believe has not be adequately addressed?

Appendix B2 TRC Modified EPA Method 19 Mass Emissions Calculations

Comment: *The QAPP appears to provide a discrepancy about who will conduct the fuel gas analysis. One portion of the QAPP indicates John Zink Company will analyze the fuel, yet this appendix provides the TRC method for collecting and analyzing the fuel. This discrepancy needs to be resolved.*

Response: John Zink is not referenced as the fuel gas analyzer. Only TRC is referenced as the fuel (waste) gas analyzing company.

Appendix B4 Aerodyne QC

Comment: *It appears that the Technical Review Panel's comments have not been addressed. We believe it is critical to the project that these issues be addressed in the QAPP. In addition, we believe a description of sample conditioning protocols should be included.*

Response: After a careful review of the references provided by Aerodyne in Appendix B, The University of Texas at Austin (UT Austin) has removed the Aerodyne references since these references are not project specific references. The references refer to completely different uses of the measurement equipment Aerodyne will be using to analyzing the flare flue gas.

UT Austin agrees with the reviewer's assertion that the methods provided by Aerodyne are generic in nature. The exact instrumentation that will be used on this project by Aerodyne is presented in Appendix G and Appendix H of the project QAPP. The implementation of these methods has not been applied in previous campaigns exactly as required by The Comprehensive Flare Study Project. Therefore, at this time, the generalized methods are appropriate definitions of the proposed field activities for this project.

The flare flue gas will be introduced into the Aerodyne measurement equipment, which is housed in the Aerodyne test trailer, through sample transfer lines. (Please see Appendix C1, C2 for a visual depiction of the sample line arrangement.) These transfer lines will begin in the center of the 12" flare flue gas sampling device (see Appendix J, J1, J2 for a visual depiction of the sampling device and transfer lines) and terminate inside the Aerodyne trailer for distribution of the collected sample to the measurement instruments in the trailer.

The Comprehensive Flare Study Project requires only one flare flue gas sampling device to conduct all of the tests approved by the project sponsor.

Appendix B7 John Zink Calculations

Comment: *In its calculation of flare tip exit velocity, John Zink appears to use actual temperature and pressures, whereas the EPA method requires use of temperature and pressure at standard conditions. This discrepancy should be resolved or at a minimum, the John Zink approach should be explained and justified.*

Response: This item has now been corrected and the correction will be reflected in the next revision of the QAPP.

Appendix B8 Aerodyne DRE

Comment: *It appears that the Technical Review Panel's comments have not been addressed. We believe it is critical to the project that these issues be addressed in the QAPP.*

Response: UT Austin believes their comments have been addressed. Please refer to page 2 of 4 in Appendix B8. An explanation of how the project is accounting for the ambient concentration of CO₂ is provided.

Appendix B10 IMACC Procedures

Comment: *We are very concerned with use of PFTIR. for reliable and accurate collection of flare plume data. These concerns are based on earlier studies conducted at John Zink for TCEQ by the University of Houston (UH) and URS Corporation (URS) in 2003-2004. Overall this appears to be a critical technology in that it may be able to measure flare efficiency real-time; however, it is critical that this technology be validated such that further use can be justified.*

The 2003 TCEQ blind test of a passive FTIR system at the John Zink facility by UH and URS left room for doubt about the accuracy of the technique. The remote sensing technique was not able to provide accurate measurement of the main combustion product (CO₂) or the trace hydrocarbon emissions that were the main target of the study. The causes for the inaccuracies were not well understood by the testers, but may be due to either the spectral reduction algorithms used to process the results or insufficient knowledge of the frequency of sky background and black body calibrations. The issue of sky radiance necessitates regular measurements of the sky background throughout all flare measurement series. Absolute calibrations require a more careful alignment of the black body source at short range to assure a full filling of the input aperture of the PFTIR telescope. It is not clear that all of these issues have been addressed, and we believe they are necessary to allow reliable and accurate plume data to be collected with passive FTIR.

The study also suggested that the Mercury Cadmium Telluride (MCT) detector that would be used for the field tests would have relatively low signal strength for propane (the fuel for the actual flare test) and total hydrocarbons (THC). One of the conclusions from the study was that future phases of the PFTIR flare test program should incorporate an Indium Antimonide (InSb) detector, in tandem with the MCT detector. This will provide the best possible results for the range of gas species that will need to be measured to provide quality flare emission data. The instrument description provided by IMACC in the QAPP does not specify which detector is being used.

In addition, the 2003 study results of the individual species concentration measurements demonstrated that there was significant uncertainty present, and the PFTIR was not able to achieve the desired level of accuracy of +50 percent for butane and propylene. We are concerned that if the level of accuracy has not been improved, then the PFTIR results will add little to the confidence of the measurements.

Response: As this comment seems to repeat concerns expressed in some of the previous comments (please see Comment and Response to Sections A4.11, A7.1 and B10.5) where UT Austin noted similar concerns and explained how UT Austin will be addressing these concerns in the study, no further response will be provided here.

Appendix E Test Plan Modification Process

Comment: *We believe that a test hold should be implemented when 80% of the budget has been expended. During the hold period, all data collected so far should be reviewed to determine the best use of funds for the remainder of the study. The test plan should then be modified accordingly.*

Response: UT Austin believe that a test of this nature should be evaluated daily. As such, the UT project team will evaluate daily progress and the efficacy of each days tests at the end of day and will make recommended changes to the project sponsor using this Appendix an any time during the test series.

Appendix H Measurement Data Quality Control Activities

Comment: *This appendix includes acceptance criteria or tolerances for each parameter/instrument; however, it does not include a description for under what circumstances a test must be stopped. Also, the acceptance criteria for the IMACC instruments is stated to be "CIE > 2". This algorithm needs to be defined.*

Response: In consultation with John Zink and the TCEQ, the UT Austin Project Team will monitor each test for safety and its intended outcome (performance data desired). These criteria will be the primary bases for considerations in terminating a test before it is completed.

Appendix J Flare Flue Gas Sampling Device Diagram

Comment: *The physical location of the Aerodyne and TRC plume sampling points and the location of the remote sensing aiming points should be described. The remote sensing aiming points and the sampling points need to be as close as possible, and the remote sensing aiming points should not be obstructed in any way by the physical sampling points. This needs to be clearly articulated in the text. Finally, Appendix I needs a narrative description on how the probe positioning (horizontal vs. vertical) will be handled and how the probe will be adjusted due to meteorology.*

Response: Please review Appendix B1 for the current description on positioning of the sampling device. UT Austin will develop an understanding of the meteorological phenomenon affecting the probe adjustment and describe the findings in the final project report.

Appendix N Flare Project Activity and Protocol Documents

Comment: *Section A6.1 – Project Overview includes a reference to "incipient smoke point" and states the definition for incipient smoke point is included in Appendix N. Appendix N should provide a justification for the somewhat arbitrary choice of "no visible emissions two flame lengths away from the flare tip". Is this the point where the flame's fuel radicals reach a limiting concentration and/or temperature which inhibits any further conversion, adding to overall inefficiency? Also, there appears to be inconsistency throughout the QAPP with exactly where sampling will occur in relation to this incipient smoke point. The sampling location (presumably one flame length), including the particular parameters (assumingly the temperature, oxygen level, and carbon dioxide concentration) that must be met, needs to be justified, clearly described, and used consistently throughout the QAPP (especially in Sections A6.1 and B1.1) so that all in situ and remote sensing technologies are directed at the same point. In particular, Appendix B 1 1 –IMACC Calibrations indicates that the PFTIR will be calibrated at 200 °C and focused at 1¹/₂ flame lengths.*

Response: The definition provided in Appendix N is the result of dialog between the UT Austin staff, John Zink staff, and Aerodyne staff. This purpose of this definition is to describe what the observation committee will be seeing when making the decision of the flare's condition. Any use of "concentration", "temperature" or "conversion" in this project's definition of the incipient smoke point would not be appropriate because one can not see "concentration", "temperature" or "conversion". The committee will be able to see if black particles are present and when water in the form of steam is not present.

The presumption of the flare flue gas sampling point for the in situ measurements being one flame length away from the flare stack is not correct. The flue gas sampling point for the flue gas sampling device will be determined by the CO₂, O₂ and temperature readings measured as described in Section B1.1 of the project QAPP. The flare flue gas sampling point for the remote sensing measurement companies may be different for each company as described in Appendix B10 and Appendix B12 of the project QAPP.

Therefore, the in situ and remote measurement companies will be sampling the flare flue gas independent of each other's requirements. This may not be the exact same location in the flare flue gas.

The University of Texas at Austin
Responses to
Jim Nunn Comments (Dated August 15, 2010) on the
Comprehensive Flare Study Project
Quality Assurance Project Plan (Rev. 0, Dated July 2010)

Page 1

3rd Paragraph

Comment: *The Leak Surveys, Inc. section of the Flare Test Plan dealing with infrared, normal video and still picture coverage calls for only one, fixed observation point at the John Zink test facility with an unstated number or types of cameras or lens focal lengths. I found that odd.*

Response: UT Austin will be using two sets of IR and video camera systems. These systems will be located perpendicular to each other to view the flare exhaust from two perpendicular directions.

4th Paragraph

Comment: Infrared video and normal video should be covered from at least four locations spread at approximately ninety degrees (90 deg) around the flare under observation for a number of reason addressed later in this email.

Response: Four locations for observation cameras of a flare test is not normal.

8th Paragraph

Comment: *Leak Surveys, Inc, Bud McCorkle and Joshua Furry on page 10 of the Flare Study Plan, appear to be the only two persons bearing responsibility for recording infrared and normal visual imagery of the flare plume and unburned hydrocarbons. They plan to use only one, fixed vantage point and an unknown number and type of cameras or lens focal lengths.*

Response: UT Austin is requiring LSI to provide two sets of IR and video camera systems to record the tests.

The University of Texas at Austin
Responses to
Zeeco Comments (Dated August 15, 2010) on the
Comprehensive Flare Study Project
Quality Assurance Project Plan (Rev. 0, Dated July 2010)

Scott Smith

Bullet 1

Comment: *I have a general concern about the influence of a pilot and the pilot heat release on the results. During the prior testing at JZ in the early 1980's, the pilot heat release was huge compared to the total heat release in the low BTU gas testing. We need to ensure pilot heat release is a known and documented testing point. If the steam tip has 8 times the flow capacity of the same gas at the same pressure and temperature, the number of pilots will need to be established in some manner relative to the flare tip capacity (fewer on the LHTS flare system)*

Response: The pilot gas flow is being measured continuously during all test by Zink and the LHV of the Tulsa Natural Gas will be calculated from GC analysis of the gas flow.

Bullet 2

Comment: *I need to research it more, but the definition of a stable flame and unstable flame do not seem to line up with what I remember from the CMA or EER testing?*

Response: Noted.

Bullet 3

Comment: *I am not sure what definition was used to determine the "rated" capacity of the steam and air assisted flare tips. My worry is that definition will be passed on and get incorporated into some EPA standard. I am not aware of any universally accepted definition of the "rated" capacity for a flare tip, as it is very dependent on the exit velocity, available pressure, gas temperatures and compositions, etc. We would recommend this be removed*

Response: The rating used for the steam and air assisted flares are based on the maximum permitted exit velocities allowed per 40CFR 60.18 (a)(4)(iii), which was determined to be 400 ft/sec for the steam-assisted flare and 217.4 ft/sec for the air-assisted flare both at standard conditions. Using the unobstructed free-flow areas for each tip (steam – 5.957 ft², air – 1.68 ft²), these maximum permitted exit velocities and 100% propylene as the vent gas, the maximum rated capacities of 937,000 lbs/hr and 144,000 lbs/hr

were calculated are used in this study for the steam- and air-assisted flare tips, respectively.

Bullet 4

Comment: *The flare tips have very different rated capacities, and very different gas side exit areas. If there is intended any direct correlation between the two tips being tested, we would strongly recommend to reduce the size of the steam assisted tip that is being used in the testing, from 36 inch down to 24 or 20 inch (match the gas exit area in the LHTS flare tip assembly)*

Response: No correlation between the two tips are intended.

Bullet 5

Comment: *Proper center steam control will be critical to ensuring proper and viable results.*

Response: We will know the flow rate of the center steam at all times and will be able to control/adjust it if needed.

Bullet 6

Comment: *Prior flare flame plume sampling used fast response RTD or Thermocouples to ensure the probe was located in the hottest or center of the plume. I see a TC is mounted on the sampling device, but do not see this being used relative to the sample collection device location?*

Response: A thermocouple will be used at both locations.

Bullet 7

Comment: *Physical measurements of the flare tip gas and air and steam flow areas should be made and witnessed to ensure proper velocity calculations.*

Response: Noted.

Bullet 8

Comment: *Will other burner or incinerator or heater testing in the facility be discontinued during the flare testing? Exhaust from other testing could have some impact on the samples being collected during the flare system testing.*

Response: This type of equipment at Zink is not in the direction of the prevailing winds expected. Your comment is noted should this equipment be in use and the wind happens to originate from the direction of this equipment.

Bullet 9

Comment: *Is there definitive information on the impact of soot on the measurement devices? Any negative impact or issues?*

Response: There are two reasons to be concerned about sampling soot. The first involves the corruption of the walls of the sampling line. The second involves the fouling of a specific gas phase instrument due to particulate contamination.

The influence of soot on sample lines:

Because the dilution probe is adding particle free nitrogen very near the inlet tip, the 30 – 120 nm soot particles that are anticipated are somewhat attenuated in their loading. When the flare will be operated in a condition that is extremely high in soot loading and not part of the test matrix, the amount of dilution flow can be increased to keep sample from entering the sample system. Furthermore, a gentle backflow will always be maintained in the sample line when it is not in use to remove semi-volatile components. Previous experience sampling from “sooty” sources suggests that a minor fraction of the medium length (C3-C8) hydrocarbons (present in those matrices) do convert their functional form via heterogenous chemistry. This is typically observed as a non-combustion source of formic and acetic acid. These compounds will be used as the bellweather metrics to deduce whether a sample line is corrupted by particulate loading. If the mass flux of either of these compounds results in 2 parts per billion in 20 liters per minute of sample flow (that is not associated with combustion tracers, CO and CO₂), the sample line will be changed for fresh tubing at the next opportunity.

The influence of soot on instrumentation:

Many of the instruments that will be used to characterize gaseous compounds will use particle filters to prevent the soot from entering the instrument. Some of the analytical equipment is not sensitive to soot but it will be filtered anyway. The quality assurance protocol requires changing these filters after each test.

Bullet 10

Comment: *Ratio of exit area between the air assisted and steam assisted flare tip do not align with the ratio of the “rated” flow capacities?*

Response: Due to maximum allowable exit velocities for 40CFR60.18 and the quantity of air required for complete combustion, air flares can not operate at comparable throughputs as steam flares of the same nominal diameter.

Bullet 11

Comment: *I am trying to understand how it can be assured the various measurement techniques being used are applicable to the same conditions in the plume? From prior testing, it seemed the position of the sample probe was relatively critical to getting good data. What definition or practice is being used to determine WAKE dominated or BUOYANCY dominated measurements? What measurement device / method will take the lead in determining the flare flame type, or proper position for measurement?*

Response: Please see Section B1.1.

Bullet 12

Comment: *How is the center steam flow controlled or varied during the testing? Are any tests conducted with the center steam turned off?*

Response: Flow control valves for the steam have been installed for this test. It is not anticipated that any tests will be conducted with the center steam turned off completely but that will be considered if necessary.

Bullet 13

Comment: *There is a drawing of a John Zink flue gas sampling device. I guess am quite surprised the flue gas sampling device was designed and constructed by JZ, as I would not have selected that company as having any expertise in the area of flue gas sampling and extraction. In the CMA testing, and EPA probe was used. Was there any third party check on the sampling device design? What is the calibration / certification procedure for the sampling device?*

Response: This device was designed as a collaborative effort between UT Austin, Aerodyne and Zink. All components except for the sampling probe were purchased and/or fabricated by Zink and assembled by Zink. The sampling probe is provided by Aerodyne, who has used this probe before for other combustion studies. The QAPP includes calibration procedures for this device in Appendix N and in Appendix H for the sampling probe and associated chemical analyzers and other instruments.

Bullet 14

Comment: *The piping and system supplying the flare gases to the air flare and steam flare seem to be small compared to the flare tip diameters. What is being used to ensure there is a uniform flow into the inlet of each of the flare tip assemblies?*

Response: After the vent gas enters the flare (near bottom), there is a diffuser (perforated plate) designed to distribute the flow across the flow area of the flare.

Doug Allen

Comment 1: *During the "Wake Dominated" data acquisition how will they know they are truly in the center of the exhaust plume?*

Response: Please see section B1.1

Comment 2: *The testing is being done on one size Steam Tip and one size Air Tip only. This will still leave a big open item in question, which is "does tip diameter have any effect on the DRD?"*

Response: This question is outside the scope of this study.

Comment 3: *When the fuel is changed between high LHV and low LHV the exit velocities being used are not the same. If the intent here is to determine the affect of steam and air assist on the minimum flow rates of a flare should this not be done by varying only one parameter at a time which is the LHV and not the LHV and the exit velocities.*

Response: The difference in the change in exit velocities is minor between the two cases. Additionally, there are other specifications imposed by the sponsor (e.g., ratio of natural gas to propylene) that also had to be met. Thereby causing us to arrive at the conditions you see.

Comment 4: *The JZ Steam Tip uses a different angle on the steam nozzles that us and probably others so does that affect the results and make them only good for JZ Tips?*

Response: It is understood that different tip designs and some features of different flare tips may limit the applicability of the study results to this two tip design only.

Comment 5: *We have no drawing of the JZ Air Tip to be used it seems to have been left out of Appendix L. I would think that the Air/Gas flow areas and geometric arrangement of the tip has a big impact on efficiency and there is probably no way to correlate the data from their tip to other manufacturer's tips or other styles of Air Tips such as internal tube type.*

Response: This Appendix was inadvertently left out when copied by the TCEQ. It is attached to this document.

Attachment: Appendix L1

