

Solar Turbines

A Caterpillar Company

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To: California Air Resources Board
Oil and Gas Section
Sacramento, CA
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**Subj: Article 3: Greenhouse Gas Emission Standards for
Crude Oil and Natural Gas Facilities**

Ref: Solar Turbines Comments to EPA OAQPS Compressor Emissions White Paper (2014)

Solar Turbines Incorporated (Solar) appreciates the opportunity to provide comments on the Air Resources Board's (ARB) proposed Draft Regulation Proposal for Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities (Article 3).

Solar is a manufacturer of industrial combustion turbines (1,590-30,000 HP). 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 Gas industry. Several compressor set packages utilizing Solar turbines and gas compressors located in CA would be affected by the proposed rule.

In April 2014, EPA released for external peer review five technical white papers on potentially significant sources of emissions in the oil and gas sector. Solar supplied comments to EPA on the white paper concerning centrifugal compressor emissions. These comments are included as an enclosure as they are referenced in the present discussion of Article 3.

Solar's comments and recommendations concerning the proposed standards for Centrifugal Natural Gas Compressors listed in § 95213(f) of the proposed Article 3 are included below.

Please contact me at 858.505.8554 or Pocengal_Anthony@solarturbines.com for further information.

- ARB has stated the purpose of Article 3 (the rule) is to harmonize CA rules with existing EPA regulations such as the NSPS rule for the Oil and Natural Gas sector in 40 CFR 60, Subpart OOOO. However, the proposed ARB rule would affect existing equipment whereas Subpart OOOO only affects new, modified, or reconstructed equipment. While EPA is likely to propose further methane control regulations in 2015, according to its own communication with industry, EPA is not considering compulsory conversion of wet to dry seals on existing centrifugal compressors. ARB's proposed rule is not a 'harmonization' but rather a novel requirement which would only affect installations in CA, imposing higher costs and operating requirements than are required in the rest of the 49 states. ARB should adopt Subpart OOOO as written if the intent is truly to harmonize EPA and CA regulations.

- In a Public Workshop presentation from December 9, 2014, ARB cites costs of \$30,000-\$50,000 for conversion of a wet seal system to dry seals on centrifugal compressors, aimed at a potential reduction of 20,000 metric tonnes (MT) CO₂e statewide. Both of these figures should be re-examined:
 - The \$30,000-\$50,000 cost estimate is erroneous as a seal conversion requires more than simply changing out the seal mechanism itself. Realistic estimates are in the range of \$700,000 to \$2.5M per compressor because in addition to the seal replacement, necessary package and controls changes drive costs higher. Although Solar believes the combination of safety, operational flexibility, and improved efficiency make dry seals the preferred choice for both new & overhauled compressors, ARB should base any rule-making requiring wet to dry seal conversions using the real cost basis.

 - ARB should clarify the origin of the 20,000 MT CO₂e figure assigned to wet seal emissions from centrifugal compressors. According to ARB's 2007 Oil and Gas Industry Survey Results, an estimate of 7,517 MT CO₂e was calculated for the seal emissions from centrifugal compressors (Table 15-7). Note that the 7,517 MT was assigned to the whole class of centrifugal compressors including compressors with both wet and dry seal seals. There clearly is a gap in what the actual emissions of CO₂e may be from compressor wet seal systems in CA.

- ARB may be citing data from various historical studies, as referenced in EPA's white paper on Oil and Natural Gas Sector Compressors (2014), showing apparent high vented flow rates from wet seal compressors as compared to dry seal systems. It should be noted that EPA's intent for the white paper was to solicit comments on the quality and accuracy of the data obtained in the few research studies that had been conducted to date: EPA was not implying that the cited research was suitable as a basis for further regulatory actions. As Solar pointed out in comments to EPA in the enclosure, such data sets are not reliable as the majority of the volumetric flow from wet seal systems is engine air and not process gas. Similarly, ARB's 2007 Oil and Gas Industry Survey results erroneously relied on an assumption from an earlier API study in 2004 that methane represented 78.8% of compressor seal emissions. Solar contends that this percentage is not accurate for wet seal systems as the actual methane fraction is much lower, less than 10% with air as the balance. Further characterization of the hydrocarbon content of the measured volume is required in order to ascertain the quantity of process gas emitted from the seal system – this is a critical gap that has been overlooked in all of the previous research to date. Until such

studies are undertaken and reliable data is obtained on actual hydrocarbon content of the seal emissions, it would be haphazard to force retrofits without this crucial information. It is recommended that ARB consult with personnel from the EPA Natural Gas STAR program about potential opportunities to conduct such research in quantifying the hydrocarbon content of compressor seal emissions.

- As the gaseous volumes vented from wet seal systems are comprised mostly of air, it is not feasible to recycle the volume back into the fuel gas or into the pipeline as it will disrupt the combustion process of the turbine or decrease the quality of the pipeline gas. Recycling would require gas conditioning and pressurization systems which would add high costs and introduce parasitic loads, decreasing the efficiency of the turbine driver and leading to higher GHG emissions on an output basis. Such additional systems for recycling the vented gas cannot be justified with the current dearth of knowledge of actual seal emissions along with the likelihood that the actual hydrocarbon content of the vented gas is much less than generally thought.
- ARB's 2007 Oil and Gas Industry Survey identified 47 centrifugal compressors out of a total of 1071 statewide; with 911 of the reciprocating type (Table 15-1). Statewide compressor seal emissions (CO₂e – Table 15-7) from centrifugals were estimated at 2% (7,517 MT) of total gas compressor seal emissions, compared to 95% for reciprocating compressors (356,096 MT). Centrifugal seals are a comparatively insignificant source of CO₂e emissions in the state, despite the high bias in the assumed methane content in the seal emissions in the cited research studies. As noted above, the 2007 Survey did not further categorize centrifugal compressors by quantity of wet and dry seals. The contribution of CO₂e attributable to wet seals is therefore unknown. As the actual costs of a wet to dry seal conversion are, conservatively, about 20 times (\$50k vs \$1M) ARB's estimate, and the already small potential reductions (7,517 MT) are likely biased high, the proposed regulation requiring wet to dry seal conversions should be reconsidered.
- The current price of CO₂e in CA's AB32 Cap and Trade scheme is around \$13/MT. Assuming the 7,517 MTCO₂e from the 2007 ARB survey could be theoretically removed by only one wet to dry seal conversion at the relatively low price of \$1M, the associated cost effectiveness of this idealized case is around \$130 per MTCO₂e removed – ten times the current market value of CO₂e. Given that the 2007 Survey emissions estimate is inherently biased high, and that the proposed rule will cause, perhaps 20 wet to dry seal conversions (the actual number is unknown) at a low price of \$1M, the actual cost of the proposed regulation could be as high (or higher) than \$20M with the benefit of only a few thousand MTCO₂e possibly reduced. Even if we consider ARB's questionable figure of 20,000 MTCO₂e, we are still talking about potential actual costs in the range of \$1,000 per MTCO₂e removed and higher.

- The crucial unknowns of centrifugal compressor seal emissions prevent a fact-based rule-making at this time. Not only in CA but worldwide. ARB should reserve or rescind 95123(f) until further information can be obtained. At the absolute minimum, the total number of centrifugal compressors with wet seals in the state needs to be determined, followed up by studies undertaken at compressor stations with varied compressor models and sizes to determine the actual hydrocarbon content of wet seal vent emissions over the commercial equipment range. Simple volumetric sampling of wet seal vents, which comprises the known data sets to date, does not obtain useful results due to the small fraction of hydrocarbons present. Further chemical analysis of the sampled air streams is necessary.
- As previously stated, if ARB is intent on enacting a rule at this time to harmonize state requirements with EPA regulations, the rule should apply to new, modified, or reconstructed equipment as currently required by federal NSPS Subpart OOOO. This would effectively align CA rules with the EPA requirements for the rest of the US. Alternatively, wet to dry seal conversions could be suggested on a voluntary basis since the minimal reductions in CO₂e are only realized at a disproportionately high cost. Emissions reduced from any such voluntary conversions should be creditable under the AB32 Cap and Trade scheme to help recoup at least a fraction of the associated cost.