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A Caterpillar Company

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To: EPA Office of Air Quality Planning and Standards
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From: Anthony Pocengal
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Re: Technical Data and Information for the EPA White Paper on Oil and Natural Gas Sector Compressors

Solar Turbines Incorporated (Solar) appreciates the opportunity to provide comments on the U.S. Environmental Protection Agency's (EPA's) white paper on VOC and methane emissions from compressors used in the Oil and Natural Gas industry (April 15, 2014).

Solar is a manufacturer of industrial combustion turbines (1590 – 30,000 hp) and centrifugal compressors used in the Oil and Natural Gas sector. Solar's fleet includes more than 14,000 combustion turbines in 98 countries. Our domestic fleet consists of approximately 7,000 combustion turbines including 2,000 compressor sets used in the Oil and Natural Gas industry.

Solar pioneered the concept of a turbine driven centrifugal gas compressor ('compressor set') with the introduction of the Saturn C16 compressor package in the early 1960's. During the ensuing years, the compressor product line has grown in keeping with the addition of new turbine models and increased application of turbine driven compressor sets in the market place.

GHG emissions from Solar's line of centrifugal compressors are potentially subject to Subpart W of the EPA's Greenhouse Gas (GHG) Reporting Program and the NSPS requirements of 40 CFR60, Subpart OOOO. Solar appreciates EPA's outreach to the industry for assistance with data compilation of compressor emissions.

Responses to the 12 questions posed at the conclusion of the white paper are included below. As Solar does not manufacture or market reciprocating compressors, comments are specified for centrifugal compressors only.

1. **Please comment on the national estimates of methane emissions and methane emission factors for vented compressor emissions presented in this paper. Please comment on the activity data and the methodologies used for calculating emission factors presented in this paper.**

   Response:
   The methane emissions factors presented in the various tables and sections of the document are difficult to compare as they are presented in different units of measurement. It would be more useful to present the emissions factors in consistent units such as in scfm as in Table 3-10, and to an extent, Table 3-8, if the scf per day are broken down further to scfm.

   The Dry Gas Seal vent emissions factor of 6 scfm per compressor in Table 3-10 is in line with manufacturer's estimates. In practice, observed vented emissions from dry seal systems from Solar compressors are less, in many cases less than 1 scfm. Breaking down the dry seal scf/day data presented in Table 3-8 to units of scfm (by dividing by 1440), the emissions factors for the processing, transmission, and storage sectors are 17.5, 22.4, and 22.2 scfm, respectively. These factors appear to have a high bias.

   Although the standard for new centrifugal compressors is dry seals, there are many compressors in the US which use wet seals and will continue to do so as the wet seal system has proven to be reliable over a long term. Solar has not offered new wet seal systems for its line of centrifugal compressors since 2004. Wet seal upgrade packages are available which enhance safety and operability on older systems.

   The historical design of Solar's wet seal system incorporated de-gas emissions recycling to the compressor suction, which minimizes de-gas emissions to the atmosphere. According to users of our equipment, emissions from our wet seal de-gas systems can be as much as 25 scfm when venting to atmosphere. However, it is likely that these flow data represent mostly engine air and that the actual methane emissions are much lower. This would be particularly true if the measurements were made from the lube oil tank vent. Published studies of wet seal de-gas emissions, as referenced in the white paper, show a large standard deviation in measured quantities. Many of the higher values may contain air mixed in with the methane. Before undertaking any further rule-making concerning wet seal emissions, existing wet seal emissions data should be reviewed to discover if the data is truly representative of methane emissions or if a substantial portion of air was measured. Also, EPA should consider this wide range of emissions (if found to be true) in any future potential rulemakings as a 95% reduction (per Subpart OOOO) may be significant in terms of overall quantity in some cases but not in others.

2. **Did this paper appropriately characterize the different studies and data sources that quantify vented emissions from compressors in the oil and gas sector?**

   Response:
   Similar to the above comments in (1), it would be more helpful for comparison purposes to have the activity data presented in consistent units such as in scfm.

3. **Did this paper capture the full range of technologies available to reduce vented emissions from reciprocating compressors and wet seal centrifugal compressors at oil and gas facilities? In particular, are there other options for reducing emissions at existing reciprocating or centrifugal compressors? For example, the EPA is aware of "low emissions packing" for reciprocating compressors but has no detailed information on this technology.**

   Response:
   Solar is not aware of any control techniques used for vented emissions from centrifugal compressor gas seal systems other than the two options discussed in the white paper. Solar cautions the use of flaring with gas seal vented emissions due to risk of the potential explosive hazard and back-flashing.

4. **Did this paper appropriately characterize the emissions reductions achievable from the emissions mitigation technologies discussed for reciprocating compressors and wet seal centrifugal compressors?**

   Response:
   Per the comments in (1) above, wet seal emissions data should be reviewed to determine if the measurements were of solely methane or also contained substantial quantities of air. Potential reductions could be revised downward if this is the case.

5. **Did this paper appropriately characterize the capital and operating costs for the technologies discussed for reduction of vented emissions from reciprocating compressors and wet seal centrifugal compressors?**

   Response:
   The capital cost of replacing a wet seal with a dry seal system is estimated as $400,000 in section 4.3.3. In Solar's experience, this value would be on the low range of cost. More realistic estimates would be in the range of $700,000 to $2.5M per compressor because in addition to the compressor seal replacement, package and controls changes can drive costs higher. Solar believes the combination of safety, operational flexibility, improved efficiency, and minimized emissions make dry seals are the preferred choice for both new & overhauled compressors. All of Solar's centrifugal compressors sold new since 2004 are equipped with dry gas seals, and Solar offers wet seal to dry seal retrofits for its entire line of gas compressors.

6. **If there are emissions mitigation options for reciprocating and centrifugal compressors that were not discussed in this paper, please comment on the pros and cons of those options. Please discuss the efficacy, cost and feasibly for both new and existing compressors.**

   Response:
   At this time, Solar is not aware of other emissions mitigation techniques which would be applicable to centrifugal compressor seal systems.

7. **Are there technical limitations that make the replacement of wet seals with dry seals impractical at certain existing centrifugal compressors?**

   Response:
   With respect to the wide variation in emissions from wet gas seal systems, as noted in (1) above, replacing a wet seal system with a dry seal system should not be viewed as a 'one size fits all' remedy for reducing emissions. Many wet seal systems that have been operating for decades may have methane emissions of less than 5 scfm. Also, historical measurements of wet seal emissions should be reviewed to ascertain whether or not the measured flows contained engine air. While technical limitations may also exist that limit the replacement of wet with dry seals in certain cases, the premise that replacing wet with dry reduces emissions may not be universally true.

8. **Are there technical reasons why an operator would use a wet seal centrifugal compressor without a gas recovery system?**

   Response:
   As it is possible that historical measurements of wet seal emissions may have contained engine air, actual methane emissions from some wet seal systems may be less than what is currently thought. Solar's wet seal system design included de-gas emissions recovery.

9. **Are there technical limitations that make the installation of gas capture systems at certain reciprocating compressors impractical?**

   Response:
   No comments provided.

10. **Please comment on the prevalence of the different emission mitigation options in the field.**

    Response:
    Solar's wet seal design incorporated de-gas emissions recycling so from the Solar perspective this mitigation option prevails. The white paper continuously mentions flaring as an option to reduce methane emissions from centrifugal compressors. In Solar's view (concurrent with many users of our equipment) flaring of compressor seal emissions can introduce inherently dangerous conditions with the potential for back-flashing and serious risk of explosion. Solar therefore discourages flaring for this reason although some customers have successfully implemented it.

11. **Given the substantial benefits of dry seal systems (e.g., lower emissions, less maintenance, and higher efficiency), are you aware of situations where new wet seal centrifugal compressors are being installed in the field? If so, are there specific applications that require wet seal compressors?**

Response:
Solar does not offer wet seal systems for use on new centrifugal compressors and we are not aware of specific applications that would require their exclusive use. All existing wet seal systems are not the same so the premise that dry seal systems have lower emissions is not universally true. A case by case analysis would be necessary.

To reiterate, historical wet seal emissions data should be reviewed to ascertain whether the measurements were of methane or a mixture of engine air and methane. This is particularly applicable when the measurements were made on gas flow from the lube oil tank.

12. **Are there ongoing or planned studies that will substantially improve the current understanding of vented VOC and methane emissions from reciprocating and centrifugal compressors and available techniques for increased product recovery and emissions reductions?**

Response:
Solar is not aware of any ongoing or proposed studies regarding control of emissions from centrifugal compressor seal systems. As mentioned above, further studies may be necessary to quantify methane in wet seal de-gas emissions measurements as many historical measurements may be skewed due to the presence of engine air.