Natural Gas Compressor Engine Survey and Engine NO_x Emissions at Gas Production Facilities

FINAL REPORT

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EXECUTIVE SUMMARY

The objective of this study was to collect the technical information required by the Texas Commission on Environmental Quality (TCEQ) to estimate the distribution of compressor engines associated with natural gas wells in the eastern portion of Texas. This study is the first TCEQ effort to conduct a detailed survey of small compressor engines in this region; currently, there are no TCEQ rules or programs that inventory small compressor engines. The study area included 110 counties bisected by, and east of, Texas Interstate Highways 35 and 37 (IH-35 & 37).

The study consisted of 3 phases. The first phase included a field survey of 64 compressor engines selected from the three major gas producing districts in the study area. This field survey collected information on engine types, sizes and operating characteristics such as loads and schedules; as well as collecting information on site conditions. The second phase of the study involved collecting detailed information from the databases of the major compressor leasing companies who provide a majority of the compressor engines used in the study area. The information collected from the leasing companies included detailed engine population distributions by engine size, type and model. A database of almost 1300 leased compressor engines was acquired from the leasing companies. In the third phase of the study, the data collected from the field survey and from the leasing company survey were combined with the emission factor information in *AP-42* to develop an emission inventory of criteria pollutant emissions for compressor engines used in the eastern region of Texas for the years of 1999, 2002, 2007 and 2010.

Some of the findings of this study include:

1. The sizes of gas field compressor engines range from 25 to 1500 hp, with approximately 40% of the gas being compressed with engines smaller than 500 hp.
2. Gas field compressor engines are operated continuously through the year at constant loads. The average load on a compressor engine is 40%.
3. In the initial year of operation, most wells do not require compression. After the first year, almost all gas is compressed using reciprocating engines. Generally these engines are fueled with raw natural gas from the field, but many engines are fueled with treated natural gas. A very few gas compressors are driven with electric motors.
4. A majority of the compressor engines in the study area are leased. The current trend is for this fraction to increase.
5. The annual emissions from gas field compressor engines < 500 hp in the study area are listed in the following table. Overall, these emissions from small engines are additional to the point source emissions from natural gas operations. However, it is possible that an emission source included in the totals below is also reported in the point source inventory, if the site was required to report emissions for reasons other than the small engine.

Pollutant	Emissions in Designated Inventory Year (ton/yr)			
	1999	2002	2007	2010
CO	21,796	23,354	23,113	22,569
NO_x	19,561	20,949	20,786	20,298
VOC	573	613	610	596
$PM_{2.5}$	192	202	202	197
SO_2	6.4	6.6	6.6	6.5

6. The estimated uncertainty of the resulting inventory at the individual county level is 128%. This uncertainty is primarily attributable to the large uncertainty associated with the emission factors used in this study. It was also influenced significantly by the uncertainty in the distribution of engine types.

Recommendations for Further Study

The large uncertainty associated with the current study is largely a product of aggregating more than 50 engine types into only 3 categories and using the average emission factor for so many varied engines within each category. However, this approach is a necessary simplification since *AP-42* emission factors are only available for 3 engine types. This report identifies 10 engine models from 3 manufacturers that comprise 52% of the engine population in the study area. One means to significantly increase the accuracy of the compressor engine inventory is to conduct the analysis at the engine model level. This alternative approach might establish 13 engine groups: one for each of the 10 most common engine models and the 3 generic engine groups identified in *AP-42*. As an alternative, there may be several new engine groups that would address the remaining engine models better than the *AP-42* groups.

A key component of this alternative approach would be to collect specific emission information and develop revised emission factors for each of the 13 or more engine models and groups determined to be significant. Many western states in the Western Regional Air Program (WRAP) have also been addressing these same emission sources and may have collected emission information on the same engine models. Another source of emission information would always be the engine manufacturers. However, the manufacturer test results may reflect ideal engine conditions as opposed to typical engine conditions in the gas fields.

Another component of this alternative approach is the collection of accurate information on engine model distributions for all 110 counties in the study area, from the compressor engine leasing companies. Although this will involve collecting sensitive business information, with sufficient assurances from TCEQ as to the protection of their information, the leasing company managers would likely share this information.

The county-level uncertainty of the resulting compressor engine inventory that is conducted at the engine model level might be reduced from 128% to approximately 35 to 40%.