

## **Appendix L**

### **Technical Justification for 99% Flare Destruction Efficiency**

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## TECHNICAL JUSTIFICATION FOR 99% FLARE EFFICIENCY

This appendix provides technical justification for the use of 99% destruction efficiency for ethylene and propylene combusted in flares meeting the specifications of 40 CFR §60.18. Rules in TCEQ Chapter 115, Subchapter H, Division 1 require calculation of highly-reactive volatile organic compound (HRVOC) emissions from flares using continuous monitoring data for the flare inlet assuming a 99% destruction efficiency for ethylene and propylene. The use of 99% destruction efficiency for these compounds is consistent with long-standing guidance from the TCEQ Air Permits Division.

The use of a 99% destruction efficiency for ethylene and propylene in a flare meeting the requirements of 40 CFR §60.18 is based on a limited amount of data from EPA flare studies conducted in the early 1980's. The data shows that the combustion efficiency of a flare under these conditions, with some unexplained exceptions, is generally greater than 99%. The combustion efficiency is a measure of the complete combustion of hydrocarbons to carbon dioxide and water. The formation of carbon monoxide decreases the combustion efficiency. The hydrocarbon destruction efficiency is thus higher than the combustion efficiency.

The information in EPA's Compilation of Air Pollutant Emission Factors (AP-42), Section 13.5, Industrial Flares, is based on the same flare study data. The emission factor for total hydrocarbons is 0.14 pound per million Btu. The compound burned was crude propylene with a heating value of less than 20,000 Btu per pound. On this basis, the calculated hydrocarbon (HC) emissions would be as follows:

$$(20,000 \text{ Btu/pound HC})(0.14 \text{ lb HC}/1,000,000 \text{ Btu}) = 0.003 \text{ pounds of HC emitted per pound burned}$$

The corresponding efficiency would be  $(1 - 0.003) \times 100 = 0.997 \times 100 = 99.7\%$

Extrapolation of the flare test results to a wide variety of compounds must be done with caution, because some compounds are more easily destroyed by combustion than others. The test results in the study cited above are based on destruction of propylene; thus, the use of 99% destruction efficiency for propylene requires no extrapolation and can be justified based on actual test data. Screening tests conducted in the early 1980's (EPA-600/2-85-106) showed destruction efficiencies greater than 99% for ethylene, comparable to the efficiency for propane and propylene. Thus, the use of 99% destruction efficiency for ethylene is supported by test data and requires no extrapolation.

The HRVOC rules require that heating value and exit velocity of flares be monitored continuously to confirm that the flares are operated in continuous compliance with the heating value and velocity specifications of 40 CFR §60.18. With these added assurances that the flares are operated properly, the assumption of 99% destruction efficiency for ethylene and propylene is supported at this time by the available data and EPA precedent.

The commission sponsored preliminary studies of a pilot test method, using a passive Fourier transform infrared spectrophotometer, for the determination of actual flare destruction efficiency. The technology is not ready for commercial use, but the commission will continue to follow technological advances in this area and will reevaluate use of the assumed destruction efficiency in the future if reliable data indicate a need to do so.