TCEQ Flare Study Technical Review Panel Comment Summary

Comments by Category

Project Scope and Design

Description	Status
Note that the flare study's Quality Assurance Project Plan (QAPP) was posted on the Texas Commission on Environmental Quality (TCEQ) Web site for public comment and was reviewed by the United States Environmental Protection Agency.	Completed
Provide diameter of flares tested in the Project Scope section.	Completed
Note expected destruction and removal efficiency (DRE) for flares combusting propylene is 99% per TCEQ.	Pending
Define "frequency" when used as a technical term.	Completed
Clarify ratio of propylene to natural gas in flare vent gas stream.	Completed
Clarify low heating value term in report by referring to actual heat content of vent gas streams (350 and 600 British thermal units per standard cubic foot).	Completed
Clarify steam-assist rates tested were at or above the minimum rates recommended by the manufacturer for the specific flare tip used during testing; quantify and document manufacturer's recommendations.	Completed
Add that industry representatives commented on these minimum flow rates and the manufacturer's minimum flow rates were augmented due to potential steam condensation issues.	Pending
Correct vent gas flow rates as percentage of design capacity flow rates for the air-assisted flare and explain that the vent gas flow rates were changed during testing.	Completed

Description	Status
If center steam was varied in any of the steam test conditions, make note of the variations in Table ES-1, Summary of Flare Test Plan.	Pending
State the total cost of the flare study.	Completed
Include a description of flare snuff point in report.	Completed
State that flare study observers requested additional measurements be performed substituting propane for propylene in the vent gas composition.	Pending
Include a list of the study observers in the final report.	Completed
Define carbon fraction.	Pending
State additional measurements were performed during each test series to better define DRE curves.	Completed
Provide more detail on sampling procedure verification.	Detailed in QAPP
Clarify how long before each test began Aerodyne would continuously sample the flare plume.	Pending
Clarify whether carbon dioxide concentrations in Section 3.0, Test Plan, are ambient or plume concentrations.	Pending
Explain why nitrogen was used to dilute the sample at the probe inlet.	Pending
For steam-assist test figures, designate which tests were performed with no center steam.	Pending
Clarify that during testing, John Zink could more easily make fine-tuned adjustments to vent gas flow rates than to steam assist rates.	Completed
When defining the term combustion zone gas net heating value, note that vent gas is the sum of both flare pilots and the waste stream combusted by the flare.	Pending
In equation ES-1, which defines DRE for a particular hydrocarbon species, the term X_{plume} should be defined as the concentration of the hydrocarbon species after combustion has been completed.	Pending
Should equation ES-1, which defines DRE for a particular hydrocarbon species, be defined in terms of mass instead of flow rate?	Pending

Preliminary Flare Test Results and Analysis Comments

Description	Status
Perform cross-correlation of species measured in flare plume to further support flare destruction and removal efficiency (DRE) calculations.	Pending scope analysis
Provide more emphasis on effect of center steam on flare efficiency.	Pending
Plot flare and ambient concentration data, perform a linear fit least squares analysis, and compare intercept values to ambient concentrations to further support DRE calculations.	Pending scope analysis
Provide more detailed quantification of hydrocarbon species present in flare plume.	Pending
Calculate DRE of methane.	Outside of scope
Add charts that illustrate the impact of vent gas heat content, assist-to-vent gas ratio, and flow rate on DRE.	Pending
Note that multiple DREs measured at a constant steam-to-vent gas ratio are likely related to the location of the steam assist.	Completed
Provide statistical analysis of impact of center steam on DRE.	Pending
Note minimum combustion zone gas net heating value content required to achieve propylene DRE of 99%.	Pending scope analysis
Note flares at the incipient smoke point can achieve 98 and 99% DRE and still be in compliance with 40 Code of Federal Regulations 60.18.	Pending
With regards to flare height, provide more analysis of how representative ambient meteorological conditions were for industrial flares with much greater heights.	Outside of scope
The combustion zone gas net heating value equation could be adjusted to determine the impact of upper versus center steam, but this would require computational fluid dynamics and combustion modeling.	Outside of scope
Combustion zone gas net heating value has the most significant impact on DRE and tracks assist-to-vent gas ratios. Emphasize in report.	Pending
Plot concentrations of products of incomplete combustion on a log scale as a function of DRE.	Pending scope analysis

Description	Status
Provide an example of how the theoretical stoichiometric air-to-fuel ratio was calculated.	Completed. Air-assisted flare DRE and combustion efficiency (CE) analysis focuses on air-assist tip exit velocity instead of theoretical air-to-fuel ratio.
Explain how the theoretical stoichiometric air-to-fuel ratio relates to flare DRE.	Completed. Air-assisted flare DRE and CE analysis focuses on air-assist tip exit velocity instead of theoretical air-to-fuel ratio.
Reword conclusion of steam-assisted flare test section, which implies that propylene is easier to convert into carbon dioxide than methane.	Completed
In Figure 7-1, which depicts the sample collector data for carbon dioxide, carbon monoxide, and propylene during two air-assisted flare test runs, a chart depicting the air assist fan rate would be useful.	Pending
Explain why carbon dioxide concentrations in Figure 7-1, which depicts the sample collector data for carbon dioxide, carbon monoxide, and propylene during two air-assisted flare test runs, are similar for the two test conditions.	Completed
Plot the concentration data presented in Figure 7-1, which depicts the sample collector data for carbon dioxide, carbon monoxide, and propylene during two air-assisted flare test runs, in an Excel chart for comparison purposes.	Pending
Provide explanation of multiple assumed flare DREs (i.e., 98 and 99% DRE) used in report.	Pending
Plot DRE for components of natural gas as well as propylene.	Pending scope analysis

Description	Status
In discussion of the impact of center steam, can the argument be made that the lower DRE results from center steam diluting the combustion zone gas while upper steam entrains oxygen?	Pending
Define equation ES-2, which defines combustion efficiency, in terms of carbon from complete combustion divided by the total amount of carbon-containing species present.	Pending
Clarify that all other conditions are held constant while one condition varies in Table ES-1, which summarizes the flare study test plan.	Pending
When the report refers to steam assist rates, the total steam-to-vent gas ratio should also be noted.	Pending

Comparison of Conventional Flare Emissions Estimates and Measured Flare Emissions Comments

Description	Status
Provide additional data (example: steam-to-vent gas ratios) in table ES-4, which compares conventional flare emissions estimates to actual flare measurements.	Pending
Provide more substantive data in conclusions section when discussing comparison of conventional flare emissions estimates to actual flare measurements.	Pending
Explain in detail why there are differences noted between conventional flare emissions estimates and actual flare measurements (e.g., differences are due to combustion chemistry or other factors).	Pending

Remote Sensing Measurements Comments

Description	Status
Perform analysis of the deviation between the extractive sampling and passive Fourier transform infrared (PFTIR) spectrometer methods and the operating conditions, to identify any systematic dependence.	Pending
Perform a comparative analysis of potential sources of PFTIR inefficiency.	Pending
The last paragraph on page 91 (stating that the Telops air flare data measurements contained too little data to perform statistical analysis) should be removed.	Completed

Description	Status
Calculate and provide error bars for both the extractive measurements and PFTIR values for CE, propene DRE, propane DRE.	Pending
Provide estimated timeframe for inclusion of Telops data in report.	Pending
Note that when plotting passive and active Fourier transform infrared (FTIR) combustion efficiency measurements for the steam-assisted flare tests in Figures 8-3 to 8-6, the values on the x-axis are ranked and have no relationship to one another.	Pending
Explain how the passive and active FTIR spectrometers work.	Pending
Explain the limitations of the passive and active FTIR spectrometers. Include an analysis of: • how radial variations in temperature and concentration affect performance; • the impact of the flare plume region in which measurements occur (i.e., emissions form in the combustion reaction (hot) portion of the plume, but absorption measurements of these emissions occur in the cooler portion of the flare plume where combustion reactions have ceased); • how the infrared portion of the spectrum is deconvoluted; and • whether the potential exists to correlate a visual or infrared image of a flare plume with flare CE or DRE.	Pending scope analysis

Preliminary Conclusions Comments

Description	Status
Perform more analysis of implications of flare measurements, e.g., potential impact on flare operations.	Outside of scope
Add combustion zone gas net heating value analysis to the conclusions.	Pending scope analysis
From the air assist flare test measurements and data presented in figures ES-11a and ES-11b, can the conclusion be made that vent gas flow rates impact flare DRE significantly?	Pending
Provide more substantive data in conclusions section when discussing comparison of conventional flare emissions estimates to actual flare measurements.	Pending
From the steam assist flare test measurements and data presented in figures ES-13a and ES-13b, can the conclusion be made that center steam assist rates impact flare DRE significantly?	Pending

Wind Effects

Description	Status
Calculate momentum flux ratio to standardize analysis of wind effect on flare DRE.	Pending
Provide information on how representative wind speeds were of ambient conditions on Texas Gulf coast.	Pending scope analysis
Provide more information and analysis of wind speed relationship to DRE.	Pending; will be in form of momentum flux ratio calculations.
Evaluation of wind effects during over-assist conditions may not be relevant since the relative impact of each has not been quantified.	Pending; analysis of impact will be in form of momentum flux ratio calculations.
Note that wind speeds will generally increase logarithmically with flare height.	Pending

Editorial Comments

Description	Status
Reduce the length of the Executive Summary.	Completed
Standardize propene versus propylene references.	Completed
When chart data are re-plotted with a change of scale (e.g., Fig. 5-15 from Fig. 5-14) then reference should be made in the caption to the original figure.	Pending
Inconsistent TCEQ project tracking numbers used in report.	Completed
Remove “comprehensive” from title of study.	Completed
Report does not meet TCEQ accessibility requirements.	Pending
Use term “vent gas” throughout report to standardize references to waste gas stream combusted by flare.	Completed

Description	Status
Standardize the acronym for steam-to-vent gas ratio in “Summary of Flare Test Results” section.	Completed
Present comparison of remote sensing and extractive test results in plain language.	Pending
Avoid references to “low” lower heating value vent gas.	Pending
Standardize references to test series and test runs; designate extra tests performed differently.	Pending
All figures in the report need to stand alone. Add captions that define test conditions for all figures.	Pending
Correct first person references in the text.	Completed
Various minor editorial comments.	Pending